



**PROCEEDINGS OF THE
24TH ANNUAL TECHNICAL
CONFERENCE OF
IET SRI LANKA NETWORK
2017**

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24th ANNUAL TECHNICAL
CONFERENCE OF IET SRI LANKA
NETWORK
2017**

Saturday 26th August 2017
Hotel Galadari Colombo, Sri Lanka

Organized by



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IET SRI LANKA NETWORK
24th ANNUAL TECHNICAL CONFERENCE
SATURDAY 26th August 2017
HOTEL GALADARI, COLOMBO, SRI LANKA



Program

8:00 am to 8:30 am	Registration
8:30 am to 8:55 am	Lighting of Traditional Oil Lamp Welcome Address Eng. Dhammika Nanayakkara, Chairman IET Sri Lanka Network

Session A- Chair – Eng. Dr Chulanthe Kulasekara

8:55 am to 9:15 am	A1: Hardware Based Virus Scanning Acceleration Rangana De Silva, Iranga Navaratna, Malitha Kumarasiri, Hasindu Gamaarachch
9:15 am to 9:35 am	A2 : Object Dimension Extraction for Environment Mapping with Low-Cost Cameras Fused with Laser Ranging Sachini Ekanayake, Nilanga Thelasingha, Bavantha Udugama, G.M.R.I.Godaliyadda, M.P.B.Ekanayake, B.G.L.T. Samaranayake, J.V. Wijayakulasooriya
9:35 am to 9:55 am	A3: “iRisk”- A Software Based Solution to Effectively Manage Information Security Risks in Organizations Using ISO 27001 Approach K.D.Dinusha Chathurangi, J.A.D.C. Anuradha Jayakody

9:55 am to 10:15 am	A4: Detecting Trading Patterns via Markov Decision Processes for Market Surveillance Asoka Korale, Fuard Ahamed, Kaushalya Kularatnam, Liam Smith
10 15 am to 10:35 am	A5: Enhancing Scrum with DevOps Saliya Samarawickrama, Indika Perera
10:35 am to 10:55 am	A6: Effect Of Fuel Viscosity On Combustion Performance Of Heavy Fuel Oil (Hfo) Fired Gas Turbines Nuhuman Marikkar, Tharindu Jayath, Kithsiri Egodawatta, Thilina Ranasinghe, Dishan Samarasinghe, Chamila Ranasinghe, Shakthi Dissanayake, Matthieu Vierling, Sven Catrin, Maher Aboujaib, Michel Molière
10:55 am to 11:15 am	Refreshments

Session B- Chair – Eng. Dhammika Nanayakkara

11:15 am to 11:35 am	B1: A Framework for Macroeconomic Stress Testing on Credit Risk Management in Sri Lankan Banking Sector D.S.A.Kandawala, J.A.D.C. Anuradha Jayakody
11:35 am to 11:55 am	B2: A Study of the Factors Affecting Successful Lean & Six Sigma Implementation in Sri Lankan Manufacturing Industry Warnakulasooriya Janaka Fernando, Sewwandi Senanayake
11:55 am to 12:15 pm	B3: Audio Assistance for Vision Impaired Individual To Recognize Graphical Content on Print Disable Documents N.D.U.Gamage, S.M.N.K.B.Senanayake, K.W.C.Jayadewa, K.L.A.D.Udeshitha, J.A.D.C.Anuradha Jayakody

12:15 pm to 12.35 pm

B4: IoT Based Framework to Increase Student Success in the Classroom of Tertiary Education in Sri Lanka: The Smart Classroom

D.M.S.P.K Dawndasekare, Anuradha Jayakody

12.35 pm to 12:55 pm

B5: Efficient and Platform Independent CLI Tool for API Migration

A.Jayakody A.K.A. Perera G. L. A. K. N. Perera V. P. Wijayaweera
M. A. M. Asbar

12:55 pm to 1.30 pm

Announcement of the Best Paper –Panel of Judges

Awarding of Author Certificates

Vote of Thanks

Eng. Dr Lalith Liyanage- Conference Chairman

National Anthem

Message from the Chairman – IET Sri Lanka Network



The Institution of Engineering and Technology - IET, (formerly known as the Institution of Electrical Engineers - IEE), is the largest professional engineering society in Europe which has more than 160,000 members in 127 countries and offices in Europe, North America and Asia-Pacific. Having established as back as 1871, IET is one of the oldest engineering institutions in the world. The IET provides a global professional network to facilitate the exchange of knowledge and ideas and promotes the positive role of Science, Engineering and Technology to engineer a better world by inspiring, informing and influencing stakeholders. The IET Sri Lanka

Network, which was set up in January 1935, serves over 1100 strong membership who live in Sri Lanka and coordinates local activities. The IET local activities include seminars, workshops, industrial visits, international conference, annual research conference, and younger members

IET Sri Lanka Network organized an extremely successful international conference on Integration of Renewable Energy into the National Power Grid this month, and the conference was highly commended by more than 290 industry professionals who attended the event.

The Annual Technical Conference is organized by the IET Sri Lanka Network for the 24th consecutive time. Holding a successful technical conference, year after year, constitutes a hallmark of excellence for a professional society. While many factors contribute to the success of such a conference, a key factor is careful planning and organizing of events in advance. The purpose of the annual technical conference is to honour outstanding technical paper presentations and publication in the fields of Electrical, Electronics, Telecommunications, Civil, Mechanical, Automobile, Marine, Aeronautical, Manufacturing and Information Technology research and innovations and practice. This conference is open to professionals in industry and academia.

We are most grateful to the reviewers Prof Rohan Munasinghe from University of Moratuwa and Dr. Pradeep Abeygunawardhana from Sri Lanka Institute of Information Technology who have so diligently supported the paper review process. I would like to express our deepest appreciation to the panelists Professor KKYW Perera, Professor Rohan Lucas, and Dr. Narendra De Silva. I would like to specially thank the Committee Chairman, Dr. Lalith Liyanage and his team, the sessions Chairmen and the entire organizing committee. Annual conference would not have been success if not for the dedicated and commendable volunteer efforts by organizing committee.

I wish this year's Conference and presenters all the very best and look forward to seeing you at the Next annual Conference.

Eng. Dammika Nanayakkara,

BSc.Eng(Hon), MEng, CEng,(SL & UK), MIE(SL), MIEEE, FIET, IntPE(UK)

Hon Chairman

IET Sri Lanka Network.

Message from the Chairman – Conference Committee



On behalf of the Organizing committee I warmly welcome you to the 24th Annual Conference of the Institution of Engineering and Technology (IET), Sri Lanka Network. The objective of holding this conference is to encourage professionals in the fields of Electrical, Electronics, Telecommunication, Civil, Mechanical, Automobile, Marine, Aeronautical, Manufacturing and Information Engineering in Sri Lanka to meet with each other, exchange ideas and share information on research, development and innovations taking place in the country.

There are Eleven (11) high standard technical papers on various engineering aspects which have been presented and accepted by the referees are published in this edition of the Conference Proceedings of the IET Sri Lanka Network 2017.

I wish to express my sincere appreciation to all who attended the conference and to those who extended their kind support to organize the event successfully. I would like to express my deepest appreciation to the Panel of Judges, Professor KKYW Perera, Professor Rohan Lucas, and Dr. Narendra De Silva, the paper reviewers Prof Rohan Munasinghe from University of Moratuwa and Dr. Pradeep Abeygunawardhana from Sri Lanka Institute of Information Technology, and the sessions Chairmen, Dr. Chulantha Kulasekara and Eng. Dhammika Nanayakkara for their fullest support. The success of the Annual conference would not have been possible without the support of the organizing committee, i.e. Eng. Anuradha Jayakody, Eng. Dayan Gunawardena, Eng. Dasitha Liyanage, Eng. Vindya Wickramarachchi and Eng. Naleen Jayasooriya. Last but not Least, special thanks go to authors who have done extensive research, written papers and made presentations.

I wish you all a very successful conference and hope to see you all at the next year's conference.

Eng. Dr. Lalith Liyanage

PhD (Northumbria/UK), MBA (eGov, Moratuwa/SL), MSc (Comp St, Essex/UK),
MSc (ElecEng, USSR), BSc (ElecEng, USSR), PG Dip (IIPM/India)
CEng, FIET(UK), MIE(SL), MBCS(UK), MCS(SL),

Chairman – Conference Committee

24th Annual Conference

IET – Sri Lanka Network

Message from the Editor



I would like to extend a warm welcome to the Engineering and Technology professionals and delegates on behalf of the publication committee, to the 24th Annual Technical Conference of the Institution of Engineering and Technology (IET), Sri Lanka Network.

This year, the papers were mainly received in the fields of Electrical, Electronic, Telecommunication, Civil, Mechanical, Automobile, Marine, Aeronautical, Manufacturing and Information Engineering. The papers that were received are based on the individual or collaborative research carried out in the industry and academia. After a careful review, Eleven (11) high standard technical papers on various engineering aspects have been selected for presentations and publication out of 34 overall submissions. The review panel for the 24th Annual Technical Conference of IET Sri Lanka Network 2017 proceedings considered not only the theoretical aspects of the papers but also the applicability of research outcomes of the papers for the industry. I would like to express my sincere gratitude to all the revivers, Prof Rohan Munasinghe from University of Moratuwa, and Dr. Pradeep Abeygunawardhana from Sri Lanka Institute of Information Technology.

I would like to express my sincere appreciation to all authors of the papers in this proceedings. It is the result of their generous contribution of time and effort on engineering and technology related research. The willingness to make an effort to share knowledge and thoughtful insights with the engineering and technology community is greatly appreciated which has made this conference proceedings possible.

Finally, the organizers would like to thank all participants for their contribution, hoping that future IET annual Technical conference meetings will further bond synergies between the different research activities.

Eng. Anuradha Jayakody

B.Sc (Hons.)(Greenwich),MSc (IS),PGD(IT),CITP ,MIEEE,MIET,MBCS,CCNA,CCAI,MCP

Chairman – Editorial Committee

24th Annual Conference

IET – Sri Lanka Network

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Hardware Based Virus Scanning Acceleration

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Abstract—A hardware-based system to accelerate virus scanning is proposed in this study. The number of files stored in a storage device increases day by day. Hence, the number of files to be scanned also increases. This causes the virus scanning process to run more slowly.

Virus scanning can be done using methods such as heuristic-based detection, signature-based detection, behavioral detection and cloud-based detection. In signature-based detection, a signature is generated for every file. The process of generating this signature is called hashing. Currently hashing is done using general purpose instructions, but this can be accelerated by adding new application-specific instructions to the processor. Experimental results demonstrate that the virus scanning process is accelerated by this system.

Keywords—Hardware based acceleration, Signature based detection, Hashing, Virus scanning, Application-specific instructions, Hotspots

I. INTRODUCTION

A clear difference in processing speed can be experienced when using a computer with and without antivirus software. This difference is caused by the virus scanning process.

A computer virus is a type of malicious software program ("malware") that, when executed, replicates by reproducing itself (copying its own source code) or infecting other computer programs by modifying them.

Computer viruses affect the system performance. Viruses access data illegally and delete data stored in a computer. These data may be important user data or system files. The illegal deletion of system files may cause a system breakdown. Antivirus software has been developed as a remedy for this.

Virus scanning is the process of searching a storage device for viruses. Antivirus software is used for this process. Currently, virus scanning is purely software based. Scanning a large set of files takes a significant amount of time. Also as the number of viruses increases rapidly, the virus scanning process would take more and more time.

There are different methods to detect a virus. Heuristics-based detection, Behavioral-detection, Signature-based detection and Cloud-based detection are some of them.

Signature-based detection is one of the oldest methods which is still used to detect computer viruses. The significance of this method is that it is highly effective towards well-known attacks. It can be performed quickly on modern systems as it reduces the amount of power required to perform these checks. This detection method consists of two main stages, calculating the hash (the signature) and checking the hash with the known virus database. A hash is a unique value for any given file. MD2, MD4, MD5, MD6, SHA-1 are some of the hashing algorithms used to calculate the hash.

This project is done to accelerate the hash calculation part of the virus scanning process. MD5 was selected as the hashing algorithm. MD5 [2] is a widely used hashing algorithm which takes any file as input and produces a 128-bit signature as the output. This algorithm was designed by Ronald Rivest in 1991. It has many applications. One of the applications is virus scanning. The 128-bit signature produced by this algorithm can be used to check if a file is corrupted. MD5 takes a variable length input and breaks it into 512-bit blocks. Then, the input is padded so that its length is divisible by 512. Padding is performed by appending a single "1" bit, and then "0" bits to the message. After operating on these 512-bit chunks, MD5 produces the 128-bit output.

Normally all the calculations are done in the processor using the arithmetic logic unit (ALU). Addition, multiplication, AND operation and OR operation are some of the basic arithmetic functions of an ALU. These functions of the ALU are repeatedly used when calculating the hash value in virus scanning. The processing time can be decreased by introducing specialized hardware components to the processor and using one clock cycle to do repeatedly used operations.

The basic processor which uses general purpose instructions is known as the base processor. This processor is later modified by adding new application specific instructions. A five stage pipelined MIPS processor [3] is used in this project as the base processor. It has 32-bit instructions. This processor is designed using Verilog. Verilog is a hardware description

language, which is used to model electronic systems. This language used in this project to extend the base processor and to simulate it. Later, the new processor is tested on a Field programming gate array (FPGA).

FPGA is an integrated circuit which can be used to solve any computable problem. It contains programmable logic blocks, which can be configured to perform combinational functions. These blocks contain smaller components, including flip-flops, look-up tables, and multiplexers. Hardware description languages are used to configure these logic block. Digital signal processing, software-defined radio, application specific integrated circuits (ASIC) prototyping, cryptography, computer vision and computer hardware emulation are some of the applications of this device.

The aim of this project is to create separate hardware components and extend the base processor in order to accelerate the virus scanning process. Separate hardware components are designed specifically to decrease the processing time of the virus scanning process. These new hardware components are designed to support and accelerate the MD5 hashing algorithm. The number of clock cycles needed can be reduced using these new hardware components. This allows the hash to be calculated faster.

II. RELATED WORK

Baojun Zhang, Jiebing Wang and Xuezheng Pan [4] have done a study on accelerating the virus scanning process. This study has been concentrated on the string matching part of virus scanning while our study is focused on accelerating the hashing part of virus scanning. In their system, the files on the client are uploaded to the server, where the server executes the virus scanning process. This requires a network connection. Our method which is standalone does not require a network connection.

Kimmo Järvinen, Matti Tommiska and Jorma SkyttäHelsinki [5] have implemented a separate hardware module for the MD5 algorithm. This has been tested on an FPGA. This module has given a very high throughput. However, this method would be costly to implement physically. This is designed specifically for MD5. If the virus scanning process starts to use a new hashing algorithm, this module would be useless. Our project is done with the intention of adding new instructions to the processor. These operations can be used for any other similar algorithm as well.

Thipakar Sabapathipillai, Sinthuja Kopalakirushnan, Dhammika Elkaduwe and Roshan Ragel [6] have done a study on accelerating virus scanning using parallel processing. This study has been done to accelerate Aho-Corasick and Boyer-Moore algorithms using GPU. It is focused on the pattern matching part of signature-based detection. Our study is done to accelerate the hash calculating process.

Changxin Li, Hongwei Wu, Shifeng Chen, Xiaochao Li and Donghui Guo [7] have done a study on accelerating the MD5-RC4 algorithm using NVIDIA GPU. The results show that the MD5-RC4 can be

accelerated by 3-5 times using GPU. However, this acceleration can be done only on computers which have a GPU.

III. METHODOLOGY

A. Hash Algorithm

A hash, which is also called a digest, is a signature for a stream of data. Hashes, compile a stream of data into a small digest. It is a one-way operation. The size of the hash is fixed regardless of the size of the input. MD5 and SHA-1 are well-known hash functions that are currently in use.

MD5 was the hashing algorithm used in this study since it is a commonly used hash function which produces a unique hash value for any file. It is quick to generate compared to SHA-1 but not secure as SHA-1.

When calculating the MD5 hash value for a given file or message, the algorithm takes the input and breaks it into chunks of 512-bit blocks. The loop in the MD5 algorithm executes once for every 512-bit chunk. And within this loop is another loop which executes for 64 times

B. Identifying Hotspots

As the first part of this study, hotspots in the algorithm were identified. Hotspots are the instructions which execute multiple times in a program. The operations shown in FIGURE1 and FIGURE2 are found in the inner loop of 64. Since this loop executes 64 times for every 512-bit chunk, these operations are used for 64*N times in a single hash calculation. Therefore, these operations were selected as hotspots.

```

if (i < 16) {
    f = (b & c) | ((~b) & d); // hotspot 1
    g = i;
} else if (i < 32) {
    f = (d & b) | ((~d) & c); // hotspot 1
    g = (5*i + 1) % 16; // hotspot 2
} else if (i < 48) {
    f = b ^ c ^ d; // hotspot 3
    g = (3*i + 5) % 16; // hotspot 4
} else {
    f = c ^ (b | (~d)); // hotspot 5
    g = (7*i) % 16; // hotspot 6
}

```

FIGURE1: Hotspots in MD5 hash algorithm

```

b = b + LEFTROTATE((a + f + k[i] + w[g]), r[i]); // hotspot 7
a = temp;#FFFFFF

```

FIGURE2: Hotspots in MD5 hash algorithm

These hotspots use multiple clock cycles to execute, but the newly added instructions are designed to execute these operations using lesser number of clock cycles. Most of the hash algorithms use similar operations. Hence, the new application specific instructions can also be used in other hash algorithms too.

MD5 algorithm uses two arrays which contain 64 elements. Both arrays are accessed 64 times when generating a hash value. These parts can also be accelerated by implementing the arrays in hardware. However, these were not implemented in hardware as it would not be practical to add a register file containing 128 entries when the data memory has only 32 entries.

C. Selection of the Processor

Selection of this processor was made based on the architecture of it. MIPS is a simple processor, and its architecture can be easily understood. A five stage pipelined 32-bit MIPS processor was used in this study for testing as it contains less number of separate instructions.

Further, the source code of the selected processor is available online [3].

In this study, the hardware descriptive language (HDL) used to modify the base processor was Verilog [8]. Icarus Verilog was used as the HDL simulation tool.

D. Alterations to the MIPS Processor

The processor selected contains fifteen Verilog modules. These modules were modified to accommodate the new instructions. Details of the modifications are given in TABLE I.

TABLE I
MODIFIED VERILOG MODULES

Verilog module	Comments
alu.v	New ALU operations were implemented An additional input was added
alu_control.v	Function values were implemented for new ALU operations
cpu.v	An addition input was added
im.v(instruction memory)	Necessary instructions were hardcoded for testing
regm.v(register file)	Modified to support an additional instruction
regr.v(used to store data of pipelined stages)	Modified to support an additional instruction

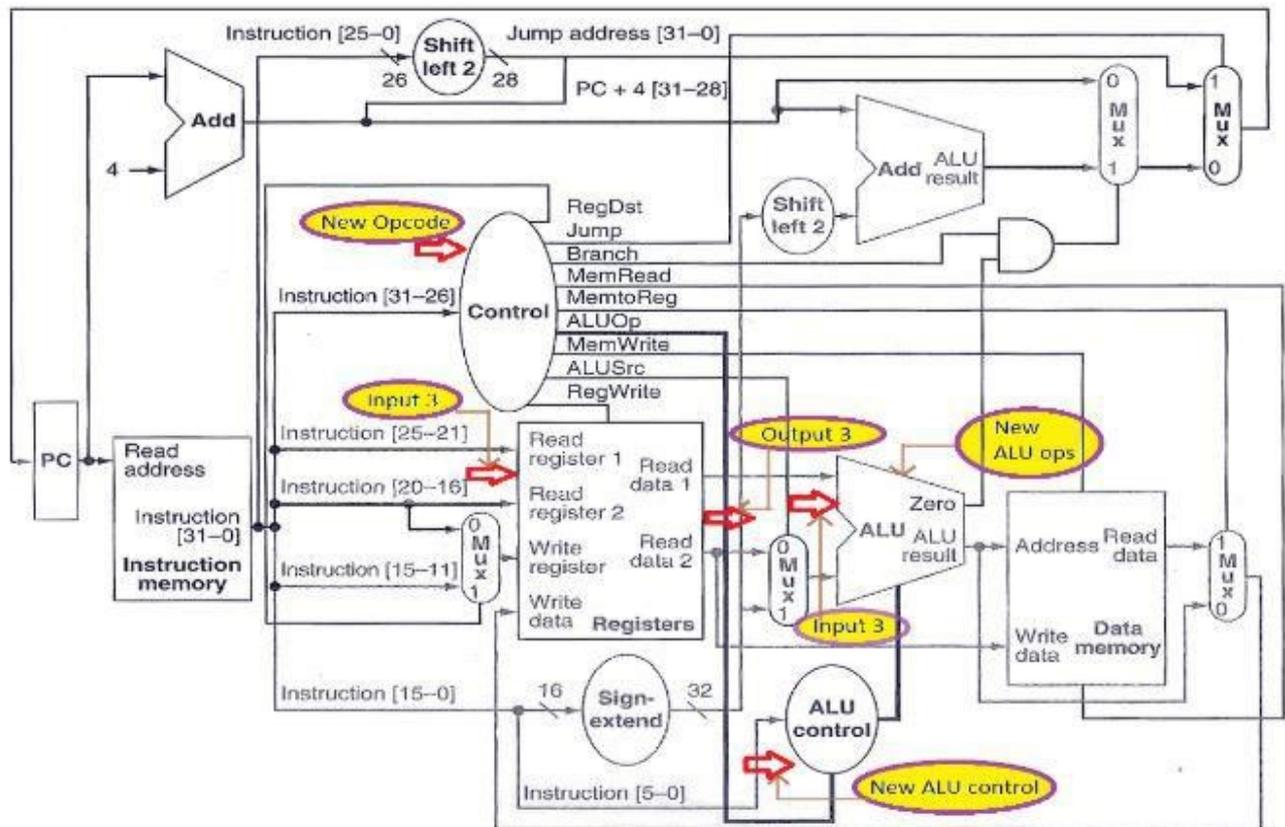


FIGURE3: Modified processor

The changes made in the base processor to accelerate the hashing process are highlighted in FIGURE3.

The ALU of the base processor contains seven basic operations. After examining the MD5 algorithm, four new operations were designed and added to the processor. These operations were designed specifically to accelerate the MD5 algorithm. Changes were done to control blocks and the ALU as shown in FIGURE3.

The ALU was modified to take 3 inputs and the register file was amended to read 3 registers at a time as shown in FIGURE3.

The new instructions designed are given below in TABLE II.

TABLE II
COMPARISON OF THE OLD AND NEW INSTRUCTIONS

Hotspots (New operations)	No. of instructions used in the old processor	No. of instructions used in the new processor	No. of clock cycles saved
$a^{\wedge} (b (\sim c))$	3	1	2
$a^{\wedge} b^{\wedge} c$	2	1	1
$(a \& b) ((\sim a) \& c)$	4	1	3

IV. TESTING AND VERIFICATION

Icarus Verilog was used for the software verification of new instructions. In order to test these instructions, assembly code of the hotspots were written to an assembly (.asm) file and relevant machine code (.hex) files were generated using a MIPS cross compiler. Then those .hex files were fed to the processor. Extracts of the old and new hex files for the double xor function ($a^{\wedge}b^{\wedge}c$) are shown in TABLE III. As shown here the last two instructions in the old version has been fused to one instruction.

TABLE III
OLD AND NEW HEX FILES(MACHINE CODE)

Olddoublexor.hex	Newdoublexor.hex
20030003	20030003
20080005	20080005
20090007	20090007
00685026	00685A43
01495826	

Both old and new .hex files were simulated using Iverilog.

The old .hex file was executed in the base processor and the new .hex was executed in the extended processor. This simulation process is shown in FIGURE4. The inputs are highlighted in red and outputs are highlighted in green in FIGURE4.

```

dilshan@dilshan-VirtualBox: ~/Desktop/new_verilog_processor/test
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ iverilog -DIM_DATA_FILE="\olddoublexor.hex\" -DNUM_IM_DATA=`wc -l olddoublexor.hex | awk {'print $1}'` -DDUMP_FILE="\t0001-final_value.fv.vcd\" -DDEBUG_CPU_REG="1" -I./ -g2005 -o t0001-final_value.fv cpu_tb.v
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ ./t0001-final_value.fv | tail -n 1 > t0001-final_value.fv.out
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ cat t0001-final_value.fv.out
xxxxxxxx, 00000003, 00000005, 00000007, 00000006, 00000001, xxxxxxxx, xxxxxxxx, xxxxxxxx, xxxxxxxx
x
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ iverilog -DIM_DATA_FILE="\newdoublexor.hex\" -DNUM_IM_DATA=`wc -l newdoublexor.hex | awk {'print $1}'` -DDUMP_FILE="\t0001-final_value.fv.vcd\" -DDEBUG_CPU_REG="1" -I./ -g2005 -o t0001-final_value.fv cpu_tb.v
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ ./t0001-final_value.fv | tail -n 1 > t0001-final_value.fv.out
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ cat t0001-final_value.fv.out
xxxxxxxx, 00000003, 00000005, 00000007, xxxxxxxx, 00000001, xxxxxxxx, xxxxxxxx, xxxxxxxx, xxxxxxxx
x
dilshan@dilshan-VirtualBox:~/Desktop/new_verilog_processor/test$ |
    
```

FIGURE4: Results comparison of hotspot double XOR in Iverilog

Since both hex files generated the same output, it was verified that the new instructions generate true results. Other newly added instructions were also tested in the same manner.

Hardware verification of the new processor was done on an FPGA board. The FPGA device used is a Cyclone IV EP4CE115F29 belonging to the Cyclone IV E family. This device has 432 M9K memory blocks. Furthermore, has 128MB of SDRAM, 2MB of SRAM, 8MB flash with 8-bit mode and 32Kb EEPROM.

Both the new application specific instructions and the blocks of old instructions were tested on this FPGA for verification.

Altera Quartus [9] is a programmable logic device design software. HDL designs can be analyzed and synthesized using this software. An HDL design can be compiled and features namely timing analysis and RTL simulation can be used to configure the design with the target device (FPGA).

The new instructions were simulated on the FPGA board using Altera Quartus software for hardware verification. New instructions generated the same output as the old instructions but using lesser number of clock cycles.

V. RESULTS

The extended processor and the base processor were tested with different hotspot instructions, and timing analysis was done separately for every hotspot. These time values of hotspots were benchmarked in both processors to test the performance.

A. Timing Analysis

Timing analysis feature in Altera Quartus was used in finding the maximum allowable frequency for Verilog instructions. Maximum allowable frequency (Fmax) depends on the instruction which takes the most time. Hence, for different hotspots the Fmax value may change. Fmax also depends on slack. Slack depends on arrival time and required arrival time of data.

Arrival time and required time is very useful when verifying the clock requirement for a setup between sequential elements in the design. Arrival time represents the time at which data arrives at the input of the receiving sequential element. Required time represents when data is required to be present at the end latch. FIGURE5 illustrates the setup check.

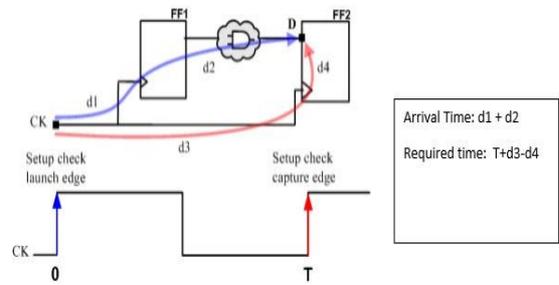


FIGURE5: Arrival time and required time for setup check

Slack is simply the difference between the required time and the arrival time.

$$\text{Slack} = \text{required time} - \text{arrival time}$$

If the slack is negative, the path is violating the setup relationship between the two relationship elements. Hence, it is necessary to maintain a positive slack.

