EATND – IOT BASED SMART ATTENDANCE SYSTEM FOR A SMART CAMPUS

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***Abstract*— Internet of Things (IoT) is the driven concept behind incorporating a large number of different and heterogeneous systems. With the implementation of smaller sensors and devices, a large variety of devices can be connected using link-layer technologies to provide various types of services. In this paper, authors focus on implementing a Smart Campus environment by implementing an IoT platform combining Wireless Sensor Network (WSN) technologies for communication and localization. Added-value services such as administration, information distribution, student localization along with a mobile application. The system aims at providing administration services to the campus authorities as well as providing information services to the students. Furthermore, the paper presents the implementation and the evaluation of the system performed with the collaboration with campus and its students.**

***Keywords*— IoT; WSN; RFID; Smart Campus**

I. INTRODUCTION

Attendance management is one important function that is conducted by universities, where most of the universities do not maintain a proper system. Therefore, there is an urgent need for creating a system that tracks student attendance. During the early days' systems that were used to supervise student attendance were cumbersome, where the attendance was marked manually, and it was a tedious task to be done and an inefficient way of marking attendance of students

As the technology has been revolutionizing over the past few years more efficient and effective technologies have been arising, integrating monitoring along with automated technologies. The Radio Frequency Identification (RFID) technology is one of an automated technology that is beneficial in improving the current traditional way of monitoring student.

In this work the authors propose a system that uses RFID readers and tags to record the attendance of the students, along with a smart notification system that notifies students regarding certain events and a smart noise level detection system that tracks noise levels within classrooms, in addition to it a student tracking system is developed to track students accessing restricted areas, as an additional feature of this system an android application is developed for the university students.

II. LITERATURE

The authors reviewed papers in various research papers to identify existing research aspect of Smart Campus Concept. Further, it divides into sub-areas such as Localization system, Smart Attendance Management using RFID, Smart Dashboard and Mobile Notification System.

A. Localization System

The aspect of localization-based systems has been widely investigated mainly, where many of these solutions were based on WI-FI.

Eddie C.L. Chan et al [1] developed a localization system based on the wireless sensor network using the Wi-Fi signal strength. This research was based on Location fingerprint method using training dataset of the RSSI parameter and it used Kalman Filter to track multiple points to characterize a trajectory (K-NN algorithm) this method lacks the accuracy of the location as the RSSI is highly subjected to multipath fading.

Joes Luis Carrera et al [2] proposed a real-time indoor tracking system by fusing inertial sensor, radio signal, and floor plan. In this system it fuses the Wi-Fi RSSI readings, the IMU's (Inertial Measurement Units) and the floor plan information in an enhanced particle filter and this system it enhances the particle filter by performing an additional re-sampling method Using this model, it could achieve an average tracking error of 1.7m and 90% is 3.2m.

B. Smart attendance management using RFID

A.A. Olanipekun and O.K. Boyinbode(2015) introduced an RFID based attendance management system[3] with VBnet software that records student attendance. The limitation of this system is that student can swipe another student tag to record the attendance and there's no proper method to track identify that situation.

Mahmood K. Al, Muna M. Al Nayar, Abbas R. Kubba (2015) proposed a Smart University concept using RFID and WSN[4] that includes student authentication using RFID tags. The implemented software system prevents the cardholder to check in two places simultaneously and attendance records only if the holder spends the minimum time required for the attendance.

C. Smart dashboard and mobile notification system

Rajesh G, Praveenraj Pattar, Divya M.N and Vara Prasad (2016) proposed an NFC Smart Notice board for university [5] that displays a notice board through NFC tags. The notices are displayed only if the student swipes the tag.

Better privacy and security system introduced using service isolation and the token-based mechanism by Siyu Yang, You Song, Honglei Ren and Xinxing Huang (2016). They have proposed an automated attendance tracking system [6], where students can use their smartphones to submit attendance in parallel. It also can identify the student and verify by voiceprint and real-time location

D. Smart Noise Monitoring

Marian Cata et al [7] develop a smart noise level monitoring and notification system based on the sensor network. It was implemented with a noise detecting sensor and with the past analyzed data as the noise level in the class will be changed rapidly with the student count and with the dimension of the lecture hall.

Kurt Eggenschwiler et al [8] introduced a system that detects the noise level inside the lecture hall with the help of air conditioning

III. METHODOLOGY

Fig. 1 shows the layered system architectural block diagram of the proposed system (Hardware layer, Communication Layer, Application Layer).

