GROW N GLOW: AN IOT BASEDHYDROPONIC PLANT SYSTEM

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***Abstract*— This paper introduces an IOT based hydroponic planting box solution which is called as Grow N Glow. This can be controlled wirelessly from anywhere in the world with the concept of IOT. This is complete IOT solution with sensors and actuators that can be controlled by any smart device, desktop, or laptop. This developed solution includes light control, exhaust controls, water pump controls, oxygen pump controls nutrition pump controls and so on. As the result complete hydroponic system was developed. Using this solution lot of advantages can be achieved. It will maximize the space, saves water, maintain a microclimate for the requirements of the plants. This solution does not use soil which is a major advantage because there will be no harm for the plants or crops. The crops will grow fast, and the harvested crops will be fresher and healthier comparing to normal crops. There are some vegetables that require specific conditions or else they will not grow. With this solution common plants can be grown regardless of the weather conditions.**

Keywords—IOT (Internet of things), Wireless, Hydroponics

I. INTRODUCTION

The main aim of the Grow and Glow is to optimize the hydroponics and practice people to do self-framing which came a trending topic with this pandemic situation and create a whole eco system that is not dependent under the natural environmental factors. [1] In hydroponics plants will be grown in a mixture of water and nutrients. EC and PH values will be set to the water solution which the seeds will germinate and dip the roots in. [2]To grow the plant sir temperature, humidity, UV (Ultraviolet) lights, water temperature needs to be controlled. Those are critical parameters that needs to be maintained regularly. This will decide how fast the plant grows. [1] After the seed is germinated into water it will grow very fast if all the all parameters that have mentioned above well maintained. Without the human interaction all the controls can be well maintained via the mobile/web application. This implies this can be controlled without humans interacting with the plants physically. [3] [4]This IOT automation processes was achieved using (Mega +Wi-Fi R3 Atmega2560+NodeMCU) Microcontroller, sensors, and IOT technology with remote monitoring of the Grow N Glow. The basic operation in the sense is sensors will monitor 24 hours into 365 days. Sensor inputs will prompt the user to do the necessary controls to the system and keep all the necessary parameters in range. There are systems which are already implemented in the market, but they are very expensive or will not control or monitor the parameters that need to be controlled accurately for a healthy growth of a plant. To grow a healthy plant studies proven that the parameters need to be monitored well and adjust the necessary parameters in correct time or else it will not grow according to the expectations of the users. [3][4]

II. METHODOLOGY

The system uses one Mega +Wi-Fi R3 Atmega2560+NodeMCU microcontroller acting as the main node that collects data. The web server that is hosted receives the data input and the updates of the sensors. The whole system can be controlled with the mobile device as well (IOS/Android). The system can fit in a small office or home space. The technology used in Grow N Glow makes it a unique product comparing with the other products that are already in the market.

A. Structure

The frame created with metal box bar, and it is covered with eco board which is a water resistant and insect free board. Front side has a magnetic rubber beading was used to front side for proper sealing of the door. The structure broken into 3 layers. Top layer is to hold the light. Middle layer to grow the plant, and bottom layer to hold the nutrients, water, and devices.