The slack analysis was done for both processors under 10ns clock period. A positive slack was obtained on all the occasions. Hence, the data path was not violated in the setup relationship mentioned earlier.

B. Performance Comparison of Hotspots in Old and New Processors

As the slack values are positive, Fmax can be calculated using Quartus timing analyzer without any violations. The verification was done using a frequency of 100MHz. Since the Fmax values of all the instructions were greater than 100MHz, it was concluded the extended processor can be used with a frequency of 100MHz. Table IV shows the detailed results sheet of the comparison of hotspots in both old and extended processor designs.

TABLE IV
PERFORMANCE COMPARISON OF PROCESSORS

Hotspot	Clock cycles reduced	Fmax old(MHz)	Fmax new(MHz)	Time saved (ns)
$a^{\wedge}(b (\sim c))$	2	102.26	104.64	20
$a^{\wedge}b^{\wedge}c$	1	122.01	105.88	10
$(a\&b) ((\sim a)\&c)$	3	106.77	111.02	30

VI. CONCLUSION

Virus scanning is a vital process in a computer. This process reduces the performance of a computer. A method to accelerate the virus scanning process was presented in this study. The method was to implement separate hardware components in the processor to

speed up the hash calculating process. In this study, a 32-bit MIPS processor was extended by adding new application specific instructions. Separate hardware components were added to accommodate these new instructions. After adding these new components, the extended processor was tested and verified using an FPGA.

When testing this new extended processor, it was seen that the hash calculation could be accelerated using this method.

An average of 4 clock cycles can be saved for each time the inner loop of the MD5 algorithm is executed in the extended processor. Therefore, if there are N number of 512-bit chunks to operate on, $64*4*N$ number of clock cycles can be gained for a single hash calculation using the extended processor.

There are few more hotspots which were not implemented in this project. The processor can be further extended and the hash calculation can be done faster if those hotspots are also implemented. If this method is combined with an accelerated string matching system, the virus scanning process can be accelerated significantly.

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Object Dimension Extraction for Environment Mapping with Low Cost Cameras Fused with Laser Ranging

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Abstract- It is essential to have a method to map an unknown terrain for various applications. For places where human access is not possible, a method should be proposed to identify the environment. Exploration, disaster relief, transportation and many other purposes would be convenient if a map of the environment is available. Replicating the human vision system using stereo cameras would be an optimum solution. In this work, laser ranging based technique fused with stereo cameras has been used to extract dimension of objects for mapping. The distortions in the camera were calibrated using mathematical model of the camera. The rectified images were used to generate the disparity map by means of Semi Global Block Matching. The noise found in the disparity map was reduced using novel noise reduction method for disparity map through employing dilation. The Data from the Laser Range Finder (LRF) has been used to identify the 2D overlay of the environment. To find the missing the 3rd dimension of the objects the disparity map was analyzed through different methods like canny edge detection and pixel-wise intensity thresholding. Out of them through comparison of the results, pixel-wise approach has been selected, due its success in identification of the dimensions.

Keywords- mapping, disparity, LIDAR, camera calibration, stereo vision, dimension extraction

I. INTRODUCTION

Mapping is in general, graphical representation of environment with various objects and features. Mapping can be used to extract object information like height size, material types, object types etc. Machine vision is giving the capabilities of human vision to a machine using technology. human vision perceives as a colorful place with three dimensions.

Mapping plays a vital role since it allows us to respond to spacious geographic and social issues. Maps are useful for understanding and identifying spatial connections and explaining concepts in a visual manner that can be easily understood. There are many applications in technology of environment mapping as military applications, disaster relief, navigation and exploration etc., this can be used in many security applications in industry as well. Simply places where human cannot access this will be an ideal solution.

Explorations human inaccessible areas, finding dimensions of unknown terrains, by implementing this proposed method on a drone can be used for constructing 3D models of the down terrain. Further this can be extended to find material types and identifying object according to

application. Number of sensors are available in the literature for detecting obstacles with help of SONAR [2], RADAR, LIDAR [3], vision systems and other proximity sensors [4].

But many of them are running under high computational power and with expensive equipment. On the other hand, stereo cameras are low cost and mapping has been done through stereo vision. Path planning techniques for traversing given point with minimum travel cost has been developed for some time [5]. Also, Laser Range Finder (LRF) is an accurate device for distance measurement. LRFs have been used for object dimension identification in many applications.

This paper outlines such approach step by step. through the proposed method, the LRF data has been fused with stereo cameras with low computational cost to extract dimensions of objects. While the LRF focuses on to finding 2D plane X, Y dimensions, the stereo camera is used to find Z dimension. The camera was calibrated and its properties were identified properly, so that the distortions can be corrected. The distortion corrected images were used to compute the disparity map. The disparity data has been used combined with the LRF data to successfully identify the dimensions of the objects in the environment. The methodology and the techniques used for noise filtering and dimension extraction has been discussed as well.

II. PROPOSED SOLUTION

In the proposed solution, two-low cost off the shelf web cameras has been used for stereo vision and an off the shelf neato XV – 11 LRF as sensors. Since camera calibration is a requirement it was calibrated properly up to 14 distortion coefficients without being limited to usual method.

From left and right images disparity map was obtained and the height of the object a found with it. Regarding the length and the width we use the LRF introducing this to find the planet of the objects and constructing the 2D environment as discussed in section [E]. There are many researches [6] [9] which have been done using stereo cameras. But, taking multiple realization is a method with much computational cost in terms of practical implementation on a suitable platform. Hence, what has been proposed is, from stereo cameras we extract the object height information and construct the 3D object using 2D information obtained from the. In addition, the latter information will be used to construct the 3D object. For this purpose, only the two left and right images are needed with object height

information and the LRF sweep information. This is not much computationally costly or unrealizable.

The cameras used has its own distortions. Radial distortions and tangential distortions are prominent among them. Hence, it is necessary to calibrate them to avoid such distortions. Calibration involves identifying the mathematical model and details of the camera, which is done in two parts. First two cameras have been treated separately and calibrated and the error parameters were found. Also for the optimum disparity map generation rectification is necessary as the distortions are corrected and the images are aligned in a common horizontal line, so that the stereo matching can be executed.

Considering the height extraction, maximum intensity value of the disparity image was considered. Hence to remove the effect of ground plane noise values a constant distance was always maintained when taking images. So that identifying the maximum intensity with the relation of pixel – cm relation height of the object was found. There is a dimension change when taking 3D to 2D plane using stereo cameras. Hence, what we proposed is a method as discussed in section F.

Instead of taking multiple realization [6] since considering practical implementation it is not more efficient hence that we introduce novel approach to reduce noise in disparity image by dilation.

Once height is there and the plane of the object is gained using LRF our focus is to implement in a mobile platform and conclude the map reconstruction.

The dimension data obtained can be used reconstruct the objects in a virtual reality. To create a 3D model of the environment accurately. The identified dimensions can be used compute volume surface area, and they can be used for through analysis of the objects to find the density, mass and many other materialistic properties. Today most of the areas are using depth extraction methods by stereo cameras with image processing. Proposed method is to take disparity using low cost cameras and dilation method is used to remove noise in disparity.

A. Camera model identification

The cameras have their inherent distortions. To find the depth accurately using cameras their intrinsic parameters have to be identified and distortions have to be corrected. The simple web cameras can be modelled as pinhole cameras. In a pinhole camera model, a scene viewed is developed by projecting 3D points unto the image plane using a perspective transformation as,

$$sm' = A(R|t)M'$$

or,

$$S \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} r_{11} & r_{12} & r_{13} & t_1 \\ r_{21} & r_{22} & r_{23} & t_2 \\ r_{31} & r_{32} & r_{33} & t_3 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

where (X, Y, Z) are the coordinates of a 3D point in the world coordinate space. (u, v) are the coordinates of the projection point in pixels, and it is a principal point that is usually at the image center. A is a camera matrix and the focal lengths are expressed in pixel units.

Real lenses usually have distortions. Therefore, without modeling them, it is impossible to calculate any accurate measurement from the cameras. For the pinhole camera

a. Radial distortions (Pincushion distortion & Barrel distortion.) and b. Tangential distortions are possible.

To identify these errors and to rectify the errors a calibration process is needed. The above mentioned distortions can be mathematically modeled as shown below. Here, $k_1, k_2, k_3, k_4, k_5, k_6, \dots, k_{14}$ are radial distortion coefficients and P_1, P_2 are tangential distortion coefficients.

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = R \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} + t$$

$$x' = \frac{x}{z}$$

$$y' = \frac{y}{z}$$

$$x'' = x' \frac{1 + k_1 r^2 + k_2 r^4 + k_3 r^6}{1 + k_4 r^2 + k_5 r^4 + k_6 r^6} + 2P_1 x' y' + P_2 (r^2 + 2x')$$

$$y'' = y' \frac{1 + k_1 r^2 + k_2 r^4 + k_3 r^6}{1 + k_4 r^2 + k_5 r^4 + k_6 r^6} + 2P_2 x' y' + P_1 (r^2 + 2y')$$

where,

$$r^2 = x'^2 + y'^2$$

$$u = f_x x'' + C_x$$

$$v = f_y y'' + C_y$$

B. Camera calibration

Camera calibration was done in two parts. First individual cameras were calibrated and the error parameters and camera parameters were found. Then both cameras were calibrated as a pair to find the stereo parameters of the setup. For the calibration process a checkerboard with known dimensions was used as shown in figure 1.



FIGURE1: Camera calibration checker board images (left & right)

From camera calibrations following parameters were found.

- Radial distortion: Correction matrix for radial distortion
- Tangential distortion: Correction matrix for tangential distortion
- Focal length: Focal length of the camera
- Principle point: Principal point of the image plane

From stereo setup calibration following parameters were found

- Rotation of camera 2:
Rotation of image plane of the camera 2 with respect to camera 1
- Translation of camera 2:
Distance from the principal point of the camera 1 to principal point of the camera 2
- Fundamental matrix:
The fundamental matrix is a relationship between any two images of the same scene that constrains where the projection of points from the scene can occur in both images.

The rotation matrix of camera two with respect to the camera one was found as,

$$\begin{bmatrix} 1 & 0.0027 & -0.0036 \\ -0.0027 & 1.0000 & 0.0016 \\ 0.0036 & -0.0016 & 1 \end{bmatrix}$$

And the translation of camera two with respect to camera one was found as,

$$[-93.1032 \quad 1.2802 \quad 0.1104]$$

Fundamental Matrix

$$\begin{bmatrix} -0.0000 & -0.0000 & 0.0016 \\ 0.0000 & 0.0000 & 0.1269 \\ -0.0018 & -0.1274 & 0.6250 \end{bmatrix}$$

Essential Matrix

$$\begin{bmatrix} -0.0048 & -0.4414 & 1.0334 \\ 0.1125 & 0.1493 & 93.1061 \\ -1.2801 & -93.1021 & 0.1459 \end{bmatrix}$$

TABLE I. CAMERA PARAMETERS

Parameter	Camera L	Camera R
Radial distortion	[0.0644 -0.2494 - 0.6359]	[-0.0101 0.3192 -2.2780]
Tangential distortion	[6.9078e-04 - 0.0011]	[-0.0048 - 0.0035]
Focal length	[729.9077 729.4782]	[733.1340 732.8580]
Principle point	[322.5457 226.0965]	[303.3310 224.2269]

The parameters found were used to correct the distortions in the images were aligned horizontally through the process of rectification.

C. Disparity map generation

In figure 2, I represent the image plane and c denotes the principal point of image plane. (X, Y, Z) are

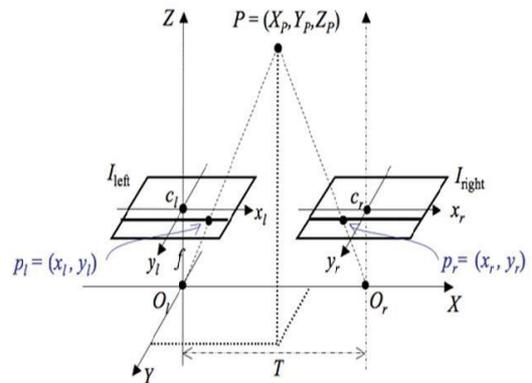


FIGURE2: Meaning of disparity

Cartesian coordinates. P denotes the real-world point and p denotes the images of that point. Subscript l and r

$$\begin{aligned} Z_p &= f \frac{T}{d}, \\ X_p &= x_l \frac{T}{d}, \\ Y_p &= y_l \frac{T}{d}, \end{aligned}$$

denotes left and right. From geometry, a relationship between real world object points and image points can be derived as,

Here d stands for disparity which can be mathematically represented as,

$$d = x_l - x_r,$$

Disparity in each pixel is namely disparity map which is most of the time generated by Semi Global Block Matching (SGBM) [1]. It has been used as the basis to create a disparity map by using stereo images shown in figure 3.



FIGURE3: Stereo images of cube.

Disparity depends on the various parameters. An experiment was conducted to find those parameters as below.

For that, image pairs were captured by increasing the distance from baseline up to 1m. Also, the texture pattern of the surfaces was varied.

The disparity was found and tuned manually to an optimum state. The parameter values were recorded. Through the experiment following were concluded

- The number of disparities depends on the distance from the baseline, it should decrease when going away from the baseline.
- As the LRF is available to measure the actual distance from the baseline, adjusting the parameters such that the relative depth of the object is observable corresponding to its surfaces would be sufficient.
- The block size depends heavily on the texture of the object surface.
- Glare on the object surfaces affects the disparity much.
- The glare on the ground plane too affect it.
- Also, it is hard to compute the disparity with unicolor objects.

Hence it is recommended that the objects and the ground plane have matt surfaces with a texture variation. Recommended distance from baseline is around 0.75 m for the camera setup used in this work. But it may depend on the scale of the object.

With the results of disparity as shown in figure 4, following adjustments were made, test environment which was a cube (30 cm x 30cm x30cm) and the distance to cube was 70 cm away from the camera which had a height of 8.5 similar to the mobile platform height since it was planned to mount the camera on a mobile robot. Distance from the camera to nearest edge of the object is 70 cm.

Figure 4(a) shows disparity map without texture surface with good light condition. Figure 4(b) shows disparity map with texture surface with poor light condition and the figure 4(c) shows the disparity map without texture surface with good light condition while figure 4(d) shows disparity map with texture surface with good light condition. From all these observations, it is proved that disparity depends on various factors.

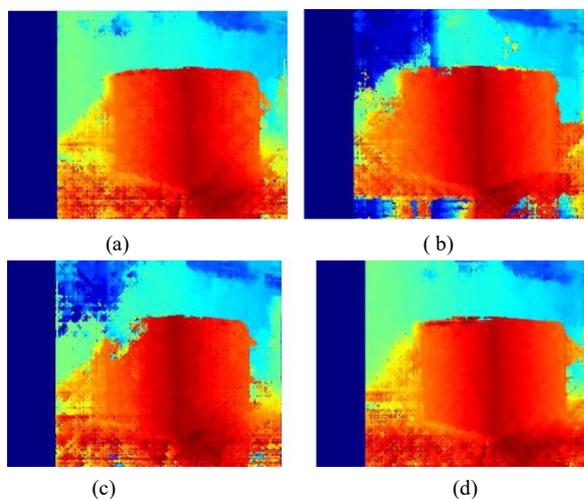


FIGURE4: Disparity maps with various test conditions

D. Disparity map smoothing

The disparity map was generated using SGBM and due to various noise components, it is not accurate. Hence, dilation was used to remove noise. Dilation is a technique used to smoothen varying intensity of pixels in raw images in simple image processing. The nature of noise that can be found in the disparity map is as large scale variations of pixel intensity than the required amount. Hence dilation will smooth out the variations.

$$(A \oplus B) = \bigcup_{b \in B} A_b$$

A_b is the translation of A by b .

E. The Laser Range Finder (LRF) for 2D map generation

The LRF, Neato laser sensor driven by the Xv-11 LIDAR controller. The laser sensor projects a pulse stream of lasers around and measures the time it takes to reflect back [7]. The distance to the reflection point can be accurately calculated (to 1 mm) from the time of flight. The error characteristics of the LRF is shown in the figure 5. The sensor then encodes the distance data into a packet and forward it to the LIDAR controller. The data packets are then decoded in the controller and relayed through the serial port up to a host device (a PC or a single board computer like Raspberry PI™). As the percentage error is small, in distances less than 3m, the LRF measurement can be used as accurate estimation of distance.

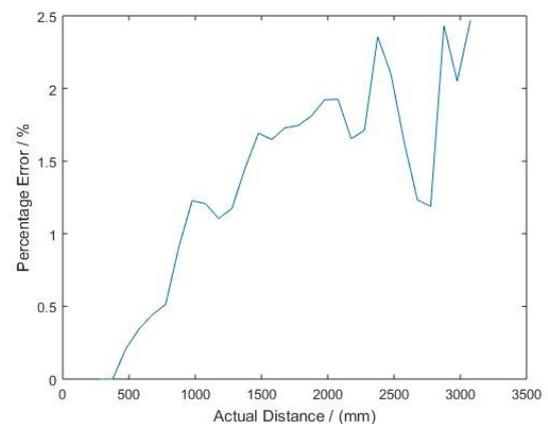


FIGURE5: The error characteristics of LRF

To acquire the distance data from the LRF, a separate algorithm was developed. Because the LRF measure the distance with lesser variance in the range of 0-3 m, only distances up to 3 m are considered. Also, there may be errors due to reflectivity effects. But many of them could be rectified by sampling through multiple realizations. Here it was about five realizations, considering speed of operation and the power consumption. As shown in figure 6 accurate 2D map can be generated using LRF with multiple realizations

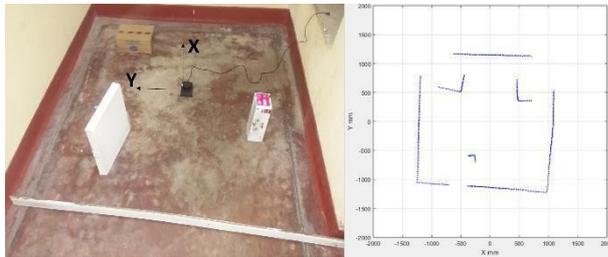
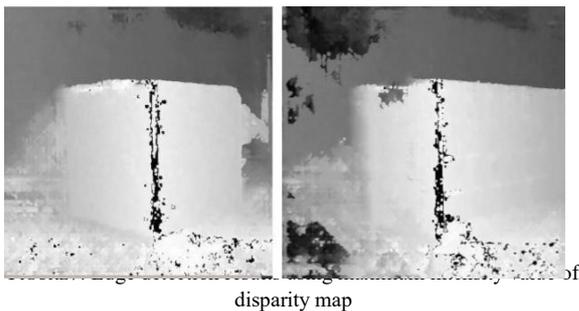


FIGURE6: 360⁰ sweep LRF data

F. Height extraction

From the disparity map we obtained, next we focused on finding the maximum intensity of that, since it is consisted with the nearest edge of the object as shown in figure 7. But the same intensity values present in the floor also affects. Hence the images were captured from a constant distance and it was found from the pixel values.

The canny edge detection method was used [8] to draw the bounding rectangular contour and obtain the height of the object in pixels as. Since the top minimum row index of the pixels with maximum intensity was known from simple calculation as below the constant was obtained in pixels. (Constant = 53 pixels). The bounding rectangle, found through canny detector, was varying for different images of the same object and the scene. Hence, another method was proposed to finds the height of the object through disparity image.



III. HEIGHT EXTRACTION METHOD USING MAXIMUM INTENSITY VALUE.

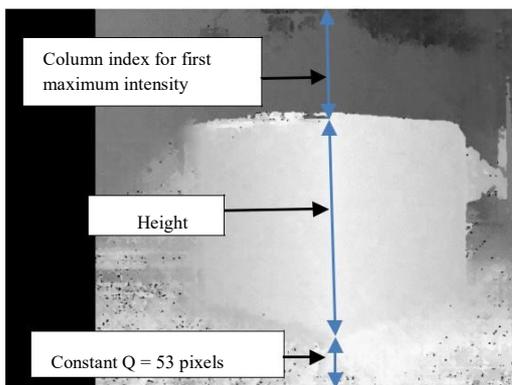


FIGURE8: Edge detection results using maximum intensity value of disparity map

First the pixel intensity values were accessed and a threshold for filtering out the maximum intensity was identified. Hence it was used to filter out the maximum intensity value of disparity map. Once it was found, the whole disparity image was analyzed row wise until first pixel with highest intensity is found. And its column index was recorded. Since the total height of the image and the number of pixels from bottom to lower end of the object are known. Once the maximum intensity points' column index is identified the height of the object can be easily calculated as shown in figure 8. Pixel –real distance relation

Since same distance and same camera height were used at all times, they are valid for this experiment also. The canny edge detector was used as in figure 9 to identify the width of the cube (30x30x30) from corner to corner in pixels.

$$\begin{aligned} \text{Width of the cube} &= 362 \text{ pixels} \\ \text{Actual distance between corners} &= 42 \text{ cm} \\ \text{Distance represented by 1 pixel} &= 0.116 \text{ cm} \end{aligned}$$



FIGURE9: Finding the corner to corner distance using CANNY edge detector rectangle

IV. CONCLUSIONS

In this paper, a method has been proposed for extracting the object dimensions for environment mapping with low cost cameras fused with laser ranging. Considering cameras, the errors were mitigated though proper calibration of cameras which was extended up to 14 levels. Furthermore, usage of simple dilation method used in 2D image processing to remove the noise in the 3D disparity map can be considered as a novel approach. This is much efficient than using processing power hungry methods that require multiple realizations. The LRF data has been processed separately to obtain the complete 2D overlay of the surrounding. The 3rd dimension, the height, has been extracted using the Pixel-wise intensity thresholding of the disparity map. The fusion of both sensors has been beneficial in generating 2D map and then converting it to a 3D map.

The extracted dimensions can be utilized to find other properties of the objects like volume and also mass, if the densities are known. Due to the usage of low cost and low power hungry devices proposed method is

economically efficient and easily adaptable. Further enhancement with industrial grade sensors is also available.

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“iRisk”- A Software Based Solution to Effectively Manage Information Security Risks in Organizations Using ISO 27001 Approach

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Abstract— In the era of information technology, aligning organizations to meet the security is a demanding challenge, so in complex organizations aligning IT security risk management with overall security risk management is an essential task. This paper presents a feasible solution, the “iRisk” framework by combines with the ISO 27001 Toolkit. The proposed framework minimizes the hassle and complexity of carrying out the information security risk assessment, saving time and resources by automating the existing system. Furthermore, this allows the user-friendly interface to feed information and identify the high risk areas, calculating impact and probability analysis and compliance reports to be generated. Finally, the sample risk assessment provides a prepopulated list of assets, assigned to a standard set of asset owners; for a typical organization. Each asset features a series of potential pre-assigned risks, in addition to the corresponding controls relevant to those risks from ISO 27001:2013.

Keywords— Information Security, ISO 27001, risk assessment

I. INTRODUCTION

Risks grow due to the increased dynamic, complex and interrelated economy and enhanced threats from a wide range of forces[1], such as financial instability, political movements, terrorism, societal requirements, extreme nature events, product recalls over more levels of the supply chain, pandemics, technical failures, frauds, espionage, sabotage, cyber-attacks and others. In the last years there were different low-probability and high-impact events, Black Swan events [2], which are almost impossible to forecast (e.g., drought, earthquake, floods, cyber-attacks). Depending on how uncertainty is handled, it can become opportunity or threat [3]. Thus, organizations have to meet different stakeholders’ risk management requirements to promote trust and long term organizations’ success. A large number of organizations are reducing their business risks by seeking assurance of supplier and partners to properly manage their risks. During the last years ISO/IEC 27001 certificated for Information Security management has increased over 20%. At the end of 2010 more than 15,600 organizations worldwide were implementing information security management and obtained certification according to ISO 27001 [4]. Several best practices (e.g., COBIT, ITIL) and national guidelines (e.g., NIST 800-53, German IT Security Guidelines) for information security management are widely used in practice. Therefore,

implemented system “iRisk” would be a good automated software based on ISO 27001 and it is for the people who suffer from manual hassle and complexity of carrying out an information security risk assessment.

“iRisk” focuses on developing a unique software based application. The main objective of an iRisk is to capture and manage all business and IT risk centrally. Making more efficiency by reducing search time. The implemented solution allows to import, generate risk register, risk analysis, easily view the high risk areas, and calculate impact and probability analysis and compliance report. The process is done by the software and it will send the data to Microsoft SQL database.

The ISO/IEC 27001 family for information security management requires the following core principles [5]:

- The defined corporate security policy regards legal/regulatory requirements and is approved by the management.
- A risk assessment must be conducted to establish the risk treatment plan in order to reduce risks to acceptable levels of risk. For the identified remaining risks the business continuity plan must be developed, implemented, maintained, tested and updated regularly.
- The needed resources must be determined and provided. All collaborators must be competent to perform their tasks. They must be aware of their activities’ security impact and how they can contribute to achieving established objectives.
- The effectiveness, adequacy and compliance of the management system must be continually improved using measurements, monitoring, audits, management reviews and by applying corrective and preventive actions in the sense of a PDCA (plan, do, check, act) cycle.

The management system must be systematically documented, communicated, implemented and continually improved. This paper is organized as follows: Section II illustrates Literature survey. The system overview of the conducted research is explained in Section III. The results and discussion of the research are presented in Section IV. Finally, the conclusions and the future work are stated.

II. LITERATURE SURVEY

Software tools that been designed to assist in ISO 27001 risk assessment and, although their use is not mandatory in the standard. It is practically impossible to carry out and maintain a useful risk assessment for an organization that has more than about four workstations without using such a tool. It is essential that the risk assessment is completed methodically, systematically and comprehensively. An appropriate software tool, designed with ISO27001 in mind and kept up-to-date regarding changing information security issues, can be effective in this process. Hence, the risk assessment is a complex and data-rich process. In any organization of any size, the only practical way to carry it out is to create a database that contains details of all the assets within the scope of the ISMS, and then link to each asset, the details of its (multiple) threats and (multiple) vulnerabilities, and their likelihood and resulting impacts, together with details of the asset ownership and its confidentiality classification.

According to the researches it was identified that very few amounts of similar deployments had been made similar to “iRisk”. Moreover, none of them were implemented based on ISO 27001. Every design that has been made was based on this idea has or had its advantages and disadvantages. The following designs have been implemented:

The most well known risk frameworks OCTAVE comes in three sizes depending on the organization size (small, medium or large). One of the benefits of the OCTAVE series is that each of the frameworks provides templates for worksheets to document each step in the process. Templates can be used directly or customized for a particular organization [6].

The NIST framework, described in NIST Special Publication 800-30, is a general one that can be applied to any asset. It follows a similar structure like OCTAVE, but uses a little bit different terminology. NIST doesn’t provide plenty of templates such as OCTAVE but it is relatively easy to follow. Since it has a focus on concrete components as systems, it can be easily used for Organizations that are new to risk assessment. Also, because the methodology is defined by NIST, it is approved for the use by US government agencies and organizations that work with them [7].

ISACA’s COBIT is an IT management framework while the ISO 27xxx is a security framework that require organizations to have a risk management program. They recommend repeatable methodologies and specify when risk assessments should take place. Risk assessment in COBIT, described in RISK IT goes beyond security risks and includes development, business continuity, and other types of operational risk in IT [8], whereas ISO 27005 concentrates on security exclusively.