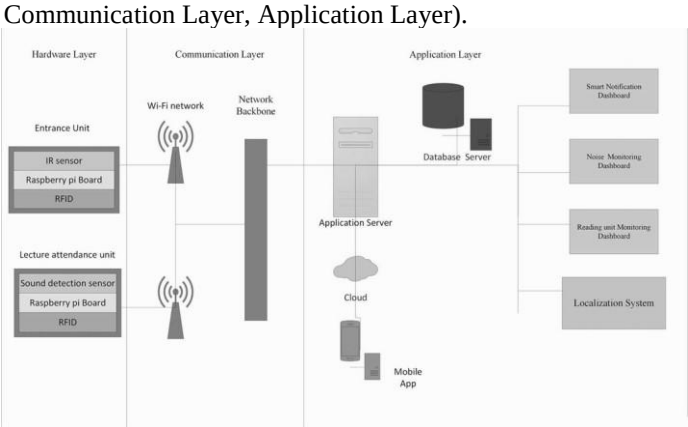

Fig. 1. System Architectures

A. Hardware Layer

The hardware layer is composed of several subunits, the EAU (Entrance Attendance Unit) and LAU (Lecture Attendance Unit).

1) Lecture Attendance Unit and Entrance Attendance Unit:

The Entrance Attendance consists of two components. One is the hardware component which implemented at the main entrance and the lecture hall entrances. The other component is a node monitoring system that is implemented to maintain a reliable and precise communication system. The Passive RFID tags are used in the system as it does not require an internal power source.

When the reader reads a tag (T) it identifies the unique id (I), of the tag and hence using that "I", it authenticates the "T", by sending and receiving information between the central attendance management server via Wi-Fi.

Fig 2 shows the authentication algorithm to be implemented in each unit.

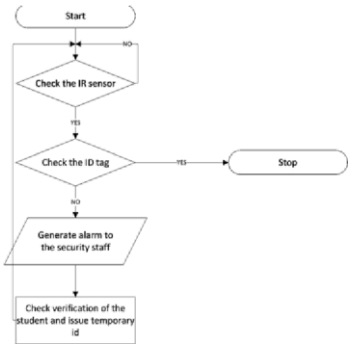

Fig. 2. Authentication Algorithm of LAU and EAU

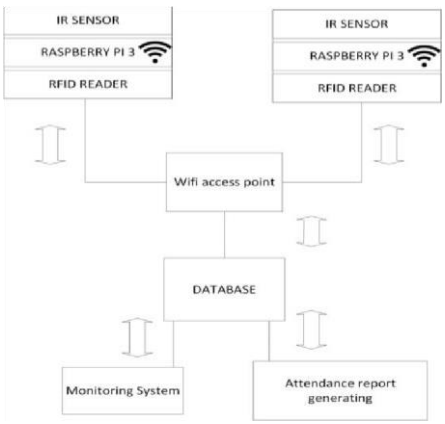

Fig. 3. LAU and EAU System Block diagram

Fig 3 shows the block diagram of the LAU and the EAU, where a node monitoring system is implemented along with each node to monitor the status of each node and report whether a node is functioning accordingly or not.

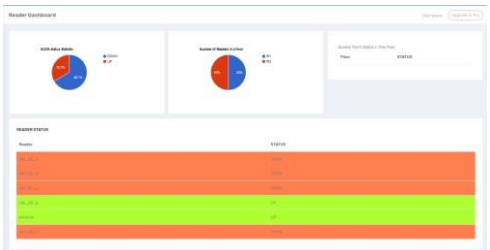

Fig. 4. Node Monitoring System

The above Fig 4 shows the monitoring system that is used to monitor the status of each node deployed, where the status will be indicated.

In addition to the monitoring system, a report is generating, which helps the administration to develop a daily report on the attendance with the time, date as well as the number of instances at which the student has attended to a certain lecture.

B. Communication Layer

Main technology that is used within this layer is Wi-Fi technology, where it is used to transmit data from the EAU/LAU nodes to the central database.

C. Application Layer

The application layer is composed of three main components that are the main server, android application, and the central database.

1) Main Server: This is the main server within the system that processors data that are collected via several sources and which is integrated with the central database as well as the android application.

2) Central Database: For processing and storage of the information collected from students a management server and databases are required, MYSQL is used as the central database within this system, where all the related to several sources are stored.

3) Android Application: The android based mobile application is developed mainly targeting the students, where they can log in to the application using their credentials and the users can search for their relevant courses and download course materials as well as view timetables and notification regarding.

The administration staff is provided with separate credentials where they can manage the overall system so that it enables to get rid of bugs that arise during the application usages as well as they are responsible for maintaining accurate information within the application.