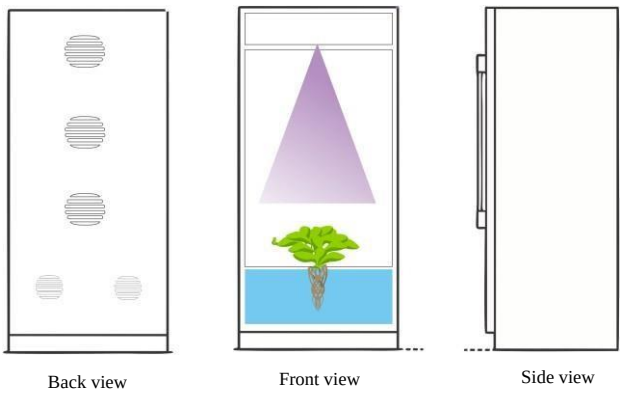

Fig. 1: Design of the Grow N Glow

B. Hardware

Mega +Wi-Fi R3 Atmega2560+NodeMCU microcontroller is the key controller of the system to collect data and send control signal. Wireless IEEE standard 802.11b used for communication with the device. The communication happens via the esp8266. The gateway will connect to the locally hosted server. So, the data will be come to the server. The server itself trigger updates from microcontroller and send instructions to the microcontroller. The server sends, the data to the mobile app and the web site. The UV light intensity and ON and OFF will be controlled with a relay module and analog values. There are two air in fan and one air out fan controlled by a separate relay module. The ESP-32 camera module mounted on the plant section can be accessed any time to view the growth of the plant. State of the whole system will be monitored with various types of sensors. The aerator will be used to add oxygen to the water so, the roots of the plant

can absorb oxygen. Mainly there are four sensors are used to gather data. Temperature/Humidity sensor, probe that conduct electricity, Water temperature sensor, and PH sensor. Electrical probe will determine and estimate the amount of salt and nutrients that includes in the water. PH sensor will give the PH values of the water. This need to be checked before putting the plant. PH sensor and the electronic probe are connected to the microcontroller. So, based on the values plant must be put into the system. After adding the nutrients to the PH value must be in between 5.6 – 6. The temperature must be measured because the PH values will change based on the temperature. With two peltries the water temperature must be maintained in between 25 – 26°C.

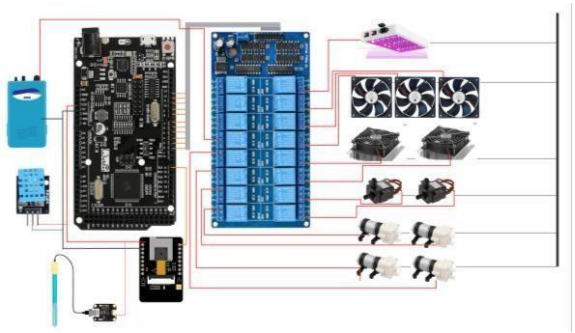

Fig. 2: Hardware connections

Device	Description
	This device is a Arduino mega r3 board comes with a specific esp. 8266 wireless chip. The processor is At mega2560. There is a dip switch to control the modes of the microcontroller.
	The relay will be used to control the power supply for the operating devices of the system. The relay module will be on normally open. When a 5V signal comes it switches the mode from normally opened to normally closed. So, the circuit gets completed and components can be controlled separately.
	This is a digital sensor that can measure both temperature and humidity. This has a thermistor and a humidity sensor. This can give both the values from a single output digital pin. This has a separate Arduino library built in which called 11. With the library this can be used easily.
	This is 12v dc water pump. So, this will pump the water to the peltier's for the colling process of the water.
	This sensor will be used to measure the hydrogen ion concentration of the water.
	The 12 v dc fans will be controlled to take the air in and out to the system. This will rotate when it supplied 12v to the module. This will use to keep a good ventilation to the system.
	This motor will be used to pump the nutrients to the water solution controlled with 12v dc power supply. This can control precisely because this has a valve inside the motor.
	This will be used to control the temperature of thewater. With this water can be cooled. Normal water goes in and cool watercomes out from these Peltier. This is powered by 12V.
	This is an inbuild module that can be connect with any esp. 8266. This will be controlled SPI (Serial Peripheral Interface) of the microcontroller. This is powered by 5V. This can be used to the monitoring of the plant.
	[5]–[7]This is a light that provides different UV spectrums with the led lighting. The lighting that the plant need in different stages can be given to the plant with this light controlled by 12V [5]-[7]

C. *Software*

The microcontroller will be programmed with Arduino IDE (Integrated Development Environment) which is using an extended version of C++ programming language. A separate web application and mobile application developed. With both this methods user can access the IOT controls and monitor all the sensors that are in the system. The Spring server will communicate with the microcontroller and the web application and the mobile application will connect to with the spring server including the SQL server database. The server will be the main controller to control all the instructions that comes from the web/ mobile application and triggering them in the microcontroller.