ISO 27005 follows a similar structure to NIST, but the terms are defined differently. ISO 27005 includes annexes with forms and examples, but like other risk frameworks, it’s up to the

organization implementing it to evaluate or quantify risk in ways that are relevant to its particular business.

Organizations that do not have a formal risk assessment methodology could firstly review the risk assessment requirements in ISO 27001 and 27002 and consider the 27005 or NIST approach. The ISO standards provide a good justification for formal risk assessments and outline requirements, while the NIST document provides a good introduction to a risk assessment framework.

The tools conforming to the above Risk Management framework will be categorized to more details in Table I. Further, Risk Management (RM) supported phases are divided into the below categories.

- RM phases supported,
 1. Risk Assessment
 - (a) Risk Identification
 - (b) Risk Analysis
 - (c) Risk Evaluation
 2. Risk treatment
 3. Risk communication

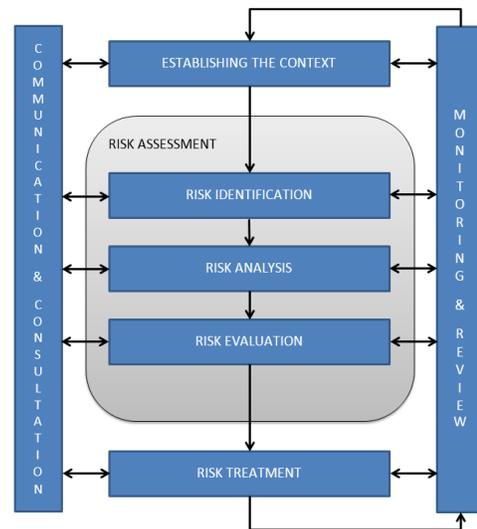


Fig. 1 Risk Management Framework

TABLE I
DESCRIPTON OF EXISTING RISK MANAGEMENT TOOL [9]

Tool	RM phases supported					RM methods supported
	1.RA			2	3	
	1.(a)	1.(b)	1.(c)			
Acuity Stream	X	X	X	X	X	ISO 27002, ISO 27005
Callio securia 17799	X	-	X	X	X	ISO 27002,

						ISO 27005
CCS Risk Manager	X	X	X	X	X	AS/NZS 4346, ISO 27002, ISO 27005, FRAP, Risk IT
CORAS Tool	X	X	X	X	-	CORAS
SAVe	X	X	X	X	X	ISO 27002, ISO 27005
TRICK light	X	X	X	X	X	ISO 27002, ISO 27005
vsRisk	X	X	X	X	X	ISO 27002, ISO 27005, FRAP

III. SYSTEM OVERVIEW

The implemented system “iRisk” is straightforward and so quick to use that it can save a significant proportion of the budget, you might otherwise spend on consultancy advice when conducting a risk assessment. The main objective of this project is implementing software for the organization to capture and manage all business and IT risk centrally. Making it more efficient by reducing the search time.



Fig. 2 Main Interface of the iRisk tool

IV. RESULTS AND DISCUSSION

A. Risk Assessment methodology

- Risk Identification

The main objective of risk identification is to identify the sources of risk, identify the assets within the scope of the Risk Assessment. An inventory of information assets will be produced of all identified assets in the form of an Information Asset Register (IAR).

As part of this step, details of information-related assets, which are being used to carry out the various business functions of company, will be collated in the form of an Information Asset Register. Examples of information-related assets, which will be considered for inclusion in the Information Asset Register, are:

- All proprietary information belonging company.
- All personnel information relating to Employees Company.
- All client information held by company.
- All supplier, contractor and other third party information occupied by the company.
- All software assets such as application software, system software, development tools and utilities belonging to company.
- All property, such as computers, communications equipment, media and equipment relating to facilities.
- All services, such as HVAC, lighting and power, associated with information systems of the company.

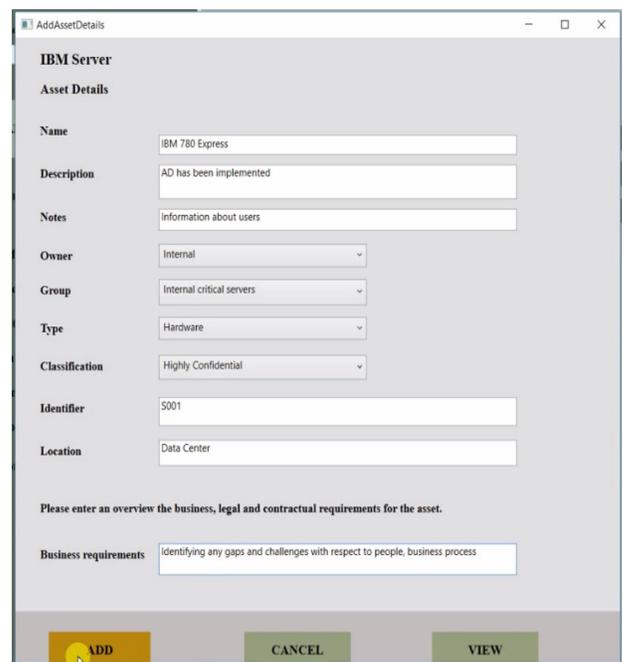


Fig. 3 Asset details interface

- *Risk Analysis*

a) Risk Impact – Analysing Consequence of a Risk

The aim of the step is to identify how valuable the assets are in the business of the company, and what might happen, if their security is compromised. Each Asset defined in the Information Asset Register will be assigned a value (3=High, 2=Medium, 1=Low) for each of the following parameters.

- Financial Impact;
- Operational Impact;
- Confidentiality;
- Integrity; and
- Availability.

The objective of assigning a value to these parameters is to ascertain what might happen if the security is compromised, so that the importance of the asset for the company can be determined.

b) Risk likelihood analysis

The realistic likelihood of the risk materializing shall be calculated as per the below table. Each Asset defined in the Information Asset Register will be assigned a value (3=High, 2=Medium, 1=Low).

TABLE II
RISK LIKELIHOOD ANALYSIS

Risk Likelihood	Rating Guideline
1 – Low	The event could occur annually
2 – Medium	The event may occur bi-annually
3 – High	The event is expected to occur quarterly

c) Calculating the Level of Risk

The level of Risk is a function of the risk impact and risk likelihood. After assigning values to risk impact and risk likelihood, the following formula shall be used to arrive at final Risk value.

Level of Risk = Risk Impact * Risk Likelihood → (1)

The following tables detail, how the risks shall be treated when the risk values fall within the defined ranges

TABLE III
POSSIBLE RISK VALUES

Level of Risk	Risk Likelihood	Low (1)	Medium (2)	High (3)
Risk Impact	Low (1)	1	2	3
	Medium (2)	2	4	6
	High (3)	3	6	9

TABLE IV
RISK TREATMENT CRITERIA

Risk Measure	Risk Treatment Required
1-3	Risk Acceptable. No further action required.
4-6	Medium Priority - Risk Treatment Required. Implement controls within the time-period specified by the business. Such risks could be accepted if approved.
7-9	High Priority - Risk Treatment Required. Implement controls immediately to mitigate risks. Such risks could be accepted if approved.

- *Risk Treatment*

Taking into consideration Risk impact and Risk likelihood, risk treatment procedures shall be identified and implemented.

A formal risk treatment plan should be prepared. The risk treatment could be any of the following:

- Avoiding the risk;
- Implementation of additional controls to reduce the impact of risk – Controls can be selected from ISO/IEC 27001:2013 Annexure A.
- Transfer of risk – outsourcing, insurance, etc.; and
- Risk acceptance – in line with the risk acceptance criteria stated in this risk assessment procedure.

The existing and planned controls will be mapped to the ISO/IEC 27001:2013 Annexure – A control.

The Residual Risk value will be calculated after considering the risk treatment option. Using the same formula (2) mentioned below.

Residual Risk Level = Risk Impact * Risk Likelihood → (2)

- *Risk Acceptance Criteria*

The information security risk acceptance shall be based on the following criteria's:

- The cost of controls are significantly higher than the possible benefits gained from implementing ISO 27001:2013 controls;
- Acceptance of risk does not violate any legal or statutory requirements;
- Regional, socioeconomic and environmental aspects that prevent the implementation of controls;
- The possible adverse impacts on business operations due to implementation of the controls and the related stakeholders' concerns and priorities;

Fig. 4 shows the iRisk tool risk configuration interface. The standard should be selected before configure the risk. Currently implemented tool is working only for ISO 27001:2013 control set. Then, likelihood and Probability range can be selected according to the scale shows in the Fig 5. After that Risk acceptance criteria shall be identified related to the above mentioned criteria. It is shown in Fig 6. Finally the asset based risk assessment can be done according to above mentioned Risk assessment methodology. “Assess Risk” option in the main interface helps to get the “Risk management” interface which shows in the Fig. 7.

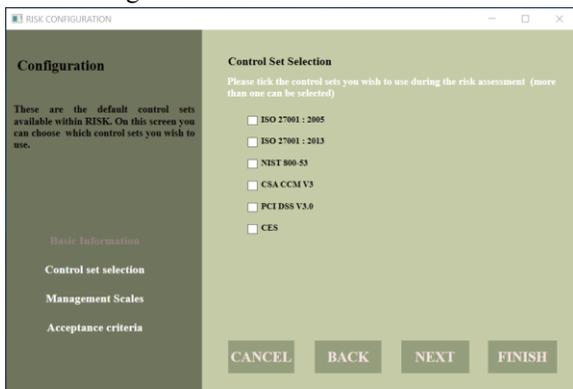


Fig. 4 Control set selection



Fig. 5 Management scale

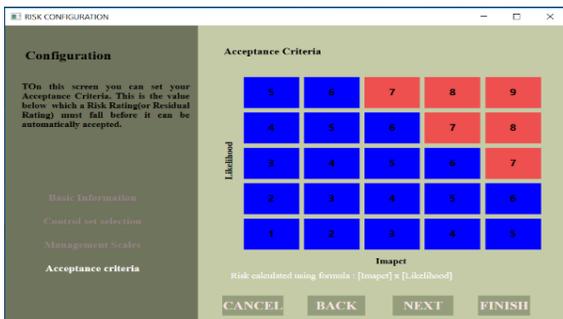


Fig. 6 Acceptance criteria



Fig. 7 Asset based risk management

V. CONCLUSIONS AND FUTURE WORK

This research work demonstrated that the implemented tool gives a unique opportunity to apply to the real scenarios in the case of risk identification, analysis and treatment. Implemented tool “iRisk” will help to minimize the manual hassle and complexity of carrying out an information security risk assessment and also saving time and resources. Further risk assessments can be repeated easily in a standard format year after year and generate reports for exporting, editing sharing across the business and the auditors.

In the future work planned to implement the same procedure for other standards as well. This will assist to identify a large amount of Risk in the organizations.

ACKNOWLEDGMENT

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Detecting Trading Patterns via Markov Decision Processes for Market Surveillance

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Abstract—Investor confidence in the markets rests in the ability to detect illegal trading activities and manipulations carried out with the intention of influencing prices. Market regulators deploy intelligent algorithms to detect these activities and identify the individuals responsible to ensure a level playing field and fairness to all participants as illegal activities result in inefficiencies and higher costs.

In this paper we present an algorithm based on AI and machine learning techniques that estimates the average trading strategy of a trader by modeling the transactions performed in response to the observed state of the market and the expected profits and losses made with respect to each transaction. Through this modeling we can compare between the strategies of different traders in addition to capturing the actions of individual traders in response to market conditions. Through this we aim to infer activities that provide certain participants and unfair advantage over others, allowing us to learn newer ways of market manipulation.

While market prices are determined through a complex stochastic process underlying trading activities the factors that largely influence prices are observable through the state of the order book which represents the supply and demand for a stock at any given time. The state of the order book can be quantified in relative terms via attributes such as imbalances in volumes, spread in the bid & ask prices, liquidity and volatility of the stock and price depth of the book. This state then influences the actions which are the particular types of orders placed by traders in search of profit. For our initial analysis we will focus on limit order books that employ a price-time priority. This is due to the fact that this is the most common priority mechanism currently used. We relate each such order to a finite set of actions using the order book at a given point in time to determine its relative standing.

We cast this problem as a Markov decision process where each state is a multidimensional variable defined with respect to attributes that reflect the relative position of the order book, the reward returned to the trader by the profit or changes to the dynamics of the order book when an order is placed by a trader.

Trading strategies are in effect sequences of orders amenable for modeling via Markov decision processes that is time varying. Each subsequent state is dependent only on the current state and the action (order) and so follow a Markov process. The number of states is kept to a finite set by defining their characteristic attributes in relative terms. The actions too belong to a limited set

as the types of orders are limited when defined in relative terms accounting for their particular position in the order book and relative volume.

The state transitions and model parameters are estimated by training on the actual states which are in effect a view of the price and order book that comes about in response to the interplay between orders placed by the trader and other influencing factors. In this way we generate an average view of the behavior of a trader based on his actions and state of the market.

Keywords—Market Surveillance; Markov Process; Markov decision process; Stochastic Processes; Trading Strategy

I. INTRODUCTION

Market regulators strive to ensure fair and proper functioning of the capital markets by enforcing legal provisions as a deterrent to market manipulation. Detecting market manipulations is important for maintaining investor confidence in the markets as manipulated markets are inefficient and bear additional costs to the investor. Regulators deploy surveillance algorithms to detect well-known types of manipulations that have patterns that are well defined. These patterns take the form of sequences of events that are defined in terms of certain types of orders, movements in the price and time intervals between such events.

Each order that is placed by a trader has a certain volume and price associated with it. The orders are placed in an order book in price-time priority which means that buy orders and sell orders are arranged in ascending and descending order of price in the buy and sell side of the order book respectively. The order book thus contains a measure of the demand and supply for a security as evidenced by the volume of orders at different price points placed on the buy and sell sides of the book. Typically it is the volume of orders at the top five or ten prices of the book that influence other traders to trade as the orders that are near the top of the book have the highest probability of executing.

The state of the order-book can be described in terms of the volumes on either side, depth in terms of the number of distinct price points in a side, the bid – ask spread which is the difference in top sell and buy prices among other attributes.

The strategy of a legitimate trader is then dependent on the

state of the order book as it reflects the total demand and supply for a stock and the difference in buying and selling prices at any point in time. Therefore one would expect many traders to exhibit similar behaviors in their trading pattern depending on the strategy they follow in the long term as they are all trading with respect to a single source of demand and supply which they all observe on a single order book.

If one is able to gauge the strategy of individual traders it would be possible to compare their individual behaviors and determine those that are significantly different, especially before and after price sensitive news publications. This may aid compliment evidence leading to potential insider dealing related manipulations. Insider dealing is notoriously difficult to detect and prove due to the complex nature of relating market news with trading behavior. However the ability to detect trading behaviors that are markedly different to the rest of the trading community and then correlate those traders (behaviors) with news events that influence market prices will provide key insights in to potential illegal activity.

Since each order sent to the stock exchange is referenced with respect to a particular brokerage and a specific trader within each brokerage, it is possible to identify individual traders or groups of individual traders involved in whatever type of market activity they engage in. Thus collusive behavior which is the manipulative trading activity of several traders trading among themselves can also be identified if their trading patterns can be isolated.

II. MODELLING THE STATE OF THE ORDER BOOK

We devised an algorithm to analyse market data stored in a stock exchange and reconstruct the order book as a series of sequential events that reflect the series of actual orders coming in to the exchange for a particular security. Thus the program is aware of each order that is placed on either side of the order book at its respective price point. Thus the program has at its disposal complete knowledge of the order book at any given point in time. Using this knowledge two attributes that describe the state of the order book are defined.

Thus each new order or amendment to an existing order placed by a trader can be classified according to these two attributes which reflect the state of supply and demand in the order book at the time the order is placed. Through this we capture the high level trading strategy of a trader with each of his activities with respect to the relative state of the order book at a given point in time. In this modelling we consider four types of order events that accounts for more than 95% of all trading activity. They are the new order, cancel, amends and fills.

A. A measure of the price depth of an order

A vector is defined that captures the maximum, mean and minimum prices on a particular side of the order book. Using this vector the price of each new order is classified as falling in to one of two intervals namely, maximum to mean and mean to minimum.

B. A measure of the relative volume of an order

A vector is defined that captures the maximum, mean and minimum volume on a particular side of the order book. Using this vector the volume of each new order is classified as falling in to one of two intervals namely, maximum to mean and mean to minimum.

C. Relative state of an order

We classify each order placed by a trader in a way that it reflects its relative position in the order book at any given point in time. Its relative position is defined by comparing at the same time the volume of the order with respect to the distribution of the total volume in the order book and its price with respect to the set of unique prices in the order book. This results in a two dimensional state that is classified by a series of adaptive and time varying thresholds.

Table 1 gives the classification of each attribute of price and volume with respect to the number of unique prices in the order book and the distribution of order volumes in the order book respectively. Table 2 gives the classification of an order by price and volume.

TABLE I. CLASSIFICATION VIA DYNAMIC THRESHOLDS

<i>Maximum - Mean</i>	<i>Mean - Minimum</i>
High	Low

TABLE II. MULTIDIMENSIONAL STATE MAPPING

Volume		
Price	<i>High</i>	<i>Low</i>
<i>High</i>	1	2
<i>Low</i>	3	4

We also define an order cancel and an order-fill as states number 5 and 6. In this way we obtain six states each for buy and sell side for a total of twelve states when both buy and sell sides are considered together. Using these states we can cast the process of trading by a particular trader as the transitions between states of a finite state machine.

III. MARKOV MODELLING OF TRADER STRATEGY

We model the orders placed by a trader as a sequence of events generated by a Markov random process where each event is mapped to one of the twelve states defined above. The transition matrix captures the conditional probability of transitioning between two successive states of this Markov model. The transition matrix is estimated from trading data for a particular security.

We divide the trading day in to a certain number consecutive

trading events delimited by a window, so that each window encompasses a fixed number of events. We then observe the traders within each such window and model their trading events as a sequence of consecutive events. This enables us to compare the average trading behaviors between traders over similar time intervals. In this scheme each window will incorporate a different number of events for a given trader. The transition matrices however are conditional probabilities that are right stochastic matrices where all rows sum to one, which enables the comparison within and between traders.

A. Markov Processes

A first order Markov process is characterized by the memory less property so that in a sequence of random variables drawn from such a process, the distribution of the next random variable in the sequence is dependent only on the current one [1].

$$P(X_n / X_{n-1}X_{n-2}\dots X_1) = P(X_n / X_{n-1}) \quad (1)$$

For the purposes of this paper, trading is modeled as being the result of a first order Markov process. However there is no restriction to higher order Markov models being considered and the analysis can proceed along similar lines by estimating the corresponding state transition matrices and anomaly detection via principal component & cluster analysis.

B. Stationarity

The probability distribution of a sequence of random variables drawn from a stationary a stationary distribution is invariant to a shift in time "l".

$$P(X_n X_{n-1} X_{n-2} \dots X_1) = P(X_{n+l} X_{n+l-1} X_{n+l-2} \dots X_{1+l}) \quad (2)$$

The algorithm is adaptive in that it estimates a transition matrix for each delimited sequence of events. This transition matrix represents the dynamics in the underlying stochastic process which may not be stationary. The goal however is to compare between sequences and determine similarities and dissimilarities between sequences and in that respect the degree of stationary of the sequence will not pose a problem to the overall conclusions made with respect to detected outliers.

C. State transition matrices and trading strategy

Trading is essentially a sequence of events that are mapped to the states of a finite state machine modeled as a first order Markov process whose state transition probabilities are captured in a state transition matrix. The transition matrices capture the dynamics in the sequence and are thereby largely representative of the strategy employed.

As the transition matrices can be estimated over a series of windows defined over a series of consecutive events it is also

possible to observe the dynamics of the strategy followed over time. Thus the changing strategies employed by a trader over time can also be quantified.

Alternatively one can calculate a state transition matrix for an extended period of time (like over a single days' worth of trading) for each trader and compare the average strategies employed across the traders.

IV. ANOMALY (OUTLIER) DETECTION CRITERIA

One of the main goals of this model is to identify traders who on average exhibit significantly different behaviors from the rest of the trading community. This is therefore an anomaly detection problem applied to the transition matrices which are representative of the average trading strategy followed. These are matrices of dimension 12 x 12 and thus have 144 elements when vectorized.

In one mode of operation each trader can have a sequence of such vectors for each transition matrix estimated over a series of consecutive windows. This type of analysis depicts the dynamics of the trading strategy of a trader over time. On the other hand one can estimate a single average transition matrix for each trader over an extended period of time. This type of analysis allows the comparison of each trader's strategy with the rest of the field. It is in this type of analysis the traders who's behaviors are markedly different from the rest can be identified. Once such anomalous traders are discovered they can be tagged for further investigation or monitored more closely for manipulations.

A. Principal components analysis in the outlier detection

The vectorized transition matrices have 144 dimensions and as such are difficult to analyze using traditional outlier detection methods like cluster analysis. Thus we employ principal component analysis (PCA) to reduce the dimensionality of the vectorized strategy matrices and compare between them.

Principal component analysis replaces the original variables with a reduced number of variables (dimensions) while accounting for as much variance in the original data set as is possible with the reduced set. All of the principal components are mutually orthogonal and represent decreasing amounts of total variation. Thus the first component accounts for the largest amount of variation, the second component the second largest amount of total variation and so on. As the PCA procedure replaces variables in the original data space with new variables (components) that are uncorrelated with each other, the vectors that are correlated in the original data space appear as groups of data points or clusters in the transformed space. Those vectors that are uncorrelated in the original data space appear as outliers in the principal component space.

Since our goal is to detect traders with widely different strategies from the norm, detecting correlation based outliers is a suitable strategy. Principal component analysis in this

regard provides the necessary tools to discover those uncorrelated data points.

V. RESULTS

In section A we present results for the dynamic trading strategy of a single trader over an extended period of time like a single trading day. In section B we present a comparison of the average trading behavior across different traders.

A. Dynamics of a trading strategy

In this model the trading day was divided into windowed intervals of 5000 events and the state transition matrix for a single trader estimated over each window. In this particular case there were 236,000 trading events by all traders in the market for this security giving rise to 46 windows, each of size 5000 events. In this way the trading dynamics of a single trader is estimated over an entire trading day

Principal components analysis while regularly employed as a dimensionality reduction technique also finds application as an outlier detection method. The traders whose trading strategies that are correlated in the original space appear as clusters in the transformed principal components space while those traders whose strategies that are uncorrelated in the original space appear as outliers in the transformed space. When one uses the heuristic that outliers are data points that are those points that are most different from the rest of the data, the distance of the point from the origin provides an estimate for the degree to which it differs from the rest of the data.

The trading strategy is a multidimensional quantity due to its representation in a transition matrix estimated over a specific period of time. Thus it's highly suited for analysis via a multidimensional analysis technique such as principal components which is suitable for detecting correlations in higher dimensions.

The transition matrices so estimated for a particular trader was subjected to an analysis by the method of principal components where it was found that many vectors were largely correlated with each other allowing their representation in a reduced space of about 10 components. In Figure 1, we depict the first three principal components and observe the clustering of the data that is due to this correlation. We also observe a few outliers that are the transition matrices that are uncorrelated with the rest of the data.

Figure 2 presents the distance of the principal component scores from the origin as a measure of comparison between the transformed data points. Through this we observe that many of the data points are indeed clustered together in the principal component space indicating their correlation in the original data space. We conclude that over many windows the trading strategy of this trader has remained largely similar. We can also use this analysis to detect those instances where the trader's strategy differs markedly from his own past behavior.

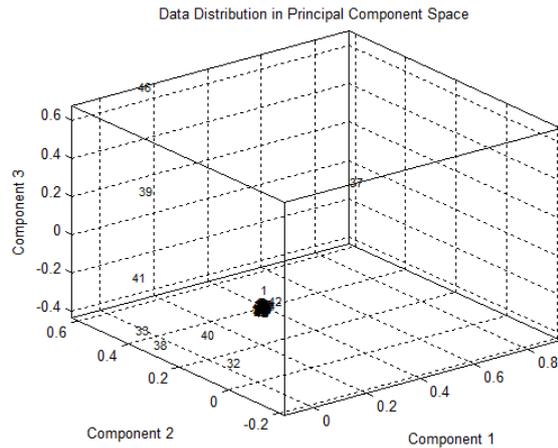


Fig. 1. Disribution of the original data in the principal component space

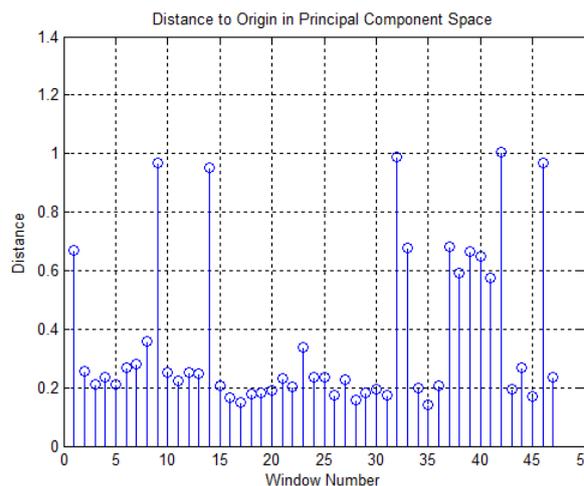


Fig. 2. Distnce of transformed data in principal component space

B. Average behavior across traders

The traders that had at least 2000 trading events across the day in question were selected for this analysis. Their individual strategies were captured via a single state transition matrix calculated on their trading pattern during the day. Figure 3 depicts the first three principal component scores of those 11 traders. We once again observe some clustering where the average behaviors (strategies) show some similarities.

The distance measure of figure 4 also confirms that several traders share broadly similar strategies while there are a few that are somewhat different. The transition matrices are somewhat dependent on the selected threshold setting scheme of which several have been explored. These include using non uniform intervals with tighter margins between top and next level, setting levels as an offset from the top of book price points or using the distribution of prices and volumes in their determination. The detected outliers are however consistent with a particular scheme as it is the relative behavior between

traders that is being assessed.

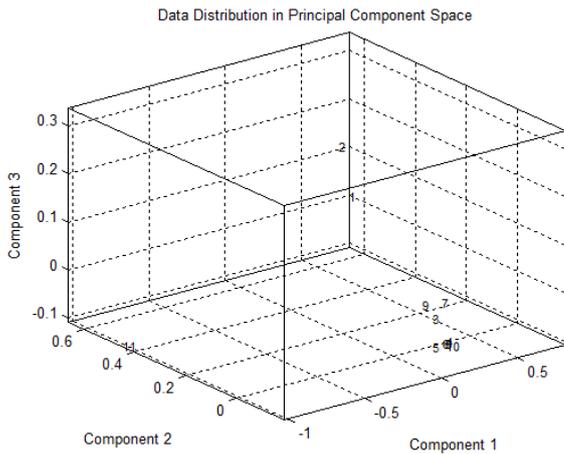


Fig. 3. Disribution of the original data in the principal component space

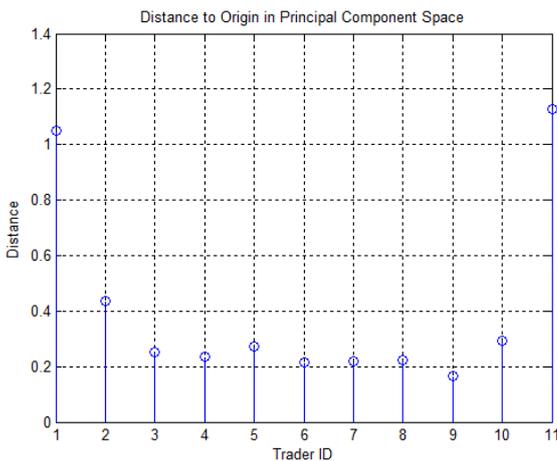


Fig. 4. Distance of transformed data in principal component space

VI. CONCLUSION

In this paper we developed a novel way of estimating the trading strategy of a trader by modeling the trading process as first order Markov process with multidimensional states that are determined via a set of dynamic thresholds. The states of the model are derived from the state of the order book and reflect the state of the market for a particular security at any given point in time.