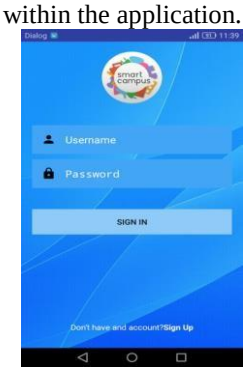

Fig. 5. Login Interface of Android Application

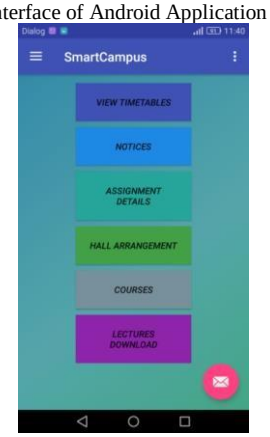

Fig. 6. The main interface of Android Application

The above Fig 5 and Fig 6 shows the interfaces used in the mobile application.

4) Smart DashBoard: Management of resources and efficient resource utilization is an important task in a university environment. The proposed system introduces different implementations like hall allocation system, special notification system, and smart notice board that embedded in a dashboard to achieve this task.

The hall notification system is implemented within the system where data relevant to the hall arrangement will be kept within a database to track the allocated halls and vacant halls, these data will be analyzed, and the students will be notified regarding vacant labs/lecture halls.

Each floor that consist of labs and lecture halls will consist of a display unit, which indicated the free lecture halls and labs within that particular floor

Fig. 7. Smart Dashboard

The above Fig 7 shows a sample screenshot of the dashboard that will be implemented.

The Smart Notification system consists of its unique algorithm to generate the notices to be displayed on the screen targeting a specific audience, which is as follow:

Algorithm – USER_GROUP_SELECTION(Y_i,D_{id},N_t)
Input – student study year indicated in Y where i=1,2,3,4 and the study department in D where id=IT, ISE, SE Output – the notice in N where the t indicates the time of the notification
BEGIN
1) Initialize 2) GET(Y_i,D_{id});
3)***if*** (Y_i > D_{id}) ***then***
4) DISPLAY (N_i □ Y_i);
5)***else*** {
6) ***if*** (Y_i < D_{id}) ***then***
7) DISPLAY (N_i □ D_{id});
8)***else*** {
9) ***if*** (Y_i = D_{id}) ***then***
10) DISPLAY (N_i □ (Y_i OR D_{id}));
11) }
12) ***}***
END

5) Localization System: A student localization system is implemented within this system to track the location of the students within the campus. The location is determined based on the details obtained from the AP's deployed throughout the campus area, where the MAC address will be used to specifically identify a user and the RSSI values will be used to locate the exact positions of a user these details will be sent to the database using the wireless sensor network.

This Localization System will be implemented on as a Web application.

Hypertext Markup Language along with PHP and JavaScript to enhance its feature. Another tool is used that is the Google Maps Embedded API.

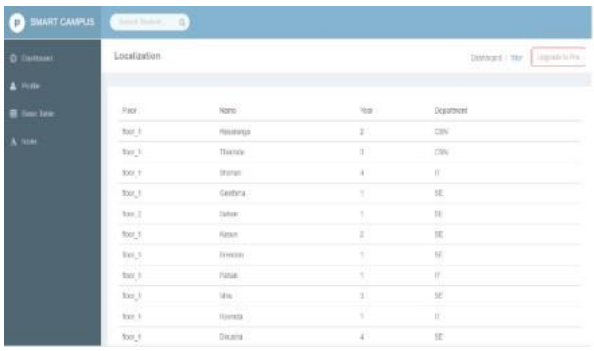

Fig. 8. Localization System

The following above Fig 8 shows the basic map created to locate the student.

D. Smart Noise Monitoring

The "Smart noise monitoring and notification system" is one of the main features and requirement in proposed smart university concept the noise level in the classroom and it will display in the web application, and also in the smart dashboard the Smart noise monitoring and notification system is calculating the lecture hall “Area” with help of length and width of the lecture hall and also it will capture the total student count in the lecture hall.

After collecting these values, the system will automatically calculate the noise level within a lecture hall by using the following equation which is derived from several parameters.

Parameters: Area (A), Noise Level (NL), Students (C)

$$A = k1 * NL \quad (1)$$

$$C=k2 * NL \quad (2)$$

Equation 3 is derived from Equation 1, where the Average Noise (N) is inversely proportional to the Area.

$$N * k3/A \quad (3)$$

Equation 4 is derived from the combination of the student count and the area.

$$N = k * (C/A) + S \quad (4)$$

The ‘S’ parameter indicates the noise sensor value obtained from the sensor deployed at each lecture hall.