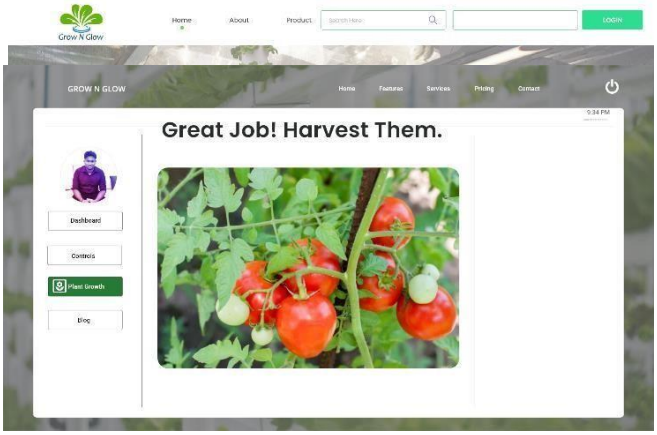

Fig. 3: Web Application Login

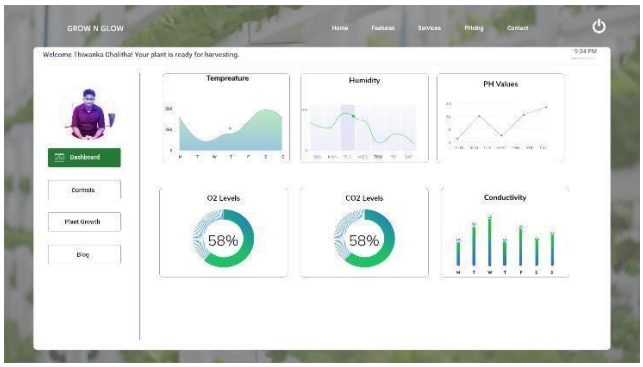

Fig. 4: Web Application Dashboard

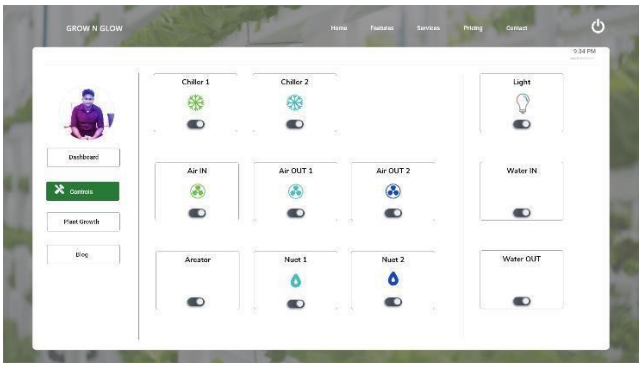

Fig. 7: Blog of the Web Application

This will be built by Angular 8 framework with Node JS. Theweb application will handle all the instructions from the userwithout any delay. Usercan be dependent on this web application or the mobile application for the ease of the use. It will depend on the user's useability. From the web appusercan view all the real -time updates of the sensors and can control the deices individually with the IOT control panel. Any new updates willbe informed in the blog on the website.So, users can use the new technologies with the device theyare using. In the same way this app will be available for bothIOS/ Android devices coded byusing Angular Ionic framework. It was used because with the same

Fig. 5: Web Application IOT

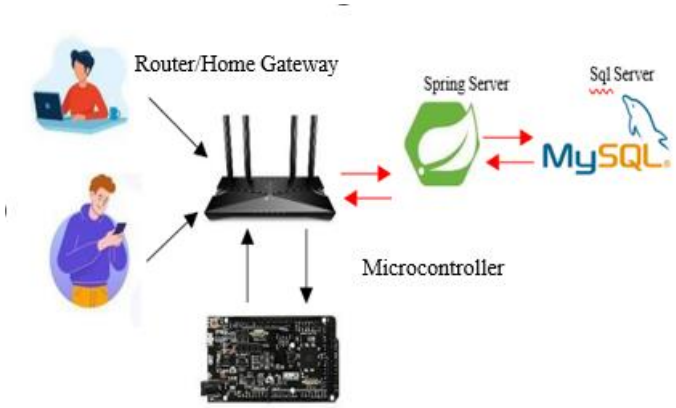

Fig. 8: Structure of the application

The user can access the web server anytime and log in to the system with the credentials. So, the requests will be processed by the spring serverand send back to the user. Any requests that will beissued to control the microcontroller it will be directed to the microcontroller via the server to the home gateway. Spring server has all the features to implement these services.