We cast the orders submitted by a trader as a series of consecutive events that are mapped to a finite set of states in a way as to reflect the current supply and demand for that security. This was done by creating a software model of the order book to relate the position of the submitted order to its relative position in the order book.

The trading therefore is modeled via a finite state machine where certain states are defined via a set of dynamic or time varying thresholds that reflect the supply and demand for that stock at any given point in time.

As modeled, the multidimensional states based on the order book are sensitive to both price and volume variations across time and any deviation from the norm may readily be observed.

As the strategy of most traders depends on the state of the market as depicted in the order book, we observed some similarities in the overall average trading strategies across a group of traders on this day.

We also observed a relative similarity of the average trading strategy across different time periods for a given trader.

These broad conclusions with respect to the trading strategies of different traders are possible because we incorporate knowledge of the state of the market in the states of the finite machine.

Our modeling can also be used to detect anomalous trading behaviors by identifying those traders whose average strategies vary markedly from the rest of the field. It can also be used to detect changing strategies of a given trader as well. This is accomplished through a process of outlier detection where correlation based outliers will indicate those transition matrices that are markedly different from the rest of the field.

We also believe that this modeling can give insights to detecting the insider dealing market manipulation as it provides a framework by which to compare between the trading strategies of different traders.

Future work may consider expanding the number of states to capture finer movements in the variables that reflect supply and demand for a security. We also believe that it would be possible to cluster the transition matrices or a reduced dimensional representation of them to find groups of traders whose behaviors are broadly similar. This type of clustering can also be used to detect outliers and thereby anomalous traders and trading strategies.

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Enhancing Scrum with DevOps

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Abstract— With the presence of Agile practices, new forms of software development practices were evolved. Scrum, XP are some of them. But none of them can support the hourly deliver. The main factor for accepting the DevOps as the current trend is the fast nature of delivery. But development and delivery are not the only parts in software development life cycle. The research was to bring the rapid delivery to Scrum using DevOps and convert it to rapid software development method. A framework was developed to practice during the development life cycle and practiced with a development team to ensure the stability.

Keywords— Rapid software development; Agile; Scrum; DevOps;

I. INTRODUCTION

Current context of software development is complex and all the manual operations are moving towards automated solutions [1]. The accelerated software delivery is a key to success in business. New technology trends i.e. mobile, cloud, mobile and analytics are demanding for better life cycle management of software. Maintaining the balance between stakeholders' requirements and developers' requirements is also a challenge. One of the most important facts is that in traditional software development approaches the yearly delivery plan has come to two-week build cycles and then to daily builds [2]. But the process has not stopped from that point, now build cycle time has been further reduced to hours [3]. The systems are cautiously evolving with the rapid business requirement changes and stakeholders are demanding for more transparency and measurements in development.

The current software development is driven by business and the main consideration factor in the business is cost [4]. Business stakeholders are more focused on reducing cost and in traditional software processes, such as waterfall the return of investment period is long. However in the current mainstream business competition the return of investment period needs to be short. To reduce the cost it is necessary to improve the software productivity and writing less code, getting the best from people, avoiding rework, developing and using integrated project support environments are the important aspect to improve the process productivity [4]. In order to improve the productivity the understanding on types of costs is a must. Development and rework costs, code and

documentation costs, labor and capital costs, software costs by phase and activity are the types of costs involve in software developments [4].

To eliminate above costs the spiral model was proposed in [4]. However the software industry continued to demand better productivity and flexibility; as a result Agile was introduced to the software development [5]. From late 1990 Agile is in the mainstream software development process types and there are many forms of the Agile process such as Scrum; the first postulated form of scrum [6]; Extreme Programming, Crystal etc.

The present status is much more competitive and business landscape is changed to demand for “continuous delivery” and “development and operations” [7]. As a result DevOps comes to the software development industry. Devops has been adopted to leading organizations i.e. IBM [8] in order to support enhanced collaboration across the organization and value chains. Other than continues delivery and coexistence between development and operation the following are also considered [9].

- Improve the quality and performance of applications
- Enhance the end customer experience
- Simultaneously deploy software across different platforms

II. RESEARCH PROBLEM

Software process models cover following items [10].

- Requirements Analysis and Specification
- Software architecture and Implementation
- Testing and Documentation
- Training, Support and Maintenance

In all the process models software maintenance was considered as a separate sub process and developers focus on rest of the process activities. This has created a crucial gap between the developers and the production and operations staff, leading to a number of challenges and process overheads. DevOps, an improved version of merged development and operations has been explored recently in order to cover the development and operation gaps, which are present in the regular software engineering process models.

As discussed above DevOps focuses on continuous integration and continuous delivery. It does not cover any managerial aspect of software development lifecycle. Organizations practice DevOps at present without a proper framework for their software process management.

III. LITERATURE REVIEW

With the increasing demand for alteration, new software development methodologies were presented. Rapid deliveries and time to market has become the most dominant factors in software industry. Traditional approaches such as Waterfall was moved out from the mainstream and new methodologies based on Agile have gained the popularity. As per Andrew and Nachiappan [5], Agile is the most used concept in the software industry. Agile introduced four principles such as:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

Above concepts do not explicitly relate with the major activities of software development lifecycle which include deriving the specification, design and development evaluation and evolution [11]. As a result several methodologies have been evolved from the basic principles of Agile concept. Scrum, Extreme Programming, Lean, Kanban are some examples.

Scrum is the widely used methodology as an Agile software development practice [5], [12] and Scrum covers the following by its rich set of guidelines. It comprises project management as part of its practices [13]. Scrum creates a product backlog about the pending development. The Scrum method includes product owners, developers which will allow the get a broad picture of the development. As per Hneif and Ow [13] Scrum is not suitable for products which focus of usability because product owner is focused on business aspect.

The other most popular Agile practice is Extreme Programming (XP) [4]. XP consist of four phases: Planning, coding, designing and testing. XP can adapt changes at any time. XP defines the concepts such as following.

- Small releases with high-value elements
- Refactoring and Pair programming
- Continuous builds
- Sustainable development and reduce maintenance costs

Above points out that XP focuses towards the technical side of Agile developments. The concept of small releases and continuous builds lead to the new concept of DevOps.

DevOps is a new approach/new trend in software development and it reduce the gap between developer, operation and the end user [3] which leads to detect problems early. As in Scrum, though the system developed according to specification it may not get validated by end users. DevOps support continuous development and integration to avoid those pitfalls. But in DevOps there is no known framework or process [3]. To become stable DevOps should have a complete software process model, which supports specification, design and development, evaluation and evolution phases.

IV. METHODOLOGY

As discussed in the previous section, demand for rapid delivery is booming. This is purely because of the competition in the business domain and having the accelerated deliver the key to success. Companies believe that the antidote to this issue is DevOps. Most of the companies adapt DevOps without knowing that the DevOps is a cultural movement. Companies who practice Agile still struggling to adapt to rapid delivery cycles.

From the literature, it's proven that the Scrum is the best methodology to be used as an Agile practice. The success behind this is based on the proper declaration of the flow throughout the software development process. Scrum never discuss about the maintaining the quality of the product. As a result one drawback of Scrum is that the developers may conform that a development has been done without the most suitable implementation. Rather than the most suitable implementation, developers may focus on the easiest implementation.

In the other hand DevOps focuses on the long run of the software with shorter feedback, quick integrations and rapid deliveries. DevOps falls behind due to the unavailability of proper defined guideline to follow during the software development lifecycle.

The study is focused on building a methodology where Scrum is used to cover the managerial aspect of the software development lifecycle and DevOps is used to support the rapid delivery requirement. Scrum is chosen because it has proven that it's the best Agile practice. Most of the software developments fails due to less control over the total flow. In Scrum the loop holes have been closed and the adaptation proved that the Scrum is the best framework in Agile. The solution will bridge the Scrum which covers the development aspects and DevOps which covers the rapid delivery aspect.

A. Gaps and overlaps

The development and deployment flow between Scrum and DevOps cannot be done without filling the missing components. To understand this need to check the role and the requirements of Scrum and DevOps in different stages of software lifecycle. Given below the stages of software development lifecycle and current scrum methodology covers the first three aspects. They are covered up to the development and release stages only. Final stage is not covered at all by the scrum process.

- Planning
- Execute
- Inspect and adapt
- Operation and support

But DevOps cannot combine directly with the current Scrum flow. To understand the gaps and missing components, first it's required to understand the industry requirement. The main requirement is to minimize the time to market factor and stability of the product. The competition between vendors are

much high and one failure may causes the business to end and increase the customer churn rate. Other than that industry need to attend the production issues as fast as possible to keep the customer satisfaction and retain the customer with the product.

According to Michaels' [14] Components of DevOps framework (namely, Metrics and measurement view, Process view, Technical view) is crossed checked with the industry requirement given above, the focus area is getting narrowed.

To cater the industry requirement, the lagging parts are fast feedback from production, push features faster to production. This is covered under the technical view. With that fact, we can conclude the Scrum doesn't need to adapt to all the views. It's enough to adapt the technical view.

To achieve the fast feedback and the frequent feature update to production requires continuous integration and continuous delivery. These are the main components of technical view. In order to achieve continuous integration and continuous delivery following factors are required [15].

1) Single Repository to Manage the Code Base

In the continuous integration and continuous delivery context a central repository is mandatory. So to merge the two solutions, it's a mandatory requirement to have a central repository.

2) Automate the Build

Once a feature is developed, developer has to test the build in the local machine. For this, the developer should have the capability to build the solution automatically. Other than that after committing the feature to main line, main line should be built automatically. This is a new concept for Scrum. So to build the solution, build automation should be introduced.

3) Keep the Build Fast

In Scrum user stories are developed from end to end. Because there's no requirement to build fast. In order to merge the continuous integration and continuous delivery to Scrum, user stories should be developed in an incremental manner and should commit to the central repository for the build.

4) Self-Testing Build.

In the Scrum context, the quality assurance team (QA team) develop the test cases for the software and after releasing a user story they test the component of the software. Other than that sometimes developers develop the unit test cases and check for issues.

5) Commits to the Mainline Every Day

In the current Scrum practice the estimations are done by whole team and estimation time are done in days. But to support "At least one commit per day" need to break the user stories feather down. This should be a responsibility of the developer who owns the user story.

6) Fix Broken Builds Immediately

This is not practices in Scrum currently and to merge continuous integration and continuous delivery to Scrum this condition should be introduced.

7) Test in a Clone of the Production Environment

In order to smooth line the continuous integration and continuous delivery, software should test in the clone of the production system.

8) Everyone Can See What's Happening

To fill the gap between the Scrum and the continuous integration and continuous delivery a tool should be developed. This will be discussed in detail under design and implementation chapter.

9) Automate Deployment

In Scrum concept of automated deployment is not present. So adhere continuous integration and continuous delivery to Scrum, automated deployments should be available. With this getting the latest executable is also possible.

B. New Framework

Supported by above facts we can conclude that the methodology should cover following areas. Each area will have a set of condition that need to satisfy. So to define the new framework the combination of Scrum, continuous integration and continuous delivery, need to modify Scrum rituals, rules. There modifications are done to support continuous nature.

- Development environment setup
- Planning
- Execute
- Inspect and adapt
- Operation and support

According to section A following are the identified Requirements and the policies for each section.

1) Development Environment Setup

In order to achieve the continuous integration and continuous delivery in a Scrum environment, the code management and the automation should be implemented. Following are the key factors that need to have in the environment.

- A Single Source Repository to manage code base
- Separate identical environments for testing, staging and production
- Build automation tool
- Test automation tool
- Configuration management tool
- Overall progress monitoring tool

2) Planning

Requirement gathering will not be much differ from the current approach. The conditions that need to cover are commits to the mainline every day and giving high priority for production issues.

Rule set for planning is given below.

- The user story estimation is done as per the current practice

- If the estimation of the user story is greater than a day, sub user story should be developed which should be shippable
- The sub user story definition is the responsible of the assigned developer. This is to minimize the time take to the meeting.
- High priority should be given to the production issue than the backlog

3) Execution

To Support continuous integration and continuous delivery in a Scrum environment can be achieved by competing the test automation and build automation.

Rule set related to developers is given below.

- Developer should write unit test cases
- Quality assurance should write the test cases
- Developer should test the code against unit test
- Developer should test the build against the test cases
- If both passes, commit to the main line
- Developer is responsible for the commit and should make sure the mainline is built successfully
- If not developer should fix it immediately
- Developer should run all the test cases in the mainline
- In this stage developer can use a code quality check tool.

4) Inspect and adapt

To support the continuous integration and continuous delivery, testing should be automated as far as possible. Some cases manual testing cannot be replaced. For example UI testing, the look and feed cannot be automated. Main focus is to automate the test and this will lead to have merged stage of implementation and testing in the software development. Each test should be executed in each environment before going to production.

Rule set for quality assurance / testing is given below.

- Should write test cases and finish before end of development
- Make the test cases available to developers to run on the new build
- Should not port the feature to staging till all the test cases passes
- Should run all the automated test cases in staging

5) Operation and support

This is the new area that appears, which was not in the Scrum earlier. This area covers the automated deployments, performance monitoring of the system and escalating the operational issues to the developer. DevOps discuss about this aspect as the fast feedback from production to development.

To support continuous integration and continuous delivery deployment should be automated. In a theoretical scenario, deployment of automation should be implemented to the production level. But in a practical scenario there can be restriction applying updates to production each day or there can be approval process on applying updates on production. But this restrictions are only valid for production and automated deployment can be done up to staging without any issue.

Rule set for Deployment is given below.

- Deployments should be automated up to the staging level

- If there's no restriction, automations should extend to production
- If there's restrictions, maximum time should be defined to release a feature to production.

Rule set for performance monitoring is given below.

- Performance issues should be escalated to developers from production
- Developers should address related performance issues in the next sprint

Operational issues can be identified either from support desk or log analyzers. Issues reported from both method should be treated as follows.

Rule set for operational issue escalation is given below.

- Critical bugs reported should be fixed in the current sprint or as hot fix
- Medium and low bugs should be added to future sprints based on the impact

C. Evaluation methodology

To verify a new method, an evaluation has to done. Without the quantitative factors we cannot say that the new method is more successful than the previous method. To compare current Scrum practice and the proposed methodology there should be an evaluation method.

In scrum evaluation, following matrices are been used [16] [17].

- Sprint Burn-down
- Epic and Release Burn-down
- Velocity
- Control Chart
- Cumulative Flow Diagram
- User stories planned versus user stories delivered
- User stories delivered versus user stories accepted
- Defect-removal efficiency (DRE)

In DevOps context following matrices are been used [18].

- Deployment (or Change) Frequency
- Change Lead Time
- Change Failure Rate
- Mean Time to Recover (MTTR)

According to paper Jeeva Padmini [19], following are the leading matrices used in Sri Lanka for agile software development.

- Work capacity
- Percentage of adopted work
- Sprint-level effort burndown
- Velocity
- Percentage of found work
- Focus factor

To evaluate the new methodology use of following matrices are proposed. This matrices coves the Scrum and the continuous integration and continuous delivery aspects. The matrices were chosen in such a way that enables to compare standard scrum and proposed methodology

- User stories planned versus user stories delivered
- User stories delivered versus user stories accepted

- Defect-removal efficiency (DRE)
- Deployment (or Change) Frequency
- Velocity

V. EVALUATION AND FEEDBACK

There were multiple aspects that need to evaluate. Those are given below and different approaches have been used to evaluate the components. Finally combined outcome had been evaluated.

- Proposed Framework
- Framework practice outcome

The proposed framework was evaluated by a set of Scrum Masters, Project Managers and Developers. To evaluate the proposed framework set of questions was used. Given below the set of question that used.

- Proposed framework will deliver better results relative to Scrum
- Proposed framework can be adapted with minimum changes
- Proposed framework contains all the necessary guidelines for development
- Proposed framework enforce the CI CD with proper guidelines
- Proposed framework improve the end to end viability (from Development to operation)
- Proposed framework improves the velocity
- Proposed framework improves the code quality and standard
- Proposed framework improves the rate of delivery
- Proposed framework improve the Mean time to recover
- Provided tool enhance the end to end visibility
- Provided tool shows the bottlenecks in the development cycle and get the early attention
- Provided tool's modular architecture enables easy integration with third-party tools

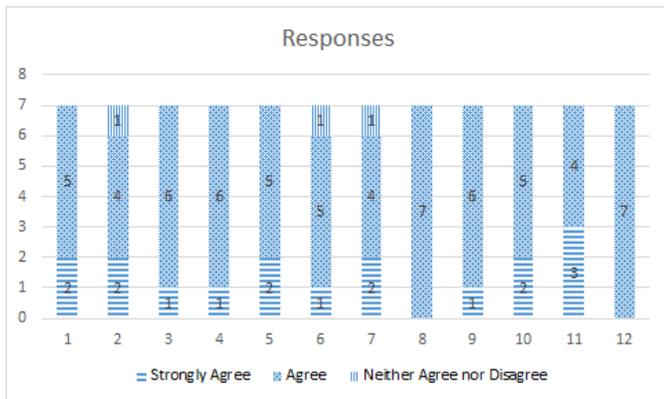


Fig. 2 Questioner responses

TABLE 1

TEAM FOLLOWING THE STANDARD SCRUM

Matrix	Value
User stories planned	5
User stories delivered	4
Percentage of user story delivered	80
User story accepted	4
Percentage of user stories accepted	100
No of Dev defects found	5
No of Dev defects fixed	3
Defect-removal efficiency	60
Deployment Frequency	1
Expected Velocity	25
Actual Velocity	20

Evaluation of results are shown in table 1 to table 3 and the comparison of results has been shown in table 4.

TABLE 2

TEAM FOLLOWING THE ENHANCED SCRUM - FIRST SPRINT

Matrix	Value
User stories planned	4
User stories delivered	3
Percentage of user story delivered	75
User story accepted	3
Percentage of user stories accepted	100
No of Dev defects found	8
No of Dev defects fixed	8
Defect-removal efficiency	100
Deployment Frequency	3
Expected Velocity	20
Actual Velocity	15

TABLE 3

TEAM FOLLOWING THE ENHANCED SCRUM - SECOND SPRINT

Matrix	Value
User stories planned	4
User stories delivered	4
Percentage of user story delivered	100
User story accepted	4
Percentage of user stories accepted	100
No of Dev defects found	5
No of Dev defects fixed	5
Defect-removal efficiency	100
Deployment Frequency	4
Expected Velocity	20
Actual Velocity	20

TABLE 4

COMPARISON ACROSS SCRUM APPROACHES

Matrix	Standard Scrum	Enhanced Scrum	
		First Sprint	Second Sprint
Percentage of user story delivered	80%	75%	100%
Percentage of user stories accepted	100%	100%	100%
Defect-removal efficiency	60%	100%	100%
Deployment Frequency	1	3	4
Expected Velocity	25	20	20
Actual Velocity	20	15	20

The first attempt of the Enhanced Scrum shown a decrease in user story delivery and actual velocity. This was due to the learning curve of the new framework. But there was an improvement in deployment frequency and the defect removal rate.

The second sprint that followed the Enhanced Scrum has shown an improvement over the first attempt and actual velocity was equal to the reference value. Also it had improved over the user story delivery and acceptance. When the second sprint was compared again the reference sprint the defect removal rate and deployment frequency had been improved.

In a nutshell, after the learning curve the Enhanced Scrum approach had improved the team performance.

VI. CONCLUSION

The rapid delivery nature that demands by the industry is major concern and development practices are searching for various alternative methods to address this issue. Though the industry follows different practices which are developed in house to cater the requirement, there's no standard framework. This framework was proposed to standardize the adaptation of continuous nature to the industry.

The most adapted methodology in the Agile context is Scrum that because of its rich management aspect. To benchmark the new framework a previous sprint data was used where the team was following the traditional Scrum practice. Key aspect that targeted at the beginning of the research was to reduce the time to go live, increase the feedback from operation and improve the end to end visibility.

The matrices were chosen to validate above key aspects. Results in the table 4 shows the outcome of the proposed framework. The comparison between traditional scrum sprint and the second sprint of the new framework shows the successfulness of the proposed framework. With the improvement of the defect removal efficiency, it proved the fast feedback from the operation. With the improvement of deployment frequency, it proves the reduction of time to go live. The expected velocity and the actual velocity was equal in the second sprint and that proves the improved end to end visibility. With that we can conclude that the proposed framework address all the key aspects.

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Effect of Fuel Viscosity on Combustion Performance of Heavy Fuel Oil (Hfo) Fired Gas Turbines

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Abstract: Fuel flexibility in thermal power generation plays a vital role in energy security in the present context because of the scarcity of petroleum resources. Among them, gas turbines play a key role since its ability to operate in multiple fuels and switch fuels during the operation. Especially in countries like Sri Lanka where the petroleum reserves are not available, burning HFO (Heavy Fuel Oil) in a Combined Cycle Power Plant with gas turbines will be an added advantage for the countries power system and the economy. The HFO is produced as a byproduct in the local refineries could also be utilized in an efficient and eco-friendly manner for Gas Turbine operation rather than using it for conventional boilers for small scale industry as done at present. This too would accrue a considerable benefit to the country environmentally and economically.

Yugadanavi 300 MW Combined Cycle Power Plant was a landmark project in Sri Lanka which started its commercial operation on 2008 as a Simple Cycle power plant while converted into Combined Cycle in 2010. It consists of two GE frame 9E gas turbines and one GE SC5 steam turbine. The gas turbines are continuing its 10th year of commercial operation being one of the critical power stations to the Sri Lankan grid by playing an anchor role in reliability. Being the first Combined Cycle power plant operated in HFO in the region, Yugadanavi was a remarkable achievement by local engineering talent of LTL HOLDINGS which is one of the leading engineering companies in Sri Lanka.

Fuel is the lifeblood of the combustion and hence proper characteristics of fuel need to be maintained. Typically, in a gas turbine, liquid fuels are atomized to break into small droplets to have a better combustion. Viscosity is one of the most significant factors which directly affect characteristics of atomization. Controlling the viscosity of fuel oil is an important aspect of an efficient combustion. A high viscosity fuel oil tends to degrade atomization which in turn leads to incomplete combustion. Meanwhile low viscosity can lead to insufficient lubrication of the wear parts of the fuel circuit and can lead to premature failures.

This paper sets out the 1st phase of field verification and the preliminary test carried out in gas turbine by varying the viscosity of the HFO and controlling the fuel temperature.

I. INTRODUCTION

Heavy duty gas turbines (GT) boast several significant assets as power production tools. Indeed, they offer a high level of reliability and maintainability as well as short installation lead times and versatility of operation in all electrical applications: peaking; cogeneration; base/half-base power production.

The primary energy of choice for gas turbines is gas in most cases, but due to the increasing price volatility of this conventional fuel, energy stakeholders are led to actively explore alternative options. This has been the case in Sri Lanka where LTL Holdings (LTL) has adopted heavy fuel oil as primary fuel with distillate oil (DO) as startup/shutdown fuel.

Burning HFO in a GT combined cycle implies developing an integral policy in the fields of power system design, fuel procurement, operation procedures and environmental aspects, with a special attention to be paid to SO_x, NO_x, and particulate matter (PM) emissions as well as on aqueous effluents.

Since 2008, LTL Holdings operates 2 Frame 9E units at their Yugadanavi 300 MW Combined Cycle power plant. This power plant has been converted to combined cycle in 2010 and both gas turbines together has exceeded 60,000 hours of successful operation on HFO as of May 2017.

After reviewing the main milestones and achievements of the Yugadanavi project, this paper covers the preliminary study of fuel viscosity in combustion performance and the financial impact on fuel heating with new viscosity requirements.

II. BRIEF OF YUGADANAVI

Figure 1 shows a general picture of the Yugadanavi power plant which is located in Kerawalapitiya, Wattala. Yugadanavi power plant, a 300 MW E-class Combined Cycle Gas Turbine (CCGT) plant featuring 2 Frame 9E GTs, 2 heat recovery steam generators (HRSG) and 1 steam turbine (ST), a plant structure denoted as a “2-2-1 configuration”.



Figure 1: General view of the Yugadanavi 300 MW CCPP

III. BRIEF PORTRAIT OF YUGADANAVI

Fuel sourcing was a difficult task from the outset and CPC (Ceylon Petroleum Cooperation) took the responsibility of supplying the fuel as per the OEM guidelines and as well as to cater the environmental regulations given by CEA. Both CPC and the power plant agreed on a Fuel Supply Agreement (FSA) and fuel was supplied in accordance with that agreement. Table 1 shows the typical fuel specification for the power plant.

Table 1: Typical properties of HFO

Density @ 15°C	970 kg/m ³
Flash point PMCC	70 °C
Pour point	< 24°C
Total sulfur content	1.69 % w
Kinematic viscosity at 50°C	170 cSt
Water content	0.24 %
Ash content	0.02 % w
Conradson carbon residue	10.61 % w
Lower Heating Value	43 MJ/kg
Vanadium	34 ppm w
Nickel	21 ppm w
Lead	< 1 ppm w
Sodium + potassium	7 ppm w
Calcium	4 ppm w

IV. INITIATION OF THE DEVELOPMENT

Initially, the HFO specification for the power plant was driven by the category “RME 180” in ISO 8217 with some adjustments to Sulfur, Sodium & Vanadium content. Therefore, CPC supplied special fuel to the power plant and parameters were almost at a constant level. Initially, the HFO heating temperature was pre-configured at 130 °C to meet the viscosity limit given by GE (10 cSt at GT fuel nozzle inlet) as per GEI 41047. Progressively, CPC upgraded their refinery process as well as the source of crude; they were able to produce suitable HFO for Yugadanavi. Also with the competitiveness of the fuel supply in the world and fuel blending, some parameters started to vary significantly.

Viscosity became one critical of them and plays a vital role in fuel combustion.

An efficient atomization is the basic need for an adequate mixing of fuel and heated air, without which, an efficient combustion cannot be obtained. Thus, it is very important to set the viscosity value in the right range. Viscosity of heavy fuel oils can be reduced by raising its temperature with a dedicated fuel oil heater. This can be done by using either; automatically regulated heaters to maintain a constant temperature or by using a manual control which can be adjusted according to the requirement.

V. PRELIMINARY FIELD TEST

A viscosity meter, which operates by measuring the damping of an oscillating electromechanical resonator immersed in a fluid whose viscosity is to be determined, was installed down-stream of the HFO heater. Basically, temperature measuring probes (24 devices) which were installed on GT exhaust was used to measure the combustion efficiency. On the other hand, installed temperature sensors in hot gas path and measurements recorded by the emission monitoring system on HRSG (Heat Recovery Steam Generator) were used as a secondary measurement. Figure 2 shows a schematic diagram of the existing system with new installation.