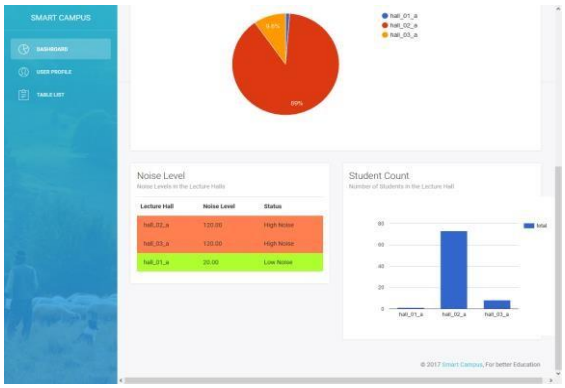

Fig. 9. Noise Monitoring System

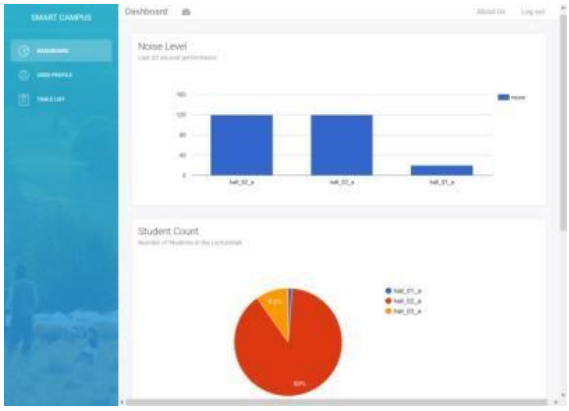

Fig. 10. Noise Monitoring Dashboard

The above Fig 9 and Fig 10 show the basic view of the Noise monitoring system.

E. Hardware Platform

1) Raspberry pi: The Raspberry pi 3 modules will be implemented at each node implemented within the campus, the RFID readers that are used to mark the attendance of the students will be connected to the raspberry pi the data collected via the raspberry pi modules will be transmitted to the server via the Wi-Fi technology.

The inbuilt Wi-Fi module within the raspberry pi is used to transmit the data

2) RFID Reader: The RFID readers will be implemented at the EAU and the LAU, where it will be connected to raspberry pi modules, the readers will be connected to the raspberry pi modules

3) LM393 Sound Detection Sensor: The Sound detection sensor used to capture the noise level of the lecture hall. The sensor is connected to the Raspberry Pi module and it transmits to the data centralized server. The sound detector provides audio output, a binary indication of the presence of sound and analog representation of its amplitude.

The sensor is used to detect and count the number of students in free lecture halls. Whenever student enters to lecture hall crossing the sensor the allocated value is increment.

PIR sensor allows sensing motion and detecting whether a human has moved across the sensor.

IV. TESTING & EVALUATION

A. Test Plan

The Test phase is carried out in basically two phases:

Phase 1: Individual Unit Testing

Phase 2: Integrated Testing

In the Unit Testing phase, each unit within the system is tested with real-time data, to check how each unit copes up with the data and how accurate the system operates.

Graphs and raw data will be used to analyze the system.

TABLE I. EVALUATION CRITERIA

Evaluation criteria for students	5	4	3	2	1
The smart tag is easy to use					
The mobile app provides essential notices quickly and efficiently					
The NFC control systems provide necessary functionalities					
The dashboard provides sufficient information based on your location and year of study					
How would you rate the system					
Other suggestions: ----------					
Rate matric *1: Excellent* *2: Very Good* *3: Good* *4: Average* *5: Not Good*					

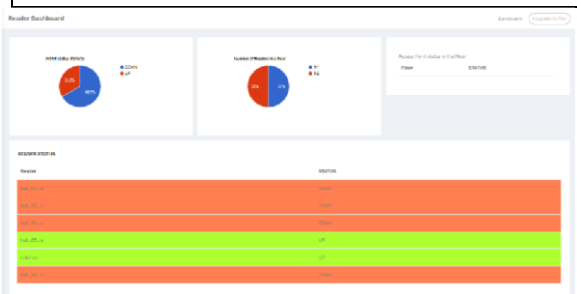

Fig. 11. Node Management Testing

The following Fig 15 shows the testing phase conducted on the node management system.

Then after performing the Unit testing and eliminating the errors of the system, each subunit of the system is integrated and the Phase 2 testing is performed, that is the integrated testing, where the integrated testing will check the following aspects of the system:

- Accuracy
- Performance
- Ability to cope with a huge amount of data
- Real-time operation
- Reliability

After the implementation of the system, a system evaluation process is performed by getting feedback from several students using the following questionnaire to evaluate the user friendliness of the system.