html code the android and IOS can be generated. Next the user interfaces ofthe mobile app will be listed. If the system finds any critical values for the sensors the system will notify the user immediately through thenotifications for the mobile app as well as the webapp. Just in case if the system device fails the whole system will shut down immediately and notify the user that there is a system failure. This will happen if any failure of the sensors happens. Itwill make sure that the other components of the system will be safe without malfunctioning.

Controls

Fig. 9: Login of the Mobile Application

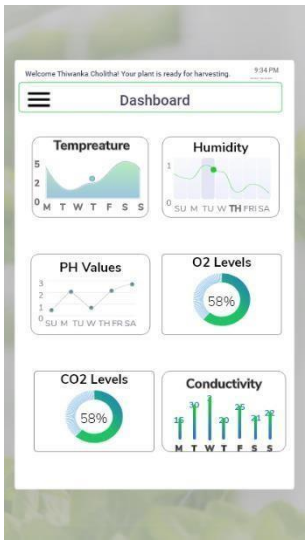

Fig. 10: Dashboard of the Mobile Application

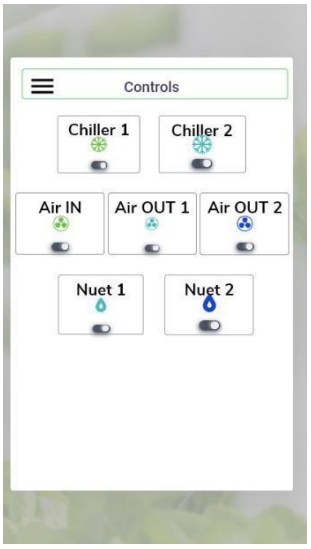

Fig. 11: IOT Controls of the Mobile Application

III. Results and Analysis

[2], [3], [8] Data was analyzed using the database records of each device. Each device data will be sent real time to the server if there are any changes of the sensors and the server will average it to the and write it back to the database hourly. The temperature, humidity, PH values, Conductivity will be collected. [2],[3],[8]

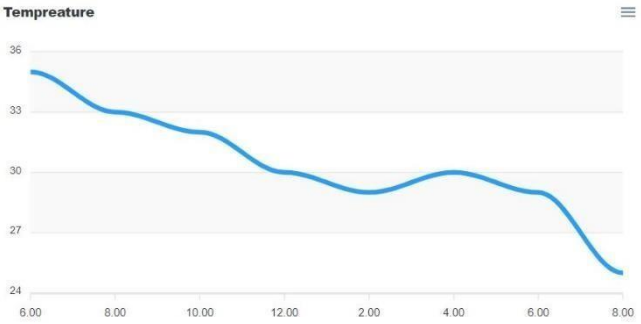

Fig. 12: Temperature Log

log in Fig. 13 shows from 28°C to 32°C throughout the day, but for the night the average is around 25 °C.

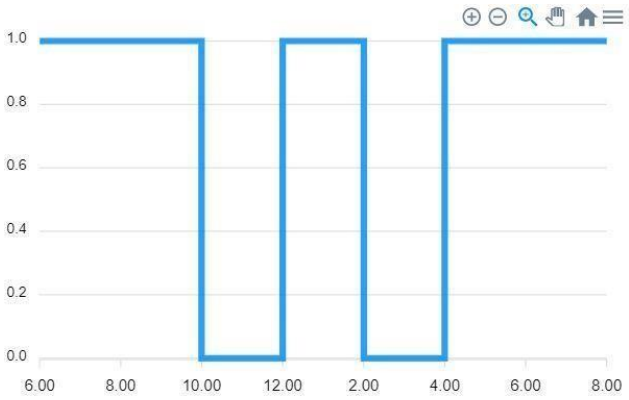

Fig. 13: UV Light Log

Fig 14 show the amount of the light was ON and OFF. This will make sure that the plant will get the optimized lighting conditions in-order to grow.