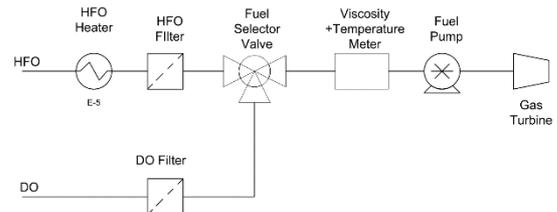


Figure 2: Schematic diagram of the existing system with new Viscometer

Four temperature settings (130 °C, 125 °C, 120 °C & 117.5 °C) were tested initially with two load cases which are 100 % and 75 % of GT load. Temperature and the mass flow measurements installed on the both side of the HFO heater were used to do the financial saving calculations. In order to investigate the long-term effects, borescope inspection technique was used in GT combustors.

VI. TEST RESULTS

Fuel sourced from Singapore is used for this test and Table 2 shows the parameters of the fuel used.

Table 2: Parameters of the fuel used for the test

Density @ 15 °C	970.7 kg/m ³
Viscosity @ 50 °C	96.3 mm ² /s
Sulfur content	1.53 m/m
Flash point	> 70 °C

Pour point	21 °C
Water content	0.1 % V/V
Ash content	0.03 % m/m
Vanadium	22 mg/kg
Sodium	6 mg/kg

Table 3 & 4 shows the variation of viscosity, density and fuel temperature at tested temperature set point of the heater when the unit was running at 100 % & 75 % load.

Table 3: Variation of parameters at 100 % load

Temperature set point	130 °C	125 °C	120 °C	117.5 °C
Fuel viscosity mm ² /s	7.527	8.171	9.378	9.928
Fuel density kg/m ³	946.40	950.88	953.23	954.51
Fuel temperature °C	128.31	123.26	118.39	115.66
Fuel flow kg/s	7.835	7.6158	7.641	7.667

Table 4: Variation of parameters at 75 % load

Temperature set point	130 °C	125 °C	120 °C	117.5 °C
Fuel viscosity mm ² /s	7.577	8.295	9.145	9.638
Fuel density kg/m ³	949.18	951.63	954.03	955.07
Fuel temperature °C	128.44	123.67	118.58	116.04
Fuel flow kg/s	6.832	6.837	6.813	6.818

Main combustion patterns were monitored using the installed thermocouples for the gas turbine exhaust temperature variation, and all 3-exhaust spread values the (difference between highest and lowest exhaust temperature readings) in order to verify even combustion in all 14 combustion chambers. Intensity values of the all 4 flame detectors, temperature distribution in between hot gas path were also used to monitor combustion dynamics and patterns. HRSG stack emissions were also

measured and variation was studied to analyze improper combustion.

Figure 03 shows the variation of exhaust temperature sensor 1 (out of 24) with time at 100 % load on the gas turbine. Graph clearly shows the variation in all the temperature set points for the fuel is in same range and it elaborates there is no significant exhaust temperature change with the fuel viscosity variation.

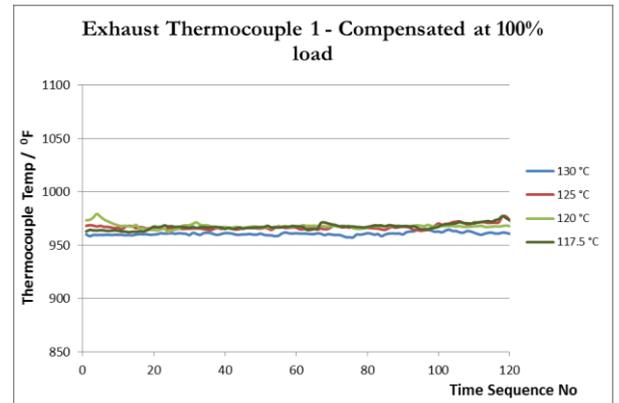


Figure 3: Variation of exhaust thermocouple 1 as a function of time at 100 % load

Figure 04 shows the variation of combustion spread 1 which will be the maximum one (out of 3) with time at 100 % load on the gas turbine. Exhaust spread indicated the difference between maximum recorded exhaust temperature and the minimum recorded exhaust temperature at a given time. Graph shows there are no significant spread change with the fuel viscosity and hence conclude the proper combustion.

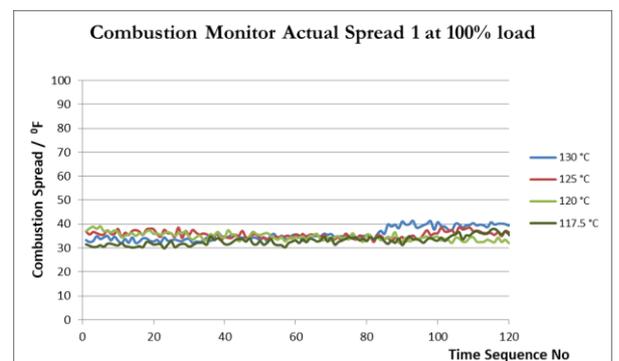


Figure 4: Variation of exhaust spread 1 as a function of time at 100 % load

Figure 05 shows the variation of first turbine temperature at the exhaust gas flow at 100 % load on the gas turbine. This will give an indication where the combustion is happening in combustion chamber. Since all the readings

related to all viscosity points are at same level, it can argue that the proper fuel atomization is happening at all viscosity levels and fuel combustion is equivalent to initial set point given by GE as 130 °C.

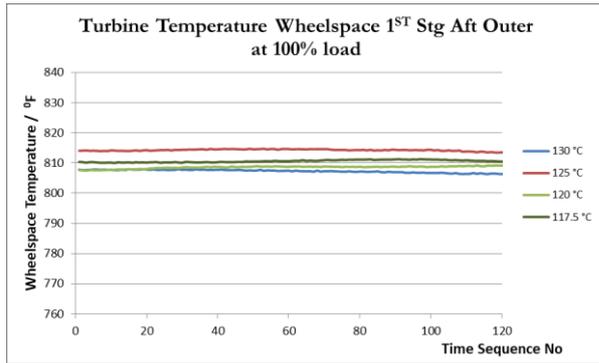


Figure 5: Variation of hot gas path temperature 1 as a function of time at 100 % load

Figure 06 & 07 shows the variation of NO_x emission and Opacity (indication of the amount of particulate matter) of the exhaust gas, with time at 100 % load on the gas turbine. Similar readings elaborate the complete combustion with same characteristics at all 4 given viscosity values.

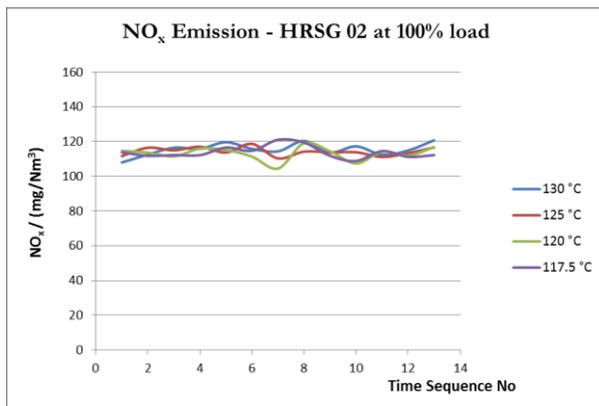


Figure 6: Variation of NO_x as a function of time at 100 % load

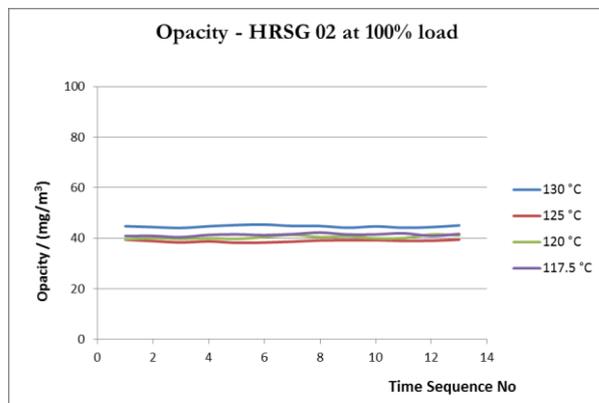


Figure 7: Variation of opacity (particulate matter) as a function of time at 100 % load

VII. FINANCIAL EVALUATION

Based on the field data collected at 100 % and 75 % load, it was clearly identified that there is an opportunity to reduce the fuel temperature at fuel nozzle inlet while keeping good combustion & emission patterns. Financial gains were evaluated after a month of operation at reduced fuel temperature. A considerable financial saving is observed during in the window of field test and detail calculations will be done during the second phase of this test.

VIII. FUTURE DEVELOPMENT AND 2ND PHASE

This experiment should be conducted over an extended period in order to pursue the evaluation of main combustion patterns. So, following steps should be considered for future testing:

1. Increase of fuel viscosity up to 12 cSt and carry out the same evaluation
2. Operate the power plant at a certain fuel temperature level over an extended period and evaluate the effects on the unit efficiency (determine best conditions for operation)
3. Operate the power plant during one cycle (combustion inspection) with fixed viscosity and evaluate/compare the parts status with the one related to baseline operating conditions

Once the above listed steps are complete, closed-loop control logic could be implemented in order to allow the GT User to set a fuel viscosity/temperature level for an improved control of the HFO heater.

IX. CONCLUSION

The expected vigorous development of the Sri Lankan economy during the forthcoming decades requires an energy efficient operating system burning petroleum products for power generation. In this context, an online viscometer for HFO operation in units such as gas turbines and boilers can provide significant financial benefits and fuel savings.

This technique can be used for any type of combustion installation burning heavy fuel oil since online viscometers are available on the market and are relatively cheap as compared with the energy savings on the fuel reheating system.

This development work has been carried out as part of a fruitful LTL-GE collaboration. This paper has summarized two outstanding initiatives aiming at improving fuel economics by using new viscosity requirements for the combustion system and reducing fuel consumption for the HFO heater.

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Contribution from plant technical staff that supported for installation and commissioning of these equipment will be well recognized.

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A Framework for Macroeconomic Stress Testing on Credit Risk Management in Sri Lankan Banking Sector

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Abstract— In Sri Lanka the financial System composes the leading financial institutions which are associated with increased growth of an economy and contributes to the nation's growth as well. Hence Financial system stability has become an integral part which safeguards financial system which is able to hold off external and internal shocks. This Process implements a healthy environment for investors and encourages financial markets and institutes for the efficient and effective functioning. The maintenance of financial system stability leads to analyze and emphasize potential vulnerabilities and risks to the financial system. Among the potential vulnerabilities and risks, Credit risk can be introduced as the dominant and leading macroeconomic risk factor in many banking sectors which has been introduced as the problem towards the financial system stability. Therefore Credit risks must be managed from financial crisis to enhance the performance, sustainable growth and consistent profitability for the betterment of financial system stability. The purpose of this research project is to propose a framework to investigate the relationship between credit risk management and its impact on performance of the Sri Lankan Banking Sector.

Keywords— credit risk, macroeconomic factors, stress testing, financial stability,

I.INTRODUCTION

Financial system stability is defined as the ability of the financial system to perform its key functions of resource mobilization and allocation, risk management and the settlement of payments, effectively at all times and even under stressful circumstances. Financial system stability is founded on the confidence of the public in the financial system. This in turn is based on the soundness, efficiency, robustness and security of financial institutions, financial markets, financial infrastructure and financial regulation. The stability of the financial system depends largely on the soundness and resilience of the principal components, i.e., financial institutions, financial markets and financial infrastructure to collectively withstand adverse disturbances and shocks. The financial system in Sri Lanka consists of the following main components:

1. Financial institutions: Banks, finance companies, other credit providing institutions (including microfinance institutions), leasing companies, insurance companies, primary dealers, stock brokers/dealers, investment managers, margin providers, stock underwriters, unit trusts, provident and pension funds.
2. Financial markets: Money market, bond market, foreign exchange market and the equity market and the derivatives market.
3. Financial infrastructure: Payment and securities settlement systems, clearing systems and trading platforms. There are also infrastructure service providers, such as credit rating agencies, credit information registries and financial information providers.

Financial stability in financial institutions is mainly based on the economic and financial influences. Hence that the financial crisis explicitly affecting to the financial institutions existence and the profitability. Following are the interrelated factors which support financial system stability, which is stable macro economy, reliable payment system, efficient financial market etc. [1]. It is necessary to measure the performance of the financial institutions and predict them for the future enhancements and to minimize the potential vulnerabilities that can be affecting to the survival of the financial institutions. Credit risk plays an integral role on banks "profitability since a large chunk of banks" revenue accrues from loans from which interest is derived [20]. Also, this credit risk may be a most serious threat to the performance of financial institutions. Hence that several researchers have investigated the impact of credit risk on financial institutions in varying dimensions. The major studies related to this related issue of credit risk and financial institution performance have reviewed in following section.

This paper is organized as follows: Section I discuss about the introduction to the area of research. Section II illustrates work related to this research area. Methodology is comprehensively elaborate in section III. Finally, the conclusion and the future works are stated in the final part stated as section IV.

II. LITERATURE SURVEY

During the past decade many literature have handled with theoretical frameworks of macro-economic stress testing and its practical application. Central bank and World Bank have emphasized the importance of stress testing to the financial stability modeling in order to safeguard the financial system from potential vulnerabilities. Today stress testing is conducted on both macroeconomic and micro economic level. Central banks have implemented their own stress testing models. Stress testing is also adopted by individual banks for the purpose of risk management.

In the study by C. Borio, C. Furfine and P.Lowe on "Procyclicality of the financial system and financial stability: issues and policy options"[3], explicitly reveal that stress testing has been adopted as a mechanism for the awareness of the relationship between risk and business cycles.

Most recent study by M. Drehmann and K. Tsatsaronis the paper on "The credit-to-GDP gap and countercyclical capital buffers: questions and answers", shows that stress testing could be adopted in effective and convenient way as a crisis management and resolution mechanism and it could raise the discipline of thinking about financial stability [4].

Basically there can be several potential vulnerabilities and the risks directly affecting to the financial systems in the banks. Risk is something that cannot be predicted exactly due to uncertainty of an event. The extensive risk that is confronted by financial institutions is credit risk, market risk and liquidity risk [1].

2.1 Financial Risk Types

A. Credit Risk

Credit risk is the risk that a counterparty may not pay amounts owed when they fall due. Credit quality often becomes the dependent variable because the stability of financial sectors mainly comes from the credit risk. This can be measured by looking at Non- Performing Loan (NPL) ratio and NPLs are defined as loans on which the borrower does not make any payments in respect of interest or principal for a period exceeding three months [2]. Following equation (Eq.1) shows the Non-Performing Loan manipulation.

Non- Performing Loan (NPL) ratio=Total Non-Performing Loan (NPL)/Total Loan (1)

Hence that Non- Performing Loan (NPL) ratio can be used as an indicator of credit risk to conduct macroeconomic stress testing for financial institutions [1], [10].

B. Market Risk

Market risk is the risk of loss due to changes in market prices such as interest rate risk and foreign exchange risk [1], [10].

C. Liquidity Risk

Liquidity risk is the risk that amounts due for payment cannot be paid due to a lack of available funds [1], [10].

Among above mentioned potential risks, credit risk has the highest severity which involves in the banking risks category. Hence that it is an essential to manage this risk to safeguard the financial bankrupts. To manage the risk first the institution must identify the risk, for that a unique process called stress testing is used to examine the potential effects on a firm's financial crisis.

2.2 Stress Testing

A stress test is an estimate of how the value of portfolio changes when making considerable changes to some of its risk factors. The main objectives are to identify and determine structural vulnerabilities in the financial system and to assess its resilience to shock. Commonly stress testing used to estimate the impacts of macroeconomic conditions. Due to that specifically called it as Macroeconomic Stress testing which is a technique used to assess the flexibility of the financial system to extreme but credible macroeconomic shocks. Macroeconomic stress testing is a forward looking mechanism that could be used to identify systemic risk to the financial sector at an early stage, due to changes in macroeconomic variables [2].

Stress testing could be conducted on many different risks. The paper of H. Hesse and M. Čihák, on "Cooperative Banks and Financial Stability", discusses about various stress tests for the individual risk factors such as credit risk, interest rate risk, foreign exchange risk and liquidity risk. In the most of the studies that were conducted on stress testing focal point is on credit risk as the primary risk in banking sector. Before calculating the liability to credit risk in case of stress scenario it is essential to create a link between macroeconomic conditions such as GDP growth, interest rate, exchange rate, inflation rate and credit risk indicator.

In the paper of M. Bofondi and T. Ropele on "Macroeconomic Determinants of Bad Loans" illustrates and analyzed Italian financial sector and captured from the study that the quality of lending depends on a small number of macroeconomic conditions that illustrate situation of economy in a broad manner. The loans quality and credit risk are impacted by changes in those macroeconomic conditions with delay [6]. Also another conformation of robust link between credit risk and macroeconomic conditions happens from the study of Virolainen on "Stress Testing with a Credit Risk Model: an Application to the French Manufacturing Sector", in this research paper collective default rates were estimated on key macroeconomic condition including interest rates and GDP growth. The test results show significant relationship between the mentioned conditions [7]. As stress testing is conducted commonly for the conditions of the

macroeconomic, there is a necessity of familiar with the macroeconomic variables that are impacted on credit risk's Non Performing Loans. Following section illustrates the variables that are going to consider in this research.

2.3 Macroeconomic variables

A. GDP Growth

Gross Domestic Product (GDP) is combine demand of an economy. A growing economy is associated with rising incomes and makes financial distress decreased. Hence that real GDP growth has negative impact towards the Non-Performing Loan [1].

B. Exchange Rate

Exchange rate is the price of domestic currency which has expressed in terms of a foreign currency. The correlation between exchange rate and Non-Performing Loan is uncertain, because it depends on international trade and country's capital account [1].

C. Inflation Rate

The inflation rate is the percentage rate of change of a price index over time [1]. The impact on inflation on Non-Performing Loan can be positive and negative [1].

D. Interest Rate

Interest rate is the amount charged which can be expressed as a percentage of principal by a lender to a borrower for the use of assets. Interest rates are typically noted on an annual basis, known as the annual percentage rate (APR) [8].

Since this research area is primarily focuses to the stream of economic and financial literature, there are two pin points were specifically used to benchmark the banking performance. It is the profitability of assets namely Return on Assets (ROA) and Return on Equities (ROE). Following literature illustrate the two performance benchmarks separately.

2.4 Financial Stability Profitability Performance Indicators

A. Return on Asset

This is the indicator of how a firm is relative to its total assets and how efficiently manages its firm's assets to generate earnings. Basically this Return on Assets (ROA) measured as a percentage and following is the equation (Eq.2) for the Return on Assets (ROA) [9], [10].

$$\text{Return on Assets (ROA)} = \text{Annual Earnings/Total Assets (2)}$$

B. Return on Equities

This is another variable used to measure profitability performance. It is the ratio of net income and total equity. It shows the rate of return generated by the owner's equity. Basically this Return on Equity (ROE) measured as a percentage and following is the equation (Eq.3) for the Return on Equity (ROE) [10].

$$\text{Return on Equity (ROE)} = \text{Net Income/Shareholder's Equity (3)}$$

There have been arguments and deliberations regarding the impact of credit risk management and financial institution's financial profitability performance. In the paper of Liyuqi on "Determinants of Banks profitability and its implication on Risk management practices: Panel Evidence from the UK", has executed extensive study and generated some results and others came up with another result that indicates credit risk management has positive impact or the effect on bank financial performance [11]. In the paper of Muhammed et al on "Credit risk and the performance of Nigerian banks", has found negative correlation and others suggest that other factors apart from credit risk management impacts on financial profitability performance [12].

Specifically in H.S. Kargi's paper on "Credit risk and the Performance of Nigeria banks", discuss the case study of Nigeria banks from 2004 to 2008 that there is a compelling relation between financial institutions profitability performance and credit risk management. In the paper, which confess that loans and advances and Non-Performing Loans (NPL) are major micro variables that determine asset quality of financial institutions [13].

T.F kolapo, R. K. Ayeni and O. Oke are discussed the research on "Credit Risk Management and Banks Performance" using panel data regression for the period 2000 to 2010, originates the impact of credit risk on financial institution's profitability performance measured by the Return on Asset (ROA) of banks is cross sectionally constant. Paper concluded that the nature and managerial pattern of individual firms do not determine the effect [14].

In A. Hosna, B. Manzura, and S. Juanjuan paper on "Credit risk management and profitability in commercial banks in Sweden" underline the effect of credit risk management on profitability level of banks, it concluded that higher capital requirement contributes positively to bank's profitability [15].

S. H. Boahene et al stated that, "Credit risk and profitability of selected banks in Ghana"[16], discussed with regression analysis to decide whether there is a compelling link between credit risk and profitability of Ghanain financial institutions and this research has followed the idea of A. Hosna, B. Manzura, and S. Juanjuan paper on "Credit risk management and profitability in commercial banks in

Sweden”[15], by using Return of Equity as a measurement of financial institution's profitability performance and a ratio of non-performing loans to total asset for credit risk management [15], [16]. The research comes up with a broad conclusion that there is an effect of credit risk management on profitability level of Ghanaian banks. And also further study emphasizes that higher capital requirement committed positively to bank’s profitability [16].

Charles, O. Kenneth's paper on "Impact of Credit Risk Management and Capital Adequacy on the Financial Performance of Commercial Banks in Nigeria", inspects the impact of credit risk management on capital adequacy and financial institution's financial profitability performance in Nigeria. In this research, six banks were chosen as the sample and the technique used to select the sample is positive sampling mechanism. The panel data gathered from financial statements from 2004 to 2009. Panel data modeling has been used to evaluate the relationship that exists among Loan Loss Provisions (LLP), Loans and Advances (LA), Non-performing Loans (NPL), Capital Adequacy (CA), and Return on Assets (ROA) [17]. The test results indicates that the credit risk management and capital adequacy related positively on financial institutions financial profitability performance, Loans and advances have a negative impact on banks’ profitability in the period which has conducted the survey.

In the paper of M. Girma on "Credit risk management and Its Impact on Performance on Ethiopian commercial Banks", illustrates the credit risk management and its impact performance on Ethiopian Commercial Banks. This research includes 10 years panel data from the licensed commercial banks in Sri Lanka for the case study, to investigate the link between ROA and loan provision, non-performing loans and total assets. The predictions explicitly say that there is a compelling link between bank performance and credit risk management [18].

The significance of this proposed research work affected since the other researchers straight away consider the correlation between performance and the Non- Performing Loans, this paper suggests to consider macroeconomic factors to evaluate the performance of the banking sectors in Sri Lanaka.

III. RESEARCH METHODOLOGY

The paper propose a method to be applied in this study is a quantitative evaluation. Besides, both the historical and ex-post facto research design shall be adopted. While the former shall be used to study and appraise the chronological level of financial facilities available to commercial banks in Sri Lanka and the level of development of the country. Following information shows the determinants to be included for the quantitative evaluation framework.

After detailed analysis of the literature regarding the performance enhancement and the credit risk management, following set of variables are considered to build a quantitative framework to evaluate the performance of the banking sector.

1. ROA/ROE (Y)
2. Macroeconomic factors (X_1, X_2, X_3, X_4)
 - GDP Growth (X_1)
 - Exchange Rate (X_2)
 - Inflation Rate (X_3)
 - Interest Rate (X_4)
3. Non-Performing Loan Ratio (NPL) (X_5)
4. Error Term (e)

According to the selected variables which has listed as above, ROA/ROE (Y) indicates the dependent variable whereas, GDP Growth (X_1), Exchange Rate (X_2), Inflation Rate (X_3), Interest Rate (X_4) and Non-Performing Loan Ratio (NPL) (X_5) as independent variables. In order to generate the framework following (Fig. 1) processes can be identified as the main phases to be followed.

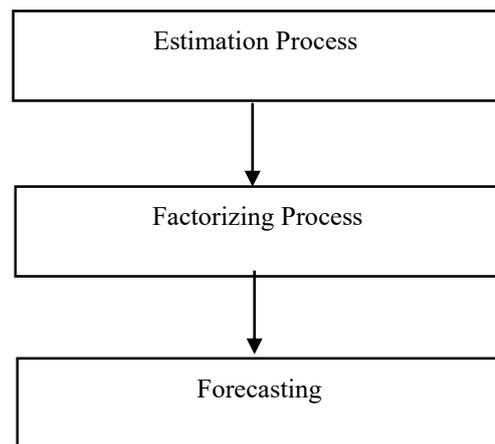


Fig 1: Main Steps of the Framework Generation

According to Fig. 1 estimation process emphasis the selection of the best predictor variables for the forecasting and it acts as an extraction method. That is done by using called Principle Component Analysis (PCA) method. As the second step factorizing process (Factor Analysis) can be done using a software to conduct the analysis on selected predictor variables in the first step. After the factorization, forecasting process can be applied to predict the performance of the banking sector to mitigate the credit risk. Forecasting can be done by using linear regression analysis. Consequently the following linear framework can be proposed to measure the performance of the banking sector.

$$\text{Non-Performing Loan Ratio (NPL)} (X_5) = a + b_1.\text{GDP Growth} (X_1) + b_2.\text{Exchange Rate} (X_2) + b_3.\text{Inflation Rate} (X_3) + b_4.\text{Interest Rate} (X_4) + e_1 \quad (4)$$

$$\text{ROA/ROE} (Y) = c + d_1.\text{Non-Performing Loan Ratio (NPL)} (X_5) + e_2 \quad (5)$$

IV. CONCLUSION & FUTURE WORK

This proposed research study is adopting descriptive and causal comparative research design. Further, this proposed model uses pooled data regression model for the analyzation. The technique of pooled data estimation takes care of the macroeconomic factors with respect to the Non-Performing Loans (NPLs) and then Non-Performing Loans (NPLs) to the ROA and ROE performance factors according to the Sri Lankan context. In future the proposed framework supposed to test using panel data of the Sri Lankan banking sector to predict the performance to eliminate the credit risk while determining the impact of the credit risk to the banking sector as it is the major risk affecting to the sector.

V. ACKNOWLEDGMENT

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A Study of Factors Affecting the Successful Implementation of Lean & Six Sigma in the Sri Lankan Manufacturing Industry

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Abstract: Understanding the full potential of manufacturing can transform it into a function that takes a proactive role in moulding business strategies and could provide companies a lead with the high competition in the field of supply chain. Lean and six sigma (LSS) framework methodology is one of the most widely used business management tools globally. This paper presents a countless number of factors affecting the successful implementation of LSS. Through a systematic methodology; the Leadership, Management, Cultural and Communicational factors were identified to have an eminent effect on successful implementation of LSS.

I. INTRODUCTION

Lean Six Sigma (LSS) is a management approach for the business performance improvement that has merged the two individual specializations of Lean and Six Sigma. **Lean Manufacturing** emphasises on reducing the waste in the process, working with lower inventories avoiding unnecessary investment and strengthening the overall business by the reduction of non-value added activities. LSS is perceived as a waste reduction technique by which the value of the product is maximized by minimizing the waste. Lean principles define the value of the product/services as perceived by the customer and then making the flow in-line with the customer pull and striving for perfection through continuous improvement to eliminate waste by sorting out Value Added activity (VA) and Non-value Added activity (NVA) (Sundar, et al., 2014). Lean Manufacturing has the ability to reduce the manufacturing lead time, trim down manufacturing costs, reduce material handling and get better quality. It also creates a region of reduced wastage, and shortened delivery time with the lower product costs with enhanced customer satisfaction and supports other improvements, which can help companies meet competitive goals (Deif, 2012 cited in Kumar & Kumar, 2015, p.321).

Six Sigma is a comprehensive and flexible system for achieving, sustaining and maximizing business success. Lean identifies inefficiencies and waste in all processes in both manufacturing and service, addressing speed, flexibility and quality while Six Sigma's data-driven analysis delivers precision and accuracy. (Hilton & Sohal, 2012). Six Sigma benchmarking begins with

process "baseline" to create a starting point for improvement (ReVelle, 2004).