The questionnaire was conducted for two student groups at the Sri Lanka Institute of Information Technology. The group details are as follows,

TABLE II. GROUP INFORMATION

Group ID	Student Count	Study stream
01	1200	• Information Technology • Computer Systems & Network Engineering • Information Systems Engineering
02	800	• Information Technology • Computer Systems & Network Engineering • Information Systems Engineering

The survey results are as follows.

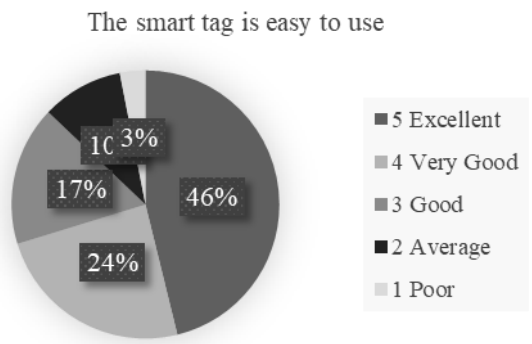

Fig. 12. Pie chart for easy use of smart tag

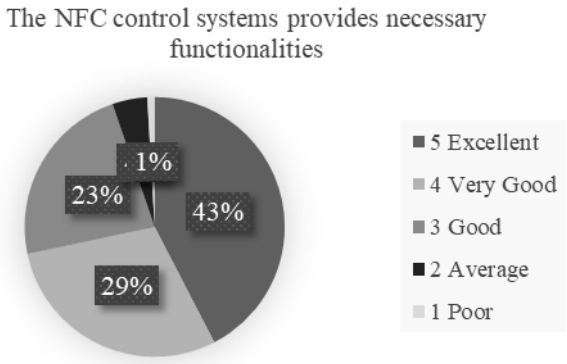

Fig. 13. Pie chart for NIC Control System

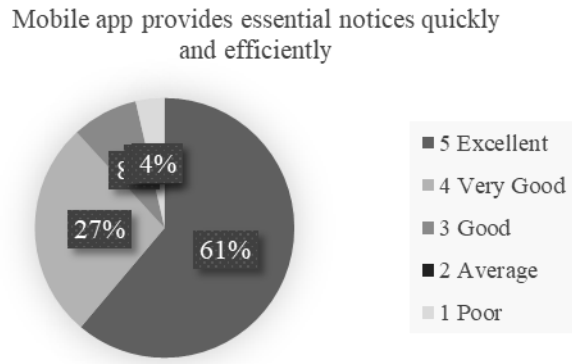

Fig. 14. Pie chart for Mobile application experience

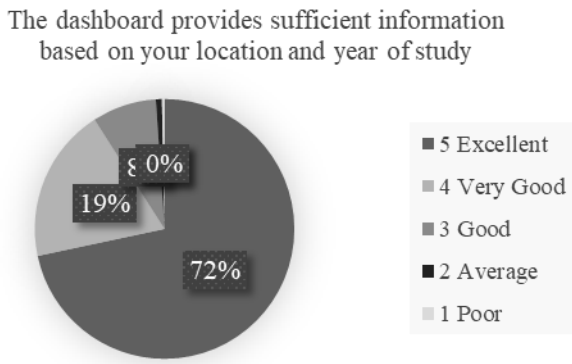

Fig. 15. Pie chart for Dashboard Experience

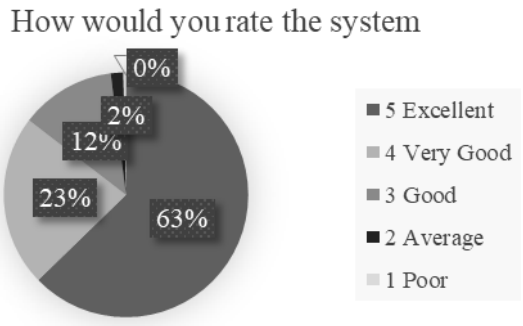

Fig. 16. Pie chart for System Rate

Example suggestions inputs include,

- Create communication link with lecturers.
- Feedback system
- Lecture hall navigation

VI. CONCLUSION

In this work, a smart campus-based solution is proposed. The system consists of four main components, a smart attendance recording system, a localization system, a smart dashboard, and a Smart Noise Monitoring System. According to the implemented system and a survey carried out by the usage it can be seen that the system is receiving averagely good reviews and that the system provides the intended outcomes.

- Student Monitoring System
- Smart Application and Dashboard
- Attendance and Hall Management system

These four components are integrated together in order to provide a single system that provides benefits to both the administration and students using this system.

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