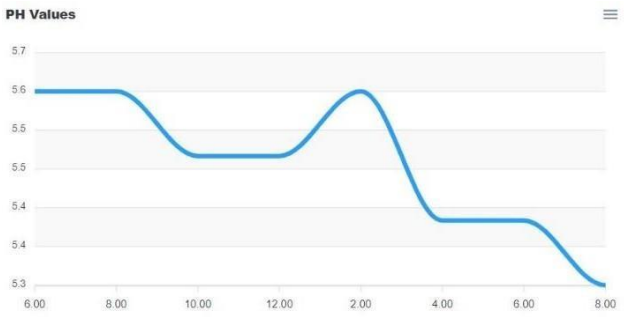

Fig. 14: PH Value Log

Fig. 15 shows the PH values overtime. This must be an average in between 5.5 – 6. When the plant uses more nutrients the PH value goes HIGH.

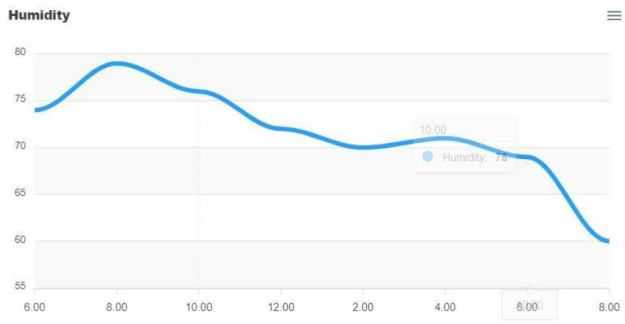

Fig. 15: Humidity Value Log

Fig. 16 will show that the humidity level of the device. This will show the vapor of the atmosphere. With this the evaporation amount from the tree can be measured.

Each separate log is very important because it very important to make sure that all the key factors are optimized according to the needs of the plant. Two separate test setups were run to test the growth of the plant. Two plants were tested one was planted in normal environment condition and one was planted inside the device.

Fig. 16: Plant status check after a week

The status of both plants was monitored through every week and, as expected the plant which is inside the system grew better and faster than the plant which was outside. The plant which was inside was big inside compared to the size of the plant which had only two leaf stems on the plant.

IV. Conclusion

The Grow N Glow system aimed to created and automated hydroponic plantation system is developed using a low cost and easy methods of using an ESP 8266 chip which uses wireless technology. So, when using the device, the manpower to water the plant, put nutrients to the plant. This farming methods does not have any attacks from bugs and small insects because mainly the soil is not used, and this will a controlled environment. This will give many benefits including the benefits that are mentioned above. With this plantation more healthier crops can be harvested. The resources can be utilized to its max because even the water is conserved because water will turn in a cycle with the nutrients. There will be no weeds because hydroponic systems are not habitable for wee seeds because there is no soil.

This is the first type of solution which is one hydroponic device which is named Grow N Grow to do the hydroponic from the farming level on home level. The final target is to achieve growing plants in an industry level and exporting the food as a good quality product of Sri Lanka. The caliber of this research project is small. When it comes to vertical farming more methods can be implemented to grow plants. This needs to achieved using the same technology that was implemented above. When it comes to the vertical farming same technology will be applied to all the devices. All the devices must be in an ad-hoc network which is a very impressive technology in wireless. All the racks will be in an ad-hoc network. Even if the growing area is massive, without any hassle all the devices can be simultaneously monitored.

So, the future work in this area includes applying this technology for vertical farming and connect all the wireless microcontrollers by ad-hocking all the devices in one network so whole device management will be an easy process and deploying mechanical robots to do the harvesting of the whole vertical farming system. In further development in vertical farming robots will be implemented to cultivate the plants and do the packaging. They will also control wirelessly.

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