Lean thinking or Lean principles has been combined with a Six Sigma program to enhance the impact on a company's performance is referred to as Lean Six Sigma. (Hilton & Sohal, 2012). (Voehl et al. 2013 cited in (Knapp, 2015)) states that Lean Six Sigma is a comprehensive system for achieving and sustaining business success through the understanding of customer-needs, data discipline, value addition by waste reduction and diligent attention to managing and improving processes through facts and decision.

LSS enables an organization to capitalize on the strengths of both quality and methodologies in an integrated manner (Manville et al., 2012). At present many business organizations around the world use the LSS framework and have secured the benefits of competitive advantages and reduced costs.

At present there is a global trend of implementing quality management practices and achieving unique goals particularly in the field of manufacturing. (Perera & Perera, 2013). Total Quality Management (TQM), Lean Manufacturing and Six Sigma are the most widely used performance improvement methodologies with an incremental approach (Lanarollea, et al, 2014).

II. PROBLEM STATEMENT

Many companies have assigned considerable organizational resources to their LSS projects, but have encountered a variety of unexpected challenges. There are many barriers to overcome for successful implementation of LSS throughout an organization. During the literature review analysis, it was identified that many companies which have deployed LSS principles have encountered problems either in attaining the expected results or failed to achieve any result at all. Also many practical examples on different industries like aerospace and health care industries have shown much reluctance to the deployment of LSS and less satisfaction on the outcomes of LSS. Such problems have been observed in companies mostly due to the cost and the time factor.

In order to implement LSS throughout all organizational levels, it was observed that a significant amount of financial and non-financial resources are required to be

allocated. But if the system had failed or not given expected outcome, it will be an enormous loss for the company.

III. RESEARCH OBJECTIVES

3.1 Main objective

The main objective of this study project is “to identify factors which affect successful implementation of LSS in manufacturing organizations of Sri Lanka”

3.2 Sub objectives (Research Purpose)

To identify the advantages of implementing Lean Six Sigma for the Sri Lankan manufacturing industry.

IV. RESEARCH QUESTIONS

The research Questions of this study survey are as follows:

What are the significant factors that affect the successful implementation of Lean Six Sigma in the manufacturing organization of Sri Lanka?

What are the advantages of Lean Six Sigma implementation to the Sri Lankan manufacturing industry?

V. LITERATURE REVIEW

5.1 Lean Six Sigma

During the last few decades, a variety of principles like Quality circles, TQM and Business Process Reengineering etc have been utilized to solve many process management problems in any industry. Many of the afore-mentioned principles diminished with the time during the long after a certain success. One such strategy that evolved during the same period of time was Lean and Six Sigma which was a cynosure for resolving quality or process related problems in manufacturing and service industries and have a significant impact on the bottom-line of co-operation globally. (Antony & Kumar, 2011)

Lean Six Sigma consists of an integration of the two independent methodologies Lean and Six Sigma (Assarlind, et al., 2012 cited in Taylor, et al., and 2016). Lean Production was first practiced at Toyota Motor Manufacturing under the leadership of Taiichi Ohno (1912-1990). In fact, for many practitioners, Lean production and the Toyota Production System are synonymous. (Maleyeff, et al., 2012 cited in Womack, et al., 1991). The focus of Lean is on reducing the wasteful use of resources and applying a holistic approach when dealing with employees, suppliers, and customers. Womack, et al., (1990 cited in Albliwi, et al., 2015) defined Lean as a “dynamic process of change, driven by a set of principles and best practices aim to continuous improvement.”

Six Sigma was launched by Motorola, in 1987. In 1988, when Motorola won the Malcolm Baldrige National Quality Award, Six Sigma became recognized as the

reason for the company’s success. Between the 80s and 90s, Motorola achieved gains of 2.2 billion dollars as a result of applying the model. (Drohomeretski, et al., 2014). Six Sigma can be applied in many different context and processes, from human relation to product design. However, Six Sigma has some main components that can be described. These main components include a clear infrastructure, fact-based decisions, effective and efficient methods and tools, systematic follow-up and feedback on results, comprehensive training programs, and uniform procedures for improvement and design of products, processes, and systems. A central aspect is committed leadership on all levels. (So”rqvist, 2012 cited in Hilletoft, et al., 2014).

Six Sigma is the philosophy that employs a well-structured continuous improvement methodology to reduce process variability and drive out waste within the business process using statistical tools and techniques (Antony & Banuelas, 2002 Cited in Nauhria, et al., 2009).

LSS emerges from the integration of the consecrated Lean manufacturing production system with the efficient Six Sigma improvement methodology (Drohomeretski, et al., 2014). Lean Six Sigma is a comprehensive system for achieving and sustaining business success through understanding customer needs, data discipline, adding values by reducing waste and diligent attention to managing and improving process. Integration of Lean Six Sigma leads to reduction of waste, Process variability and errors while contributing to improvement in the business process (Bendell, 2006).

Lean manufacturing has five key principles: Understanding of Waste, Understanding of Value Chain, Process Mapping, Pull Production and Continuous improvement/ Seek Perfection. (Womack & Jones, 1996; Mason-Jones, et al., 2000; Bendell, 2006; Dahlgaard & Dahlgaard-Park, 2006 ; Shah & Ward, 2007; Thomas, et al., 2009). Utilizing a statistical, data based scheme the Six Sigma approach optimizes process by determining the relationship between critical process inputs and the essential process outputs and resetting the inputs accordingly (Oguz, et al., 2012 cited in Taylor, et al., and 2016). The key components to successful implementation of Six Sigma is mostly related to the commitment of top management, the supporting infrastructure, training and statistical tools (Henderson and Evans 2000; Van Iwaarden et al. 2008; Brun 2011; Gutiérrez 2012).

5.2 Necessity of Lean Six Sigma

In order to compete and survive in the globalization market, industries must adopt new tools and techniques, facing the challenge for delivering their products quickly at low cost and good quality. (Kumar & Abuthakeer, 2012 cited in Avalos, et al., 2014). (Atmaca & Girenes, 2013) Shows that in the increasingly competitive environment, it is hard for the companies that do not prefer increasing productivity as one of the fundamental goals of the company to be able to survive and to compete in the long term. This will also cause

weakening productivity and the reduction of the firm's market share, sales and profitability. Therefore, productivity should be evaluated as one of the most important indicators of the business performance. Maintaining high productivity levels in their process, increasing the quality of the Products, increasing customer-satisfaction and decreasing the organization expenses are the main objectives for the organization. (Nourbakhsh, et al., 2013 cited in Avalos, et al., 2014). Many organizations have reported significant benefits today as a result of Six Sigma implementation. (Coronado & Antony, 2002).

According to the authors, both the pull production system and Six Sigma require that the organization has a culture focused on continuous improvement. The integration of Lean and Six Sigma allows employees to have greater autonomy in relation to operational processes making the process of continuous improvement more solid. It also allows the organization to obtain enhanced performance through the application of tools that contributes to the continuous improvement of processes (Drohomeretski, et al, 2014). Waste in product manufacture is costly to the company and thus requires minimization if not elimination. Lean Six-Sigma strategies can help achieve minimization of waste while improving productivity and profitability (Goriwondo & Maunga, 2012).

5.3 Benefits of Lean Six Sigma

In the manufacturing context, Six Sigma benefits are related to various areas such as reduction in process variability, reduction in in-process defect levels, reduction in maintenance inspection time, improving capacity cycle time, improving inventory on-time delivery, increasing savings in capital expenditures, increase in profitability, reduction of operational costs, reduction in the cost of poor quality (COPQ), increase in productivity, reduction of cycle time, reduction of customer complaints, improved sales and reduced inspection (Aboelimged, 2010).

5.4 LSS in Sri Lankan Manufacturing Industry

An increasing number of manufacturing companies are choosing to employ quality programs to improve their manufacturing performance. By focusing on the performance of a product, the companies gain procedure experience. After using such quality program over time, product and service quality as well as lower rejection costs should be attained (Wang & Chen, 2012) but it is understood that the manufacturing organizations in Sri Lanka do not perform effectively in terms of resource utilization in order to compete with the international competition. There are several management shortcomings contributing to this ineffectiveness (Musadik, 2003).

Old models of productivity improvement techniques do not perform well further due to technological advancement and never ending customer demand. Today, the manufacturing industry of Sri Lanka faces the same scenario so that the industry needs to adopt new strategies (Dilanthi & Deegahawature, 2014). Sri

Lankan Apparel Industries encountered problems such as long lead time, lack of product development, weak marketing and low labour productivity partly due to out-dated technology. The manufacturing Excellence Programme is one such new productivity improvement strategy utilized by such industries (Dilanthi & Deegahawature, 2014). Export-apparel manufacturers in Sri Lanka identified possibilities for such industries to implement the LSS methodology for improving the efficiency. Sri Lankan apparel manufacturers adapt Lean Manufacturing to meet global business challenges of production system (Perera & Perera, 2013).

But most Sri Lankan industries do not pay sufficient attempts to apply LSS to improve the performance, although more weighing is given to more conventional Japanese concepts (5S, Quality circles and Kaizen etc) (Musadik, 2003).

Only very few companies have implemented it, among which apparel companies are the pioneers. Moreover not all companies have implemented the same Lean tools as well as the level of implementation differs. While some benefits through Lean some claim that entire Lean journey is a failure.

5.5 Factors affecting LSS implementation

Through the extensive literature survey, a large number of factors that hinder the implementation of LSS have been identified. Amongst the factors, lack of clear vision, changing business focus, unmanaged expectations, obscurity about organizational objectives are omitted due the less relation shown to the objective of the research. As per the literature review below mentioned are the significant factors which involve in LSS implementation in a manufacturing facility

- Lack of top management involvement and support.
- Lack of quality driven Training on LSS methodologies, Tools and Techniques
- Cultural and organizational resistance
- Lack of Communication
- Improper project selection and prioritization
- Failure to link LSS to business strategy
- Failure to link LSS to the customer
- Failure to link LSS to suppliers
- Failure to link Sigma to employees
- Limited resources and skills to facilitate
- Lack of awareness of the benefits of LSS

5.5.1 Lack of top management involvement and support
Management engagement and commitment is a key to the Lean Six Sigma implementation in any organization (Zhang et al, 2012). Without the involvement of Senior Management it is absolutely a waste of energy and time for launching the LSS initiative. First key factor in every large company is the determination of the top management to implement the program even though it is not clarified whether benefit from the project or the top management's support is achieved first. It is observed that the Top management's involvement becomes intensive upon the visibility of the results. The

most important factor for successful Six-Sigma implementation is observed management leadership Laosirihongthong, et al.,(2006).

5.5.2 Lack of quality driven training on LSS methodologies, tools and techniques

Many organizations use some kind of systematic approach in order to decide which tool or technique to be utilized in certain situations, when to apply them and how to apply them (Antony et al, 2012). Selection of LSS tools and techniques solely depends on the needs of the organization.

Since methodologies vary from organization to organization, there is no standard methodology and organizations must be capable of choosing the most appropriate tools and applicable to them (Pande & Holpp, 2002). Therefore continuous training is also critical for Lean Six Sigma application, and especially this training related to LSS tools and development of soft skills since it is critical to have a clear understanding about LSS tools and methodologies for a successful implementation (Vouzias, et al, 2014). Therefore continuous training is also critical for Lean Six Sigma application, and especially this training related to LSS tools and development of soft skills since it is critical to have a clear understanding about LSS tools and methodologies for a successful implementation (Laosirihongthong, et al., 2006).

5.5.3 Cultural and Organizational resistance

Culture shows the behaviours of employees in an organization and strategies that can be managed in support of organizational goals (Antony et al, 2012). Lean Six Sigma involves some cultural and employees behavioural changes within the organization from this strategy to be fully successful (Zhang, et al, 2012). The creation of a supportive organizational culture is an essential platform for the implementation of Lean manufacturing (Jayaraman, et al, 2012). It also involves a substantial change in the organization structure and infrastructure. When important change occurs, the people in the organization are afraid of the unknown and they do not understand the need for change. Organizational belief and culture could likely to play a role to moderate the relationship between CSFs and successful LSS implementation. So that some companies that have succeeded in managing change have identified that the best way to tackle resistance to change is through increased communication, motivation and education. It is important as well to get as much practical feedback as possible from employees, plan the change through a detailed LSS milestone, delegate responsibilities when possible, and empower people to make their own decisions (Coronado & Antony, 2002).

5.5.4 Lack of communication within the organization

Only through effective communication, employees will be more engaged and work as a team for various problem-solving scenarios. A communication plan is important in order to involve the personnel with the LSS

initiative by showing them how it works, how it is related to their jobs and how they benefit from it. Through effective communication, organizations can establish a common language for change and improvement (Antony et al, 2012). It is very important to assess the result to track down the progress on Lean Six Sigma projects. Rather than working individually, successful Lean implementation required cross-functional teamwork of all employees in the organization. Brainstorming and frequent communication are typically considered important ingredients of successful implementation of various improvement initiatives (Staats, et al, 2011; Jeyaraman & Teo,2011).Hence, it is important that organizations pay attention to communication both in terms of vertical and horizontal communication.

5.5.4 Improper Project selection and prioritization

The project selection methodology enables organizations to deal with large volumes of proposed projects, enables comparison to be made between different types of projects and allows one to forecast which project will give the best return (Harry, et al., 2010 cited in Antony, et al., 2012). It is different for every organization to priorities on what criteria. These includes need of the organization, inefficiency in particular process, market need etc. Every project should be selected so that it will help the company improve competitive advantage, business profitability, process cycle-time, throughput yield, etc.(Zhang, et al,2012). As Lean Six Sigma is a project driven methodology, it is essential to prioritize projects which provide maximum financial benefits to the organization. (Ingle & Roe, 2001). If this process is not followed properly, it will cause project failure.

5.5.5 Failure to link LSS to business strategy

Lean Six Sigma must not be treated as another stand-alone activity. It requires adherence to the whole philosophy rather than just the usage of a few tools and techniques of quality improvement.LSS Projects must be targeted for process and product improvements that have a direct impact on both financial and operational goals (Pande & Holpp, 2002). In every single project, the link between the project and the business strategy should be identified. It should also demonstrate in money figures, the benefit of the project in financial terms and in which way it will help the business strategy (Coronado & Antony, 2002).

5.5.6 Failure to link LSS to the customer

All these methodologies for process improvement exist to make the customer more satisfied, the customer to get more service quality and, at the same time for our processes to become value adding (Psychogios, et al, 2012). Projects should begin with the determination of customer needs, requirements, and expectations. The process of linking this strategy to the customer has being divided into two steps by (a) identifying the core process, defining the key outputs of these processes, and defining how much cost or profits could be reduced or

increased; (b) identifying and defining the customer needs, requirements, and expectation. it is essential to set project goals based on reducing the gap between the company’s expected and actual performance, especially in terms of delivery time, reliability and customer satisfaction.

5.5.7 Failure to link LSS to suppliers

Linking the continual improvement process to suppliers is important for adopting this strategy. It could be facilitated by long-term cooperative relationships with as few suppliers as possible to ensure that the quality materials and/or services would be provided. Maintaining a small number of suppliers improves product quality and productivity of buyers by encouraging enhanced supplier commitment to both the customer responsiveness and quality improvement (Harry, 2000; Harry & Schroeder, 2000). Successful linkage encourage suppliers to become involved in the buying firm’s design of products, and give them a chance to offer suggestions regarding product and/or component simplification and improvement. They can also help purchasers procure the materials and parts that can be used most efficiently (Hendricks & Kelbaugh, 1998)

5.5.8 Failure to link LSS to employees

In many cases, employees think that new business strategies could put them at risk of losing their jobs if their performance is seen to be under the required level. So that it is better to give a better understanding about the procedure and maintain a good link with employees (Albliwi, et al,2014). Using Six Sigma accomplishments as the key measure for management performance and compensation,making Six sigma training mandatory for promotion and to award monetary bonuses based on successful implementation of Six Sigma projects have been identified as the potential factors which could link LSS to employees (Desai,etal,2012).Also it is important for LSS employees to have good relations with each other to enhance the probability of project success, and make an effective working environment (Albliwi, et al,2014).

5.5.9 Limited resources and skills to facilitate

A clear infrastructure for improvement that involves all levels of an organization helps to ensure management support and staff involvement (Kumar, et al, 2006). Implementing LSS projects requires using resources. These resources are not always available in the organization; hence, this is undoubtedly a big challenge in LSS implementation.

5.5.10 Lack of awareness of the benefits of LSS

This is one of the top challenges facing businesses, but can be tackled through training and education, as well as by getting lessons from previous successful stories of other organizations (Snee, 2010).

5.6 Categorization of Identified Factors

According to the literature review it was identified that the factors which affect the LSS implementation can be categorized into five main factors as

Table 1 Categorization of factors affecting to successful LSS implementation

Factors relating to Leadership and management	Lack of top management involvement
	Improper project selection and prioritization
	Failure to link LSS to business strategy
Factors relating to Communication	Lack of communication
	Failure to link LSS to the customer
	Failure to link LSS to suppliers
	Failure to link Sigma to employees
Factors relating to Financial capability	Lack of awareness of the benefits of LSS
	Limited resources and skills to facilitate
Factors relating to Skills and Expertise	Lack of quality-driven Training on LSS methodologies, tools and techniques
Factors relating to Organizational Culture	Cultural and organizational resistance

Source: Researcher’s Construction

5.7 Indicators of Successful LSS implement

Success of LSS implementation is measured by two important measures as (a) Operational Performance and (b) Organizational Performance.

5.7.1 Operational Performance

The success of LSS is typically measured by operational performance. The term of internal process is used interchangeably with operational performance in some studies. Operational performance reflects the performance of internal operations of the company in terms of cost and waste reduction, product quality improvement, delivery performance, flexibility and productivity improvement (Jeyaraman and Teo, 2010). The success of Lean directly benefits the internal operations process.

5.7.2 Organizational Performance

Organizational performance reflects revenue growth, net profits, profit to revenue ratio and return on assets, and non-financial aspects, such as investments in research and development, capacity to develop a competitive profile, new products development, market development and market orientation (Jeyaraman & Teo, 2010).

VI. RESEARCH METHADODOLOGY

Through literature review a conceptual model was developed in which LSS implementation was identified as the dependant variable and five independent variables which were identified as the factors hindering the successful LSS implementation. A set of research questions were derived based on the conceptual framework in such a way to cover all the independent variables of the framework.

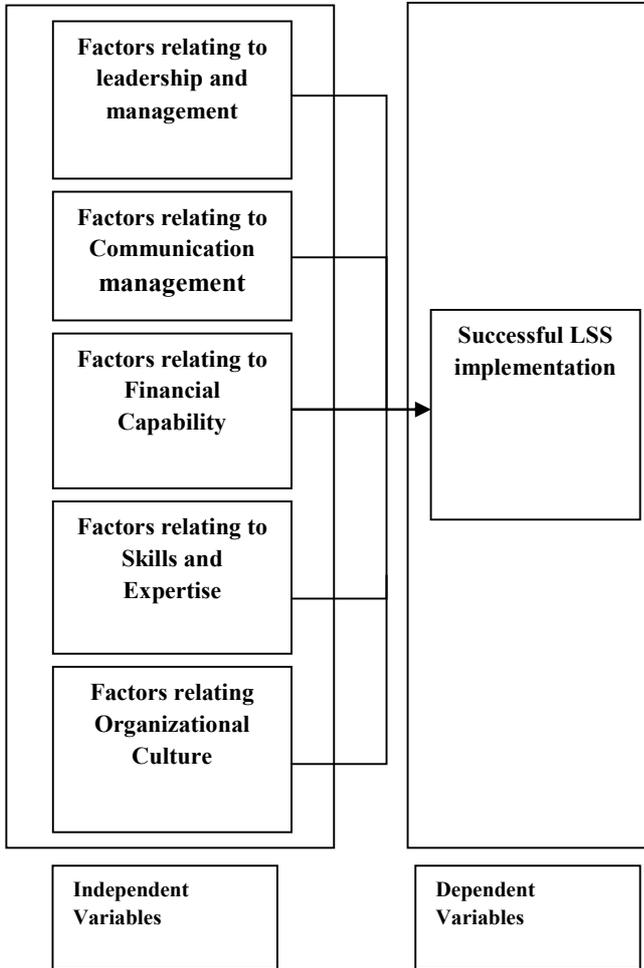


Fig 1- Conceptual Framework

Source: Researcher’s Construction

A questionnaire with two parts as Section A and Section B was distributed in which Section A for Demographic information and Section B for studying about the selected dependent and independent variables. The questions directly queried the aforementioned quality dimensions of the successful implementation of LSS in Sri Lankan manufacturing industry. All questions in Section B were based on measuring the research variables on five points Likert scale responding format. Respondents were requested to indicate their level of observation for each question under the selected items in the questionnaire using five point Likert scale given as follows **1=Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5=Strongly Agree.**

According to research, data was collected representing all manufacturing industries of the country. This includes all manufacturing organizations in Sri Lanka which is in private sector. To select the industries, the

researcher couldn’t find out any source about the organizations which have implemented or attempted to implement Lean and/or Six Sigma in the respective organizations. Accordingly, when sampling the industries, the researcher used randomly selected organizations and they were given research questionnaire. Therefore, it can be considered as the convenient random sampling method. The researcher tried to cover all the provinces and all major manufacturing sectors when collecting data.

The descriptive statistics and inferential were used for the data analysis in this study. The Statistical Package for the Social Science (SPSS 20.0) was used to lead the data analysis. This software helps the researcher to describe profile of respondents and analyse correlation between independent variables mediator and dependent variable as well as to find suitable factors for the study. All the responses and information collected from this survey were tested using statistical techniques such as Mean, Frequencies, Percentage, Standard Deviation, Pearson correlation, Reliability, and factor analysis. As the data analysis tool SPSS V20.0 is used. Firstly, the data was tested for reliability. Then by the scatter plots correlation between variables were observed. After that Pearson Correlation coefficients was calculated and hypotheses were tested.

Hypothesis testing is done by both correlation and regression analysis in order to validate the relationship between dependent and independent variables.

VII. RESULTS

6.1 Presentation of correlation between variables

6.1.1 Scatter plot between factors relating to Leadership and Management factors vs Successful LSS implementation.

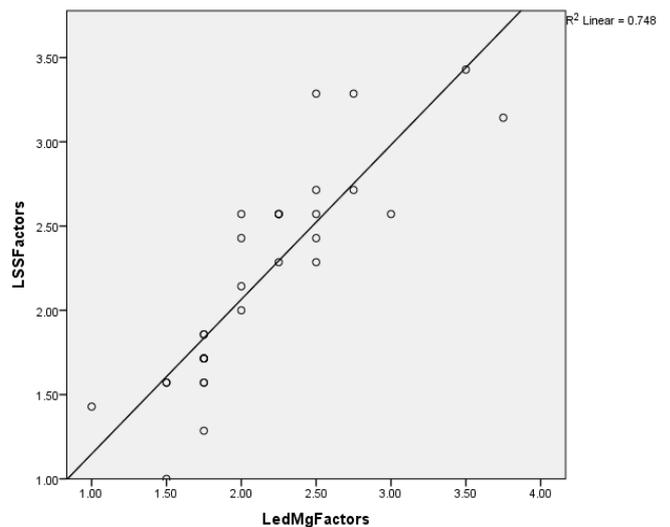


Fig 2: Leadership and Management Factors vs LSS factors

Source: Research data-SPSS output

According to the above graph it is clear that 75% of the successful implementation of LSS can be explained by factors relating to Leadership and Management.

6.1.2 Scatter plot between Communication factor vs Successful LSS implementation

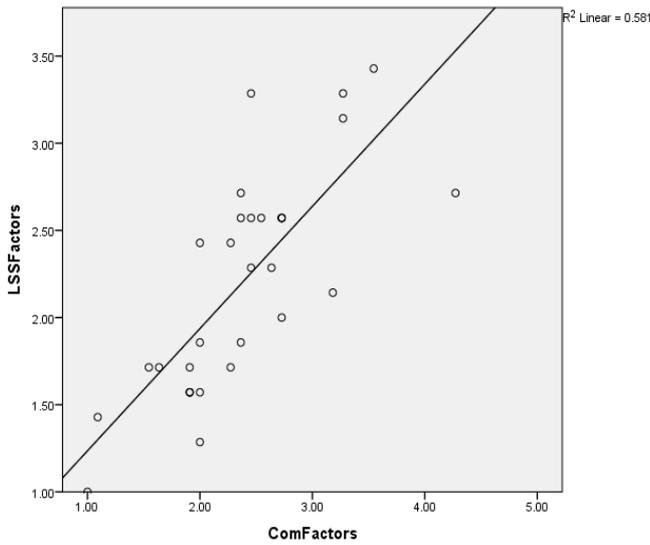


Fig 3: Communication Factors vs LSS factors

Source: Research data-SPSS output

According to the above graph it is clear that 58% of the successful implementation of LSS can be explained by factors relating to Communication.

6.1.3 Scatter plot between factors relating to organizational culture vs Successful LSS implementations.

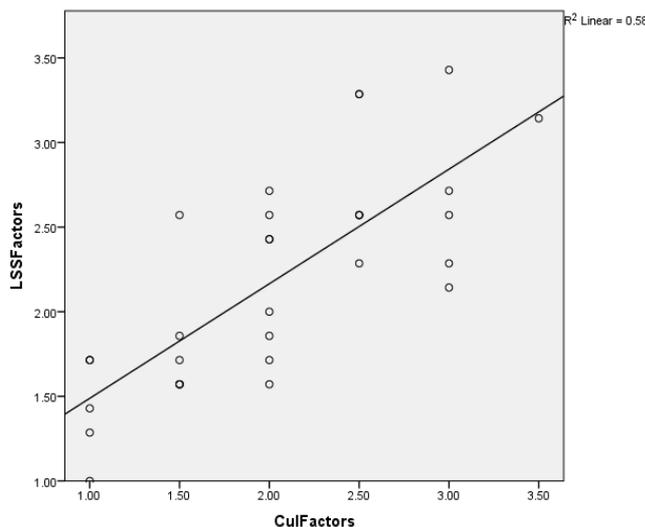


Fig 4: Cultural Factors vs LSS implementations

Source: Research data-SPSS output

According to the above graph it is clear that 58% of the successful implementation of LSS can be explained by factors relating to Organizational Culture.

From the above scatter plots it can be observed that there is a positive strong relationship between the dependent variables and independent variables.

From the above graphical representations it can be observed that industries should concentrate on the more significant factors of leadership and management, communication and cultural factors for higher possibilities of successful LSS implementations.

6.2 Tabular representation of correlations through Regression Analysis

Table 2: Model summary of the regression analysis

Model	R	R square	Adjustable R square	Std. Error of the estimate
1	0.855 ^a	0.787	0.759	0.30932

According to the table 4.14, R^2 value (the "R Square" column) indicates how much of the total variation in the dependent variable, can be explained by the independent variables. It indicates that R^2 for the model is 0.787. It implies that 78% of the successful LSS implementation can be explained by the model. Therefore, it is evident that there is a positive relationship between independent variables and the dependent variable. So that all three independent variables cultural factors, communication factors, and eldership and management factors have a positive impact on successful LSS implementation.

6.3 Tabular representation of correlations through correlation analysis

		LSS factors
Leadership and Management factors	Pearson correlation	0.865
	Sig. (2-tailed)	0.000
	N	31
Communication Factors	Pearson correlation	0.762
	Sig. (2-tailed)	0.000
	N	31
Cultural Factors	Pearson correlation	0.764
	Sig. (2-tailed)	0.000
	N	31

According to the table 4.15, there is a strong positive correlation of leadership and management factors with successful LSS implementation. ($r_{XY} = +0.865$). Likewise other two variables, cultural factors and communication factors also have a strong positive relationship with successful LSS implementation, and their coefficients are + 0.762 and +0.764 respectively. The fact that all of these correlation coefficients have positive values indicates that increases in one variable correspond to increase in the other. The level of significance for leadership and management factor,

cultural factors and communication factors are considered as 0.01.

VIII. DISCUSSION

This research shows that there are three main categories that have a significant impact on the successful implementation of LSS in the manufacturing industry of Sri Lanka. They are Leadership and Management factors, Cultural factors and Communication factors.

Under leadership factors there are three sub factors as (a) Top management involvement and support, (b) Proper project selection and prioritization and (c) Link LSS to business strategy.

Similarly there are five sub factors under communication factors as follows (a) Proper communication within the organization, (b) Link LSS to the customer, (c) Link LSS to suppliers, (d) Link LSS to employees and (e) Good awareness of the benefits of LSS.

Through the online survey it was identified that the companies which had implemented LSS had gained benefits on the following areas as cost and waste reduction in internal operations, improved product quality, speed and efficiency of operations enhanced, growth in annual revenue, net profit increment, increase in investments in research and development and in new product development etc.

IX. CONCLUSION

The purpose of this study was to find out factors affecting to successful Lean and Six Sigma implementation in Sri Lankan Manufacturing industry. This study presented results of a study that surveyed 71 manufacturing organizations in Sri Lanka.

Through the study and the researched methodology followed it can be concluded as only factors relating to leadership and management, communication and organizational culture has a positive impact on the LSS implementation. Following sub factors were derived upon intensive study of the factors under three main factors. The following sub factors as involvement and support of top management, proper project selection and prioritization, linkage of LSS to business strategy, proper communication chain within the organization, LSS linkage to customers, supplier, employees, good awareness of the benefits from LSS etc.

Also through the research it was further found out the advantages obtained by industries in Sri Lanka by LSS implementation. Few such advantages are cost and waste reduction of internal operations, improved product quality, speed and efficiency of operations enhanced, growth in annual revenue, net profit increment, increase in investments in research and development, and in new product development etc.

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Audio Assistance for Vision Impaired Individual To Recognize Graphical Content on Print Disable Documents

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Abstract - A print disabled person is a person who cannot effectively read printed documents because of visual impairment. The print disability prevents a person from gaining information from printed material in the standard way, and requires them to utilize alternative methods to access that information. Hence, this paper presents a mobile-based audio assistance to read textual documents, which contains graphical contents such as images, tables and mathematical equations to overcome above-mentioned challenge. Further, this paper discusses the test results and evaluations to justify feasibility of the proposed solution.

Keywords—*vision impairment, textual document, graphical contents, OCR technology*

I. INTRODUCTION

According to the Rauha Maarmo, the project manager of Celia library “print disabled person is a person who cannot effectively read print because of a visual, physical, perceptual, developmental, cognitive, or learning disability” [1]. Print disability prevents a person from obtaining information from the printed material in a regular manner, and requires alternative methods to access that information. Print disabilities include visual impairments, learning disabilities, or physical disabilities that impede the ability to manipulate a book in some way [2]. The term was coined by George Kerscher, a pioneer in digital talking books [3]. Visual impaired people require third party assistance or brail converted material to read printed documents even though the digital books are available. Further, there are technological advancements to scan and read the printed materials using a variety of software as well as apps. Existing applications are unable to read equations, images, tables in an accurate way as sighted people do. Therefore, a solution capable of delivering higher accuracy to read printed material with existing technology plays a significant role in an assistive technology research area. This paper presents mobile-based feasible solution named as “Schmoozer” that provides audio assistance to navigate through mobile application, autofocused image capturing of

printed papers, store captured images, classify selected text, images, tables and equations and read aloud generated digitized text. Therefore, “Schmoozer” would allow vision impaired individuals to unbraided document reading without others interaction. The remaining section of the paper contains the methodology, implementation and conclusions.

II. BACKGROUND

Vision is one of the main senses people use to see, grasp knowledge, experience and the world. According to WHO, it is estimated that [4] 285 million people suffer from vision impairment or blindness in the entire world. Sri Lankan contribution [5] to this statistic is 996,939 among 20 million populations. Mentioned statistics prove that a considerable amount of the population cannot view anything or view properly. However, people who suffer from incomplete vision or blindness also have rights to acquire information. “Audio assistance for visually impaired people to understand graphical content on textual documents”, which is the research project, introduces a solution to ensure the grasping information right of visually impaired people. Moreover, the main target is visually impaired students.

Thousands of research have been carried out for many years to ensure the information, education and technology access for blind or visually impaired individuals. Evolution of technology leads to inventing a number of ways to connect visually impaired individuals with technical tools. The term “Assistive technology” refers to any “product, device, or equipment, whether acquired commercially, modified or customized, that is used to maintain, increase, or improve the functional capabilities of individuals with disabilities” [6]. Due to it, they require special attention [7] to educate vision impaired individuals. The assistive technology is recommended to eliminate barriers in education and employment for visually impaired individuals where they

could be able to complete schoolwork, explore, take tests or read books along with sighted people [8].

Audio assistance or text reader is a recognized assistive technology mechanism that supports visually impaired people to listen to the contents of printed or handwritten documents. As the main target is visually impaired students, it is important to have a reader, which enables to identify and state the contents in printed documents implicitly. It will allow students to listen to their textbooks, assignments, exam papers within a short period after analyzing.

The textual document contains images, mathematical equations and tables. Therefore, it is a must to recite those graphical contents for the visually impaired person to get the accurate idea of the document. Image processing is a method to translate an image into digital form and perform edit or searching operations on it, in order to acquire an improved image or to abstract useful information from the image [9], which is a highly recommended technology for autonomous graphical contents identifying the mechanism. Machine learning is another mechanism to train electronic devices like computers to grow and change when exposed to new data. It is a type of an artificial intelligence that allows computers to learn itself without explicitly programmed [10]. Consequently, mentioned techniques used to image recognition in an effective manner.

The research team provides a solution with a combination of above-mentioned mechanisms for autonomous document recognition to heighten the process of clasping knowledge by providing quick access to the information without the barrier of physical disability. "Schmoozer" is a mobile application that has the capability to auto capture a print disable document and upload it into server automatically, identify image regions accurately, generate digitized text from graphical images, mathematical equations and tables, and redirect digitized text into a text to speech engine that has the capability of reciting document content to the visually impaired individual.

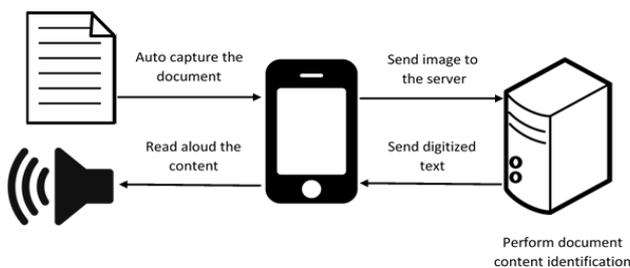


Fig. 1. System Overview

Figure 1 illustrates the system overview of the research solution. The research team hopes that the assistive technology document reading solution will lighten up the dreams of the visually impaired individuals in near future.

III. RESEARCH OBJECTIVES

The main objective of this application is to encourage visually impaired students to gather knowledge in the easiest way. Without reading document or books gaining knowledge is a very challenging task. Therefore, research group is introducing a solution to help the blind students to grab the knowledge of the documents without seeking others help. With this application, students can do their studies without any problem. The solution also will be very helpful to the teachers and parents because they do not want to read aloud all the text document contents to their children. As an additional feature, the application supports voice command inputs. While listening to the document, user can stop the reading by providing voice command as an input. All the implemented features will provide fascinating experience to vision impaired people to see the world by their own.

IV. METHODOLOGY

This section discusses the methodology carried out to implement the proposed portable solution as mentioned in the introduction.

Vision impaired individuals have to auto capture and upload an image of print disable document into the "Schmoozer IIS server" to start the print disable document reading process. Uploaded image go through image cropping function and graphical region identification function. When graphical region identified as a graphical image, mathematical equation or table, it will automatically redirect to graphical image identification, equation identification or table identification function accordingly. Functions implemented throughout the application development are listed down below.

A. Edge Detection and Image Auto Capturing

It is difficult for a blind person to capture an image by identifying edges of the document. Therefore, edge detecting, auto capturing and image uploading steps are used to complete the requirement. Fig. 2 shows the flow of auto capturing process

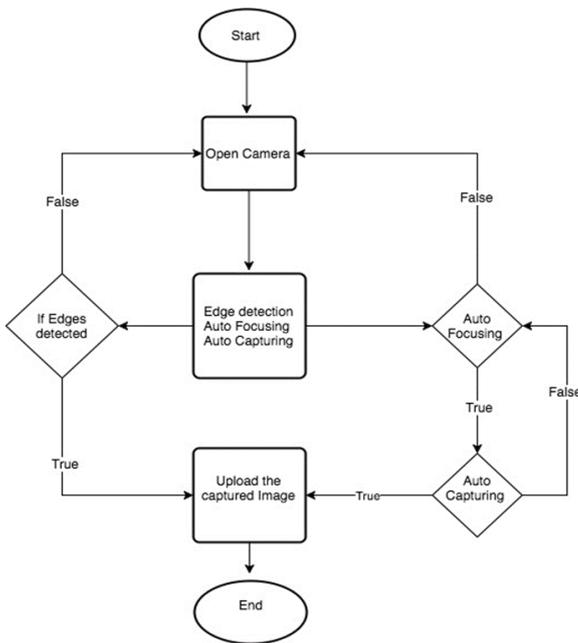


Fig. 2. The flow of image auto capturing process.

1) Edge detecting

The mobile application captures the printed document when the person places camera towards the document by detecting the edges of it. Canny edge detecting algorithm was used to detect the edges of the document and Gaussian filter applied to smooth the image in order to remove the noise. It is essential to avoid false detecting caused by noise. Then get the intensity gradient of the image. Non-maximum suppression is going to get rid of spurious response. After that, potential edges are determined to apply a double threshold. Finally, hysteresis tracks the edges smoothly.

2) Auto Capturing

The mobile application has the capability of auto capture and uploads the image of printed document to the server after detecting document edges smoothly. To auto focused the document, “Camera. Autofocus Callback interface” used to notify on completion of camera autofocus. The auto capturing function completes by saving a photo of the document as a byte array and automatically upload to the server using REST protocol via the internet.

B. Graphical Content Identification

Text, graphical images, mathematical equations and tables are the main graphical components in a document. Separate identification of document content is the core function in “Schmoozer” mobile application, which is totally based on image processing. Image processing functions are not

suitable to execute inside the mobile phone due to mobile phone’s processing speed is insufficient. Therefore, research group decided to use Internet Information Services (IIS, formerly Internet Information Server) [11] for the entire image processing related functions. At the end of the image processing the processed outputs were redirected to the Text to Speech (TTS) engine of the user’s mobile phone, which delivers audio format of the document to the users. Following steps were carried out to identify graphical contents printed on documents.

1) Graphical regions identification

Text, graphical images, equations and tables are the main regions in print disable documents.

Authors collected images of mathematical equations, text, tables and graphical images and stored them in separate folders. Then apply HOG feature extraction and Support Vector Machine (SVM) algorithm on the collected set of images to convert them into a trained data set.

When a vision impaired individual uploads an image of a document to the IIS server, the image is cropped and going through “Graphical region identification function”. The function has the capability of extracting HOG features of cropped image and suggest the region using SVM.SVM algorithm contains a predefined function called prediction. The trained dataset and a single test data (cropped image segment) input to the function. The function compares HOG features of the input segments with the HOG features stored inside trained dataset to classify and label the input segment. (Ex: Input segment is an equation, Input segment is a table).Based on the label generated by SVM, the “Schmoozer IIS server” redirect identified image segment to graphical image identification, mathematical equation identification or table identification functions. All steps in “Graphical region identification function” converted into DLL file to use it in the web service.

2) Graphical image identification

The main purpose of the “Graphical image identification function” is separately recognizes and label the images available in print disable document. Authors implemented a strong dataset, which contains a huge amount of images of living beings and many single objects with significant behavioral changes. Then applied HOG feature extraction to identify unique features in the graphical image and convert into a decimal value to store in a database. The database was trained using SVM algorithm to convert the dataset into the trained dataset.

When “Graphical image identification function” obtain a cropped and identified image segment from graphical region identification function it extracts HOG features and converts into a decimal value. The decimal value was compared with the trained data set to find the name of the object. Prediction quality of SVM algorithm used for decimal value comparison task. If the decimal value of input test image matches with any decimal value inside the trained database, the labeling value of that image is assigned to a variable and generated a meaningful digitized text that describes the graphical image. Then it automatically opens a text file and writes all the digitized outputs on it. All steps in “Graphical image identification function” converted into DLL file to use it in the web service.

3) *Mathematical equation identification*

The main purpose of the “Mathematical equation identification function” is to separately recognize characters and symbols in a mathematical equation that are printed on documents, and convert them into digitized text. The first step was designing of mathematical symbols and numbers using Photoshop in bitmap format. Bitmap files are easy to create and pixel data stored in a bitmap file could be accomplished by using a set of coordinates that allow the data to be conceptualized as a grid. Therefore, all the major mathematical characters were created in bitmap format and stored inside a folder called “letters_numbers. Then created a Matlab template and match each character /mathematical symbol/number into created bitmap images.

The “Mathematical equation identification function” obtained input images from the “Graphical regions identification function”. The segmented image with equations went through “Equation” function and faced to set of preprocessing tasks. Read image, Convert to grayscale, Convert to BW, Remove all object containing less than 9 pixels, Resize letter (same size of the template) are the preprocess followed to adjust the input equation match with the created template. After preprocessing, each single character in the equation converted into a binary value. Finally match every character of the input image with the binary value obtained from the created template and regenerate the equation as digitized text. Function’s output is set of single digitized values for single character/symbol in the equation. Then it automatically opens a text file and writes all the digitized outputs on it. All steps in “Mathematical equation identification function” converted into DLL file to use it in the web service.

4) *Table data identification*

The main purpose of the “Table data identification function” is to recognize the type of data table (whether it is 2columns or 3columns) and convert table data into meaningful digitized text. Implement a strong dataset with a huge number of 2 column and 3 column tables is the foremost step in table identification process. Then applied HOG feature extraction to identify unique features of 2 column and 3 column tables and convert into a decimal value to store in a database The database was trained using SVM algorithm method to convert the dataset into the trained dataset..(If user required identifying more columns, it can be done easily by adding more columns tables to the collected images of tables.)

When “Table data identification function” obtain a cropped and identified table segment from graphical region identification function it extracts HOG features and converts into a decimal value. The decimal value was compared in with the trained data set to find the type of the table whether the table has 2 or 3 columns. The data inside the image of the table was read using in build OCR function of Matlab and wrote the data into a text file.

All steps in “Table data identification function” converted into DLL file to use it in the web service

Table data reading functions were built inside the web service. “Tableread” function implementation identify the table type by observing Matlab “Table type identification” function’s output text file. Text file, which contains table data redirect to the special functions that have the capability of generating a meaningful output according to the type of the table. If the input image is a two-column table, the text file obtains from Matlab OCR function pass through “TwoColTableReading” function and provide a meaningful sentence that implies table headers and table data separately by adding the values in a text file into two element array. If the input image is a three-column table, the text file obtains from Matlab OCR function pass through “ThreeColTableReading” function and generate a meaningful sentence that implies three table headers and table data separately by adding the values in text file into three element array.

C. *Implement web service.*

Mobile application and the server connectivity were established through web service developed using c# language. Generated DLL files for image regioning, graphical image identification, mathematical equation identification and table data identification are added to the web service.

Then all the functions were published in IIS server to host the document content reading functionalities. IIS server bridge the server processes with the mobile application to cater vision-impaired individuals.



Fig. 3. Connectivity between mobile phone and the server

Figure 3 illustrates the connectivity between mobile phone and the server. When user uploads image to the server, it calls corresponding functions for creating objects.

D. Audio Assistance Functionalities

When a vision impaired individual captures an image of a document and auto uploads to the server, it goes through a set of graphical content identification functions mentioned above and generate digitized text that allow to read aloud by TTS engine. Audio assistance function collects all the digitized text files and arrange as a single paragraph of a document.

Then generated paragraph go through the implemented dictionary function to correct spelling errors. Finally, formatted sentence has been sent to the mobile phone.

The finalized text received by the mobile phone immediately redirects to the text to speech engine. The TTS engine has been designed with the compatible for Android devices above “Kit Kat” version. The process of the TTS engine is covered input text sentence into the speech format. Designed engine includes key features such as familiar speech accent with the adjustable speech rate. After generating the output from the TTS engine, it delivers to the user. To distribute the output with attractive and user-friendly style design the mobile app front end. The front end of the schmoozer application mainly contain two option such as (Vision Impaired) VI MODE and the SIGHTED MODE

1) VI mode

VI mode is specially designed to improve vision impaired students studying specifications. User Interface (UI) design with button click events is challenging task because of user unable to see the buttons on the application. Therefore, to avoid that problem as well as improve efficiency and effectiveness “Schmoozer” UI design follows four gesture

recognition activities. Single tap event gives all the user guidelines for the application handling process to continue document reading. Long press event starts the reading document content to the user. The document reading synthesis is provided in clear and meaningful voice accent with the adjustable delivery speed. Therefore, the user can understand the document content smoothly. Scroll event use to stop the speech. Double tap event will open mic to input voice commands. By providing a voice command such as “STOP” or “PLAY” user can handle reading. Using this gesture events user can grasp the document contain knowledge without any difficulty.

Vibration is enabled with all these gestures to feel the gesture activities to the vision impaired individuals. To avoid close the application by accidentally pressing back button it disables the back button when the application is open. By pressing home button user able to exit the application.

2) SIGHTED mode

SIGHTED mode is designed for the ordinary people to read the document content in a meaningful manner. Sighted mode contains the simple button click events. Using this buttons user can handle the application very easily.

Without purchasing high cost, awkward or ineffective document reading product or application both sighted and visually impaired person can use schmoozer mobile application to gain the document content information and improve their depth of knowledge.

V. RESULT AND DISCUSSION

The main target of the research is to build an application that read document contents for vision impaired user groups. Therefore, the application consists of autofocusing and image capturing techniques to reduce the time taken to capture the image. The captured image converts into a byte array before sending it to the backend server. It could be able to increase the sending speed because it will compact the size of the file.

After the upload the captured image, graphical region identification is the foremost task of converting print disable document into digitized document. The accuracy of region identification was calculated with 40 test images

The accuracy of the function is in high volume. Therefore, the authors are able to prove that HOG feature extraction with the combination of SVM algorithm is a good solution for extract real content inside captured image.

TABLE I. ACCURACY CALCULATION FOR GRAPHICAL REGION IDENTIFICATION

Scenario	Number of occurrences	Number of Occurrence meets expected output
Identify image regions	10	10
Identify text regions	10	10
Identify table regions	10	8
Identify equation regions	10	10
$\text{Accuracy} = \frac{\text{Number of correct output occurrence}}{\text{Number of occurrence}} \times 100\% = \frac{38}{40} \times 100\% = 95\%$		

The graphical image identification function is also totally based on HOG feature extraction and SVM. Even though accuracy value calculated for regions, the authors did the same kind of test with different types of images. The sample data size was 45

TABLE II ACCURACY CALCULATION FOR GRAPHICAL IMAGE IDENTIFICATION

Scenario	Number of occurrences	Number of Occurrence meets expected output
Identify significant images accurately	15	15
Identify behavior variations of an image accurately	15	14
Identify color variations of an image accurately	15	15
$\text{Accuracy} = \frac{\text{Number of correct output occurrence}}{\text{Number of occurrence}} \times 100\% = \frac{44}{45} \times 100\% = 97.778\% \approx 98\%$		

Mathematical equations in captured images should be converted into machine editable format in order to recite by the TTS engine. Due to some existing TTS engines were unable to read mathematical symbols like $\pi, \infty, \sqrt{\quad}, \Sigma$ authors created digitized text with an English word that describes mathematical symbols within “read_letter” function.

Ex: Values given to the mathematical symbols through “read_letter” function

π = pi ∞ = infinity

$\sqrt{\quad}$ = square root Σ = sum

Represent mathematical symbols with English word enhanced the performance of TTS engine.

The accuracy of the equation identification was calculated by providing weighted matrix. Ten images of mathematical

equations were executed within test application to calculate the average accuracy.

Weighted Matrix

Expected output = 1

Number of operators and operands in equation = n

Weighted value for one operator or operand (W_n) = 1/n

Number of accurate operators and operands in = A_n

Actual output

Accuracy of the digitization process (A_c) = $W_n \times A_n$

Maximum accuracy (A_m) = 100 x execution number

Average accuracy (A_a) = $[(\sum A_c) / A_m] \times 100$

TABLE III. ACCURACY CALCULATION FOR MATHEMATICAL EQUATION IDENTIFICATION FUNCTION

Exe no	Expected digitized text	Actual digitized text	W_n	Accuracy ($W_n \times A_n$)	Percentage $A_c \times 100\%$
1	2+3=5	2+3=5	1/5 = 0.2	0.2x 5 = 1	100%
2	10 + 5 -2 = 13	10 + 5 -2= 13	1/7 = 0.14286	0.14286x7 = 1	100%
3	2 x 10 = 20	2 x 10 = 20	1/5 = 0.2	0.2 x 5 = 1	100%
4	X + 2x + 5y = 53	X + 2x + 5y = 53	1/9	(1/9) x 9 = 1	100%
5	Y = mx + c	Y = mx + c	1/6	(1/6) x 6 = 1	100 %
6	A = πr^2	A = pi r toThePower 2	1/5 = 0.2	0.2 x 5 = 1	100 %
7	3/5	3 - 5	1/3	(1/3) x 2 = 0.6667	66.67 %
8	(10 x 5 + 3) / 2	(10 x 5 + 3) - 2	1/9	(1/9)x8 = 0.889	88.9%
9	Sin θ	Sin θ	1/2 = 0.5	0.5x 2 = 1	100%
10	a ² + b ² = c ²	A toThePower 2 + B toThePower 2 = C toThePower 2	1/8	(1/8) x 8 = 1	100 %
Average accuracy (A_a) = 955.57 / 1000 = 95.56%					

Table identification is a process that uses set of functions to extract characters inside a table and generate meaningful digitized text. 30 input images were tested with the application to calculate the average accuracy of “Table data

identification” function. Table IV contains the results of the function.

TABLE IV. ACCURACY CALCULATION FOR TABLE DATA IDENTIFICATION FUNCTION

Scenario	Number of inputs	Number of correct outputs
2 column tables with single line borders	6	6
2 column tables with double line borders	6	6
2 column single line border tables without 1 header	3	2
2 column tables without borders	5	4
3 column tables with single line borders	6	6
3 column tables with double line borders	4	4
Average accuracy (Aa) = $\frac{\text{Number of correct outputs}}{\text{Number of total inputs}} \times 100\% = \frac{28}{30} \times 100\% = 93\%$		

Calculated accuracy values prove that the functions used to build the “Schmoozer” application have accuracy more than 90%. Therefore, authors assume that the combination of above-mentioned functions provides best autonomous, accurate document reading service to visually impaired individuals.

VI. CONCLUSION

Vision impairment is a huge barrier for a considerable portion of humans all over the world to move with their colleagues, competitors, parents or even with their partners. The situation becomes more sensitive when vision impaired students have to deal with many documents to gain knowledge. Requirements stated by vision impaired individuals for document reading was, a user-friendly mobile application which has the ability to auto capture document image, identify and read aloud documents that contain text, images, equations and table. The research team has developed a mobile application with all the requested facilities to provide user-friendly cost effective accurate document reading solution for them. The major benefit of building a mobile application is that the vision impaired individuals has no need to spend additional cost to by document readers separately or learn Braille technique from the beginning. The solution also has the capability to cut off printing Braille document that contains embossed text.

This paper provides the reasons behind choosing the topic, and how the background survey was done to finalize the solution and methodology for implementation with the testing process. Methodology, Testing and the result presented in this paper are totally based on auto focusing and auto capturing the image, image segmentation with images, mathematical equation, table reading and audio assistance.

Among the group of vision-impaired individuals, students are the most important segment due to they are the future of the nation. The research team identified that reading print disable documents without other’s help is the most challenging problem due to documents that could contain text, images, mathematical equations and tables. The majority of existing products are unable to identify images, tables and mathematical equations. To overcome from the situation, research team build a solution that provides auto-capture an image of print disable document, Image processing to convert image content into digitized text and read the content to the visually impaired individuals. With all these key features, schmoozer application is able to provide better service to the visually impaired people to gain the document contain information and fulfill their knowledge.

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IoT Based Framework to Increase Student Success in the Classroom of Tertiary Education in Sri Lanka: The Smart Classroom

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Abstract -- The smart classroom concept has appeared in the literature as an Internet based remote education system; or as intelligent environment equipped with an assembly of many different types of hardware and software components. In the process of everyday teaching, lecturers are usually trying to find out if the students were satisfied with the lecture, which part of a lecture was interesting, which presentation techniques and approaches were more attractive and effective than the others, which groups of students need more help regarding the lecture. The goal of this research is to track the attention level and performance of students and identify different groups of students according to their level of engagement to the lecture and thereby increase the interactivity of them during the lecture hours. Also offering help by lecturer to students who need more help by tracking down their learning patterns is considered. Furthermore personalizing lecture in order to reach out for these different groups of students is suggested in this research. This will empower lecturers to constantly deliver good presentations and make better impact, while the audience will benefit from interesting lectures thus making the learning process interactive, more efficient as well as more pleasant and even entertaining.

Keywords: *Smart Classroom, IoT, HCI, education, interactive learning,*

I. INTRODOCUTION

Introduction of IoT has affected numerous aspects of society in beneficial ways. It has advanced the living quality of humans immensely.[18] IoT is a cutting edge technology which connects physical objects, machines, computing devices and people and allows them to transfer data amongst them without any human to computer or human to human interaction.

With the dawn and growth of the IoT, physical atmospheres are becoming smarter and more interconnected than ever before. This has transformed the human lifestyle by enlightening sustainability, effectiveness, accuracy and economy in almost

every feature of their life. IoT has been leveraged in many industries such as healthcare systems, traffic management, energy management, education, environment monitoring, smart homes and smart cities.

A. EFFECT OF IoT ON EDUCATION

Many educational organizations are using IoT to rationalize procedures, influence data and uphold sustainability. [1] The practice of smart objects and wearable devices is well recognized in a number of universities. Empowering technologies like sensors, chips and other wearable devices that are all well understood by many, effortlessly mass-produced, and low-cost have become abundant in education and used broadly in classrooms.

Education has transformed from a knowledge-transfer model to a dynamic cooperative self-directed model by the disruptive influence of technology in educational institutions at present. This has enforced many institutions to reconsider teaching and learning. The inspiration of technology can be seen in many phases of education from student commitment in learning and content formation to help teachers deliver custom-made content. Many educational organizations are using IoT to rationalize procedures, influence data and uphold sustainability. The practice of smart objects and wearable devices is well recognized in a number of universities. Empowering technologies like sensors, chips and other wearable devices that are all well understood by many, effortlessly mass-produced, and low-cost have become abundant in education and used broadly in classrooms. Hence this paper presents a framework to increase student success in the classroom in Sri Lanka aiming tertiary education.

II. LITERATURE REVIEW

The perspective of the existing work is concerned with digitalization of the ambient, conversion of written materials into electronic form, tele-education, human to computer interaction, web based distance learning etc. Among the researches that has been done in order to apply IoT concepts to

education to increase the quality of learning and teaching process, following are the ones that were highly related to this research. Subsequent sub sections A to E explore and analyze five selected researches conducted in IoT.

- a. The Effect of the Internet of Things (IoT) on Education Business Model
 - 1). Campus Energy Management and Eco-System Monitoring
 - 2). Secure campus and classroom access control
 - 3). Student's health monitoring
 - 4). Improving Teaching and Learning
- b. Smart Classroom: Real-Time Feedback on Lecture Quality
- c. Smart Classroom Roll Caller System with IoT Architecture
- d. Towards a Smart Campus with Mobile Social Networking
- e. The Research of Smart Campus Based on Internet of Things and Cloud Computing

A. The Effect of the Internet of Things (IoT) on Education Business Model

This research which is based on the recent IoT projects in education, researchers categorize the application of IoT in education into four groups: energy management and real time ecosystem monitoring, monitoring student's healthcare, classroom access control and improving teaching and learning. The researchers have investigated and analyzed how this platform has transformed the Education Business Model and added novel value proposals in based on the Canvas Business Model.

This study [1] is a qualitative research that emphasis on the education business model. The goal of this research is to give a solution to the following question: "How has the emergence of IoT affected the education business model in higher education?" According to this research and several other researches, the researches has identified following applications of IoT in higher education

1) Campus Energy Management and Eco-System Monitoring

Internet of things has been functional in energy management and Eco-system monitoring for years, in order to deliver energy effectively for a more ecological future. This has caused in the

introduction of Smart Grid. Many service companies can efficiently balance power generation and energy usage to deliver more efficient procedures by addition of intelligence to the current set-up. Energy consumption data will be collected automatically to improve economy, efficiency and reliability of the systems through sensors and actuator systems. This concept permits universities to produce a green campus environment by decreasing CO2 releases, observing and adjusting energy and water usage to provide a healthy atmosphere for teaching and learning. The design of a green campus has been suggested to manage computers and air conditioning systems in order to save energy. A practical example presented in this paper is, COMFORTSENSE which is another energy management project employed in Campus Luigi Einaudi, University of Turin. This project takes benefit of IoT technologies to improve building energy efficacy and security.

2) Secure campus and classroom access control

Constructing a safe and secure place in universities and managing students' access to classrooms, laboratories and other places in the university is a challenge addressed in this context. This is done by fetching new technologies into education such as RFID (Radio-frequency Identification) and NFC (Near Field Communication). The authors in [3] has developed a classroom access control method over NFC to make a real time classroom control instrument. This classroom registration system is based on a network of connected sensors that can gather classroom access information and show the status of the classroom on both a web based application and university TV panels. The author in [4] has suggested a technique for observing student attendance by using RFID tags in student ID cards. This system registers student IDs when they arrive the classroom and tracks their present location in the campus by the usage of geofencing technology. The Sookmyung Women's University (SWU) has implemented access control systems in the campus based on IoT and converted the university to a smart model by installing sensors and NFC tags. Students can check the availability of free desks in the library and reserve suitable seats [5]. The Bournville College has applied Cisco Physical Access Control Technology to control access to different parts of campus. This has helped to handle access to 400 doors in the main campus. This also observes foot-traffic patterns and sends notifications to the building management system. According to a survey carried by the Bournville College, 95% of the students has agreed that the system makes a safer learning environment for them.

3) *Student's health monitoring*

The IoT applications are seen in an extensive range of healthcare applications, from observing patients to avoiding disease. It upgraded access to a higher quality health care and also condensed the cost of care. The student health state is an important factor in determining the student's overall academic performance and therefore admission to an eminent health care service is important in any educational organization. A commonly seen application of IoT in healthcare is the use of wearable technology. Wearable devices can monitor physiological signals over long periods of time in a non-invasive and non-obtrusive way. The most common examples of these wearable devices are smart watches and fitness bands. A study has shown how RFID technology is used to implement an eHealth resolution which is called Electronic Medical Records or EMR in order to observe students at risk of high blood pressure through by using wearable devices [6]. The Oral Roberts University is trying to use the wearable technologies to monitor satisfactory health and physical education progress for online students. The wearable device will alert students to get up and move after long periods of sitting as many online learners undergo back pain and neck pain and other similar problems. The university will also analyze the collected data to understand if the smart watch has inspired online students to do more exercise.

4) *Improving Teaching and Learning*

IoT can support organizations to advance the quality of teaching and learning by providing a more affluent learning experience and real-time actionable insight into students' performance. It can generate a smart learning environment where students are able to customize the environmental variables such as room temperature to their best choice. Bob Nilsson [7] claimed that IoT devices like e-books, tablets, sensors, fitness bands, virtual reality headsets are being used in education at present in order to track and observe students in various traits like understanding students' learning patterns. In another research [2] a smart classroom has been suggested which can measure and analyze the effect of various parameters in the physical environment like temperature, noise and CO₂ level on students' attention. A smart classroom system will decide in real-time whether the environment is enhanced to make the most of student's ability to focus on a lecture at any given time. Also using wearable technology in the educational setting can improve the lecturing procedure with minimum disturbance in the classroom [8]. In another research [9] it was mentioned the potentials of using wearable technology to obtain and process data to improve knowledge

in higher education. For instance, Google Glasses and Sony smartwatch are used in the Universitat Politecnica de Valencia classrooms to allow the lecturer to gather important information about student knowledge building process. Students can receive data from neighboring sensors outside the campus, in historical and urban locations or in the public gardens.

In this research which was carried out by BAGHERI and the team, a contrast between the new and the traditional education business models is done. It demonstrates that IoT can offer numerous benefits for educational organizations. These benefits can be summarized as follow: reducing cost, personalized learning, time saving, enhanced safety, improved comfort and collaboration. This has also caused in new customer relationships and channels by forming a virtual and personalized relationship.

B. Smart Classroom: Real-Time Feedback on Lecture Quality

The objective of this paper [15] is to find out how intelligent ambient can be used to give real time, automatic feedback on the quality of the lecture based on a number of parameters. The researchers have addressed the prospective of using IoT to build a smart classroom, i.e. a classroom that can give real-time, automatic feedback on the quality of a lecture, i.e. about the present level of interest of the auditorium and the level of satisfaction of the auditorium with the lecture and the lecturer. Such real-time feedback will facilitate the lecturer to adjust the lecture during the presentation to attain the maximum impression and also to alter the following lectures based on the "lessons learned" from the previous circumstances. Researchers mentions that this is the first effort to state the problem of live feedback on lecture quality and analyze the requirements. In another research automated capture of audio, video, slides, and handwritten annotation during a live lecture has been proposed [10]. Podiums developed at MIT can measure several features of interaction, including nonlinguistic social signals by analyzing the person's tone of voice, facial movement, or gesture utilizing wearable device [11]. A related research was done [12] where wearable sensors were used to create a social index of interest. These devices must be worn in order to provide parameters for measurement. This is not the most conspicuous solution as the entities are not behaving naturally when they know that they are being observed. However, earlier work can be a good opening point for future research. The researchers address the problem of real time feedback on lecture quality, by observing the parameters available in audience and their digital representation in time scale in this research paper.

C. Smart Classroom Roll Caller System with IoT Architecture

This paper [14] states that smart classrooms are normally differ from other ubiquitous information technologies such as RFID. Also it shows the absence of one effective procedure to collect the 100% student real attendance in time at the end of every period of class by the academic office. In this paper, they propose an efficient mechanism by IoT architecture for this purpose which is the Smart Classroom Roll Caller System (SCRCS) that installed at every classrooms of university and read the student's ID card progressively to present the total number of the actual attendance on the LED display of SCRCS at the start of every class and let the all ID cards be visible on the multiple slots of SCRCS. Lastly, the academic office will gather every student's attendance at every class on time and help students have decent study performance. Fundamental aim of this paper is an attempt to solve the problem of completing the every undergraduate student's 100% attendance every day. In fact, these smart students usually ask their classmates to bring their student's card to roll call for every lesson. Therefore, the traditional RFID roll call system cannot void this event. Also there is no automatic tool to confirm the real time attendance or to double check every hour attendance of two/three hours lesson. This paper is proposed an investigation of making roll call for every student's attendance easily by SCRCS.

No doubt this solution would decrease the general absent rate. This is one successful tool to help students study well enough to compete after graduation. There is a causal effect of absence on performance for students: missing class leads to poorer performance according a study [13].

D. Towards a Smart Campus with Mobile Social Networking

The growth of wireless communication, the fame of smart phones and the increasing of social networking services had made mobile social networking a hot research topic. The features of mobile devices and necessities of services in social environments increase a challenge on building a platform for mobile social services. In this paper, the researches intricate a flexible system structure based on the service-oriented requirement to help social interactions in campus-wide environments. They have designed a mobile middleware to collect social perspectives such as the proximity, the cell phone log etc in the client side. The server backend, groups such contexts, examines social connections among users and offers social services to facilitate social interactions. A prototype of

mobile social networking system is deployed on campus. Also several applications are employed based on the proposed architecture to exhibit the effectiveness of the architecture.

Campus is basically a social environment where lots of social connections happen. To bring more suitability to campus life and enhance social relations, they propose to build a smart campus based on mobile social networking. [16]

E. The Research of Smart Campus Based on Internet of Things and Cloud Computing

Smart campus is proposed to be built by embracing internet of things, cloud computing & virtualization technology based on existing network and by analyzing present state of digital construction and network development in Wuhan University of Technology. This is done by combining with the building situation of domestic institutions.

The most important part of building smart campus is the infrastructure construction. This article primarily discusses the construction of Internet of Things based on ubiquitous network and the construction of cloud data center. A more humane and high-efficiency learning and living environment can be built by forming Internet of Things based on ubiquitous network since it can convert traditional passive service to active service. In the meantime, building cloud data center by utilizing virtualization can bestow it with storage capacity and computation capacity which are more extensible and more efficient. Also features, such as robustness, reliability and security, can also be improved greatly. Nevertheless in this research there are still other technical details which need to be studied further. For example, how to enhance performance and how to assign scheduling resources reasonably after storage and server devices of different brands and different types are pooled? What are matching problems between important applications and general applications? And which are key computing methods of service discovery and service providing within IoT system etc. Those are key aspects for future work. [17]

III. CONCEPTUAL FRAMEWORK DERIVED FROM THE LITERATURE REVIEW

The primary purpose of this framework (figure 1) is to monitor the attention level of the audience during a lecture and improve interactivity of the students with students and with the lecturer using smart devices. The monitoring part will be done using IoT devices.

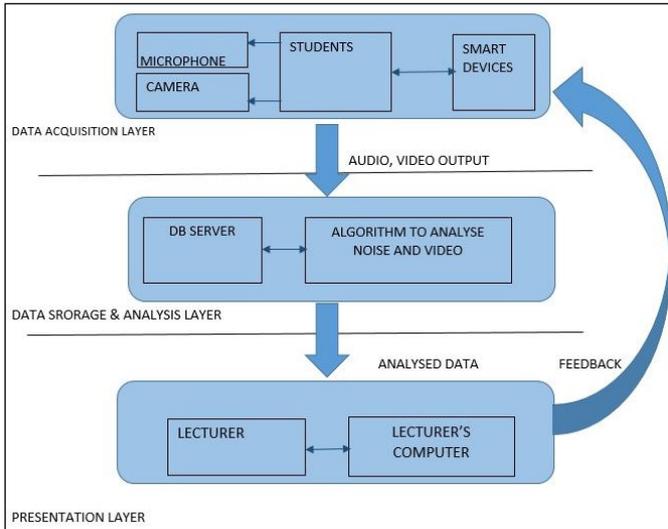


Figure 1. The conceptual framework

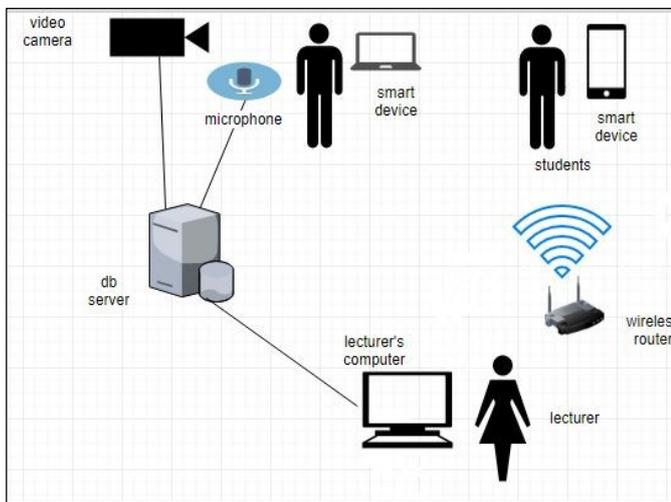


Figure 2. The system architecture

Mainly two parameters are considered to measure the attention level; Movements of students and the noise level in the classroom. The proposed high level architecture diagram is presented in the figure (2). According to the proposed system, to capture the movements, a video camera is used. Extreme movements are eliminated using a threshold to eliminate cases like, the lecturer walking in the classroom. Noise level in the classroom is monitored using several microphones. The data collected using IoT devices will be analyzed and the result will be presented to the lecturer on his computer in real-time. If the lecturer notices a less attention level among students he can change the mode of lecture or change current activity by sending a different activity to the smart devices of students to grab their attention and check their knowledge so far. Also students can participate in group activities using their smart devices to make the learning process more interactive.

IV. CONCLUSION AND FUTURE WORK

The smart classroom concept has appeared in the literature as an Internet based remote education system; or as intelligent environment equipped with an assembly of many different types of hardware and software components. In the process of everyday teaching, lecturers are usually trying to find out if the students were satisfied with the lecture, which part of a lecture was interesting, which presentation techniques and approaches were more attractive and effective than the others, which groups of students need more help regarding the lecture. The goal of this research is to track the performance and progress of students and identifying different groups of students according to their level of engagement to the lecture and thereby increase the amount of knowledge they absorb with the lecture hours. Also as a sub objective offering help by lecturer to students who need more help by tracking down their learning patterns is considered. Also personalizing lecture in order to reach out for these different groups of students is suggested in this research.

Merging the IoT technology with social and behavioral analysis, an ordinary classroom can be transformed into a smart classroom that actively listens and analyzes voices, movements, behavior, etc., in order to reach a conclusion about the lecturers’ presentation and listeners’ satisfaction. This will empower lecturers to constantly deliver good presentations and make better impact, while the audience will benefit from interesting lectures thus making the learning process shorter, more efficient as well as more pleasant and even entertaining. The implementation and testing of this system will be done as future work of this research.

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Efficient and Platform Independent CLI Tool for API Migration

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Abstract—Development organizations maintain separate environments for development, quality assurance and production etc. These environments execute independently and have their own deployment and own methods of traffic controlling that are handled locally. In such a process artefact allowed to be created only at development environment, tested in QA environment and then would promote to the production environment for promotion. In a API managing product company when moving API management products from one environment to another, all the created APIs need to migrate across different environments to save the developer time and effort at various environments. In order to achieve accurate and efficient migration, artefacts should be portable and transferable to any new environment without any major post migration changes and additional effort.

In this paper, we present a more powerful, efficient and generalized CLI tool that can be used by any REST based API managing applications to perform API migration in a more precise manner. We analyzed the current migration techniques use by trending API Management products and identified the major sieve point that needed to be addressed. Taking those faults into consideration we identified the appropriate mechanism to migrate APIs across different environments.

Keywords—API migration, REST API, CLI tool, platform independence

I. INTRODUCTION

API management is the process managing activities related to API creating, publishing, monitoring and life cycle management of the APIs. There are several commercially available as well as open source products standardize this management activity. Before such a product been released in-to the market, it traverses through different environments in the organization as Dev, QA to verify the product is ready

to release. While the product been proceeding at various environments, all the APIs created in one environment should be passed in-to another to examine the expected functionality uniquely across several environments. This can save the developer's time in recreating APIs in new environment as well.

Migration of API comprises of two key processors as exporting and importing. Exporting refers to moving of APIs from one environment to another and import refers to receiving APIs in-to a new destination environment. Export of APIs involves in retrieving all the API resources including API definitions, swagger definitions, thumbnails, WSDLs and documentations to another environment. During the process of API import, should be able to rebuild the API using the received API resources.

This paper organized around presenting our product, API migration tool which can perform API migration on behalf of the excessive manual work. Remainder of the paper organized as follows: the next section will point out the drawbacks we identified in current existing migration mechanisms. Then we will discuss about our product and its functionality. In the following section, we will list our findings. Finally, we conclude with the contribution of this work.

II. BACKGROUND

In order to test the API manager product during each stage of pre-marketing process consistent background environments needed to be maintained. Therefore, developers try to re-create these APIs in a new environment. When there's no any clear defined mechanism to export and import the APIs created in the past environments, Developers has to set up and publish these APIs in the new environment manually. Manual creation of APIs causes several identified issues as below [1].

Additional developer effort requires in recreating the same API in different environments. Creating an API with minimal features in single given environment cost average of 2 minutes. Number of such APIs are created in the process of developing an API management products as WSO2 API manager, Apigee etc. re- creating these APIs in several other environments is a wastage of developer productive time.

Extra time spends on recreating APIs will drag the test schedules and thereby extend the final release days of the product. Further, it is a waste of productive time that can be used in any feature development tasks.

Loss of actual functionality and features. Even though the developers somehow manage to create the APIs in the new environments, some of the functionalities and the features need to be tested can be missed due to the lack of knowledge in building a full functional API as known by the individuals of the developing environment.

As a solution to address above mentioned issues APIs created in the developer environment needed to be a bundle and transfer to each environment. Only 39% of the total API managing products in the market have defined a mechanism to copy and migrate APIs across different environments. These API managing products have defined different approaches to perform API migrations. Still, some drawbacks have not been addressed as a whole in any of those migration mechanisms. Following are few such dominant drawbacks that reveal after the market research and the literature survey on current API import/ export processors [10].

Platform dependency. Most of the API migration mechanisms, migration tools are heavily relying on the built-in platform technology and cannot be accessed via other API managing products. This is mainly due to the tight coupling between tool's functionality and the programming language used in building the tool [2].

Delegation of major key security functions to third parties. Most of the current migration tools rely on third party integrations to perform security functionalities directly on behalf on them. The trust

relationship between the third-party application and the operating application is the foundation of this bond. APIs are proprietary properties. Therefore, security becomes a key factor that needs to address in advance. Sometimes this trust relationship can be broken and application can be open to intruders, therefore in order to withstand this circumvent alternative security mechanisms or stronger authentication techniques should be integrated into the tool [3].

Individual components should be deployed separately. Single API consist of a number of components as API definitions, swagger definitions, API thumbnails, documentation, WSDL and any migration policy sequences. In most of the migration tools each of these components needed to be deployed separately during the process of importing API to a new environment. This has a considerable effect on the performance of the migration process. In the process of bulk import and export this manual work increase in multiple times as per to a single API import and export. Ultimately, it's a waste of productive developer effort and time.

File exchange through third party applications. In the current process of exporting followed by few available API managing products, created APIs can be compressed in to .zip or into any other portable version and these archives been sent through a third-party software application like email, skype, google plus or using any other file sharing service. However, this procedure has open passage to intruder attack risks. It is better to handle the API migration through docker files which will be a perfect solution for unauthorized access via external parties.

Useful bandwidth wastage. When comes to the API management based on REST API implementations, Retrieving API's resources from data sources perform number of REST API invocations and same when storing components in-to the data sources of the destination environment. A number of REST API calls moving back and forth reducing the utilizable bandwidth allocated for the entire process.

Considering above facts, its showcase that there's unfilled requirement of a more explicit tooling support for the domain of API migration. The purpose of this

paper is to forward a preferable solution to the API migration process addressing above mentioned limitations.

III. METHODOLOGY

The objective of the project is to introduce an efficient and platform independent solution for migration of APIs across different environments. This tool is a generalized CLI tool, build for API migration which will facilitate the smooth and powerful transferring of APIs across different environments in the domain of API management. The CLI tool will minimize the effort and time in re-creating APIs in when product moves between environments as Dev to QA or QA to production.

Tool is a generalized migrating tool that can be used in different API management application by different vendors. Another main benefit of the proposed tool is, the tool will be a platform independent tool which can be used in different operating systems.

Tool comprised of several major key functionalities including built-in authentication mechanism, export of single and multiple APIs, import of APIs, API deployment in the google cloud using docker and kubernetes.

Security. The CLI tool equipped with a built-in authentication mechanism to ensure a strong secure authentication process. Therefore, it has minimized the dependencies with external third-party authentication mechanisms.

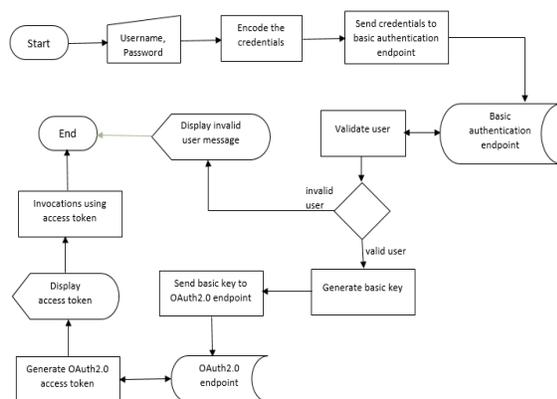


Figure 1: The Authentication mechanism of the CLI tool

Encapsulated authentication operations are undertaken to prevent any unnecessary external intruder actions. Figure 1 provides the detail flow of the authentication mechanism followed by the CLI tool. User can log in to the tool using a valid username and a password. This user credentials decide about the environments that the user can access into. Valid user name and a password then concatenated and encrypted and sent to the basic token endpoint. Basic token endpoint will issue a basic token with expiration period. This encrypted basic token can then be sent in to an OAuth 2.0 endpoint which will return a valid OAuth 2.0 token. OAuth token is use by the CLI tool to call the REST API endpoints to retrieve the resource components of the APIs. These components can then can be bundled and sent to the next environment.

Export. Retrieving all the components related to a API as API definition, swagger definition, documentation and bundle them up to a transportable file refers to as API export. The figure 2 illustrates the process followed by the CLI tool perform above functionality.

User can execute the tool with the credentials of the API details. API details can either be the UUID of the API or combination of API name, version and the owner of the API. Once the request been sent, CLI tool search for the API in API store. If it is a valid API CLI tool will retrieve all the components related to the API separately from the persistent data source and write in to a folder. Component belongs to API includes API definition, swagger definition, thumbnail images, mediation policies, documentations and any WSDLs if available. Finally created API been compressed and convert into a transportable file, which can be used in the API import process in the receiving end.

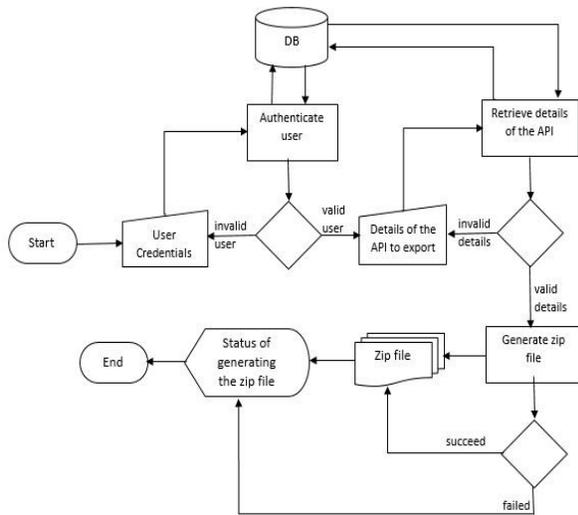


Figure 2: The work flow on exporting an API.

Import. In API import a publisher will receive a compressed version of an API or a collection of APIs. Publisher can create those into the new environment by executing the CLI tool. Figure 3 illustrates how the API import perform inside the CLI tool.

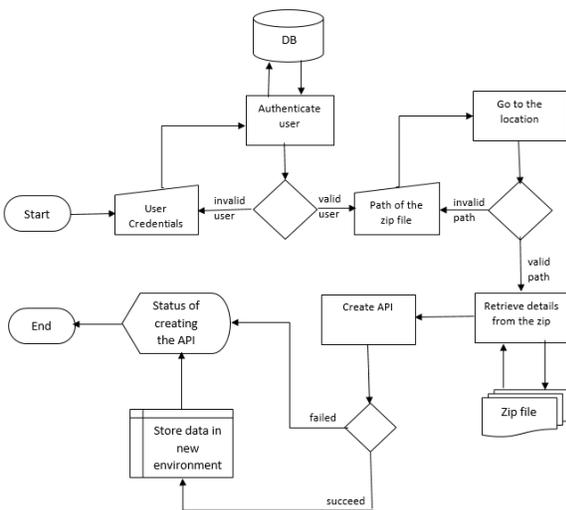


Figure 3: The work flow of the API import.

User can run the CLI tool with the valid credentials and path to the imported API file. Tool will validate the user and path to the imported file. If valid, CLI tool will extract all the content inside the imported file to a temporary location. There after tool execute number of REST API invocations to re-store the component in the persistent data source of the new environment.

After storing data tool can publish the API/APIs in the new environment.

Deployment of API files using docker and kubernetes.

The main communication mechanism used in REST APIs are HTTP calls, there can be many numbers of HTTP calls as per the user’s requests. It will be affect the performance of the product while wasting a certain amount of network bandwidth. As a solution, introducing a way to minimize the number of HTTP calls to achieve the use of a minimal number of resources per requests to improve the performance and accuracy of the tool. Moreover, including Docker in the product to make more efficient service since Docker has many potential advantages in the fields of usability, performance and security against traditional virtualization [4],[8]. Base Docker image from the Docker hub will be taken through the CLI tool and then push the API to the retrieved Docker image. After that, it can be pushed directly to the Docker hub again. Another production environment can access the pushed Docker image with the API in their environment to execute the tasks. Therefore, Docker makes easier to deploy CLI tool in several isolated environments [6], [7]. Always there may minor variation between development environments; unless having own repository environment. By using Docker, fulfil that gap by keeping consistent environment because Docker containers are configured to keep dependencies internally.

Furthermore, involving kubernetes in the tool will also benefit the user, since it can handle complex scenarios on the deployment and to give users the ability to access their API’s with more efficient and scalable approach while providing zero downtime deployments, continuous deployment and high stability of deployed services [5],[9]. Therefore, the purpose of Kubernetes is to make it easier to organize and schedule the application across a fleet of machines. At a high level, it is an operating system for the user’s cluster. It handles what specific machine in the datacenter each application runs on.

The configurations needed to be done at the user end will be minimized by the above-mentioned techniques by enhancing the automation functions which will be included in the proposed tool. The final implemented CLI tool will mainly achieve API migration in

different environments, platform independent, high efficiency, provide powerful built-in authentication mechanism and minimalist usage of the available bandwidth while minimizing the identified drawbacks and improve the performance of current migration tools in API management products.

IV. CONCLUSION

API migration is becoming an essential functionality supported by API managing products which will allow developers to migrate the created APIs in one development environment to another as well for the API publishers to exchange their created APIs with other API publishers. Current mechanisms provided by several API management products have identified problems which are not addressed yet. Therefore, a requirement for a powerful, platform independent and efficient CLI tooling supporting for this domain is still at a growing stage. We presented new CLI tool which could overcome those identified issues in current existing tools and have a capability to address the performance issues currently undergoing.

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