International Journal of Internet, Broadcasting and Communication Vol.12 No.1 130-136 (2020)
http://dx.doi.org/10.7236/IJIBC.2020.12.1.130

IJIBC 20-1-18

A Study on IoT based Real-Time Plants Growth Monitoring for Smart Garden

Mi-Hwa Song

Assistant Professor, Department of Information and Communication Science, Semyung University, Jechon, Korea
mhsong@semyung.ac.kr

Abstract

There are many problems that occur currently in agriculture industries. The problems such as unexpected of changing weather condition, lack of labor, dry soil were some of the reasons that may cause the growth of the plants. Condition of the weather in local area is inconsistent due to the global warming effect thus affecting the production of the crops. Furthermore, the loss of farm labor to urban manufacturing jobs is also the problem in this industry. Besides, the condition for the plant like air humidity, air temperature, air quality index, and soil moisture are not being recorded automatically which is more reason for the need of implementation system to monitor the data for future research and development of agriculture industry. As of this, we aim to provide a solution by developing IoT-based platform along with the irrigation for increasing crop quality and productivity in agriculture field. We aim to develop a smart garden system environment which the system is able to auto-monitoring the humidity and temperature of surroundings, air quality and soil moisture. The system also has the capability of automating the irrigation process by analyzing the moisture of soil and the climate condition (like raining). Besides, we aim to develop user-friendly system interface to monitor the data collected from the respective sensor. We adopt an open source hardware to implementation and evaluate this research.

Keywords: *IoT, Arduino, Open source hardware, Real-time service, Smart Garden*

1. Introduction

Internet of Things (IoT) refers to the implementable of Machine-to-Machine (M2M) communications which is a crucial component of growth in the digital market. IoT is can also be described as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things' have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network. The integration of IoT with human being in respect to communications, collaboration and technical analytics enables to pursue real-time decision.

Manuscript Received: January. 18, 2020 / Revised: January. 23, 2020 / Accepted: January. 29, 2020
Corresponding Author: mhsong@semyung.ac.kr
Tel: +82-43-649-1645, Fax: +82-43-649-1747
Assistant Professor, Department of Information and Communication Science, Semyung University, Jechon, Korea

There are many problems that occur currently in agriculture industries. The problems such as unexpected of changing weather condition, lack of labor, dry soil were some of the reasons that may cause the growth of the plants. Condition of the weather in local area is inconsistent due to the global warming effect thus affecting the production of the crops. Furthermore, the loss of farm labor to urban manufacturing jobs is also the problem in this industry[1-3]. Besides, the condition for the plant like air humidity, air temperature, air quality index, and soil moisture are not being recorded automatically which is more reason for the need of implementation system to monitor the data for future research and development of agriculture industry. As of this, we aim to provide a solution by developing IoT-based platform along with the irrigation for increasing crop quality and productivity in agriculture field.

The goal of this research is to develop a smart garden system environment which the system is able to auto-monitoring the humidity and temperature of surroundings, air quality and soil moisture. The system also has the capability of automating the irrigation process by analyzing the moisture of soil and the climate condition (like raining). Besides, we aim to develop user-friendly system interface to monitor the data collected from the respective sensor.

2. Conventional Technologies

As IoT technology advances, existing researches on monitoring plant growth have continued to grow[4-5]. Figure 1 is a general components of a smart greenhouse[6]. The controllers are crucial in the system where different sensors (soil, temperature and humidity) and actuators (like your shade screens and LED lights) are connected to and link to the automation software.

Several commercial products have been released to enable smart gardens. The Growtronix system[7] can monitor early every aspect of an indoor garden. The systems are extremely configurable and have the ability to monitor, Temperature Sensors, Humidity Sensors, CO2 Sensors, PH Sensors, EC/TDS Sensors, Light Detectors, PAR Light[8]. Also PlantHive will provide the climate and sunlight all year round for the plants to grow inside the product, along with the artificial intelligence of IoT Smart Garden. It also prevents plant-threatening infections. Users don't have to spend a lot of time growing plants or spraying pesticides to exterminate pests[9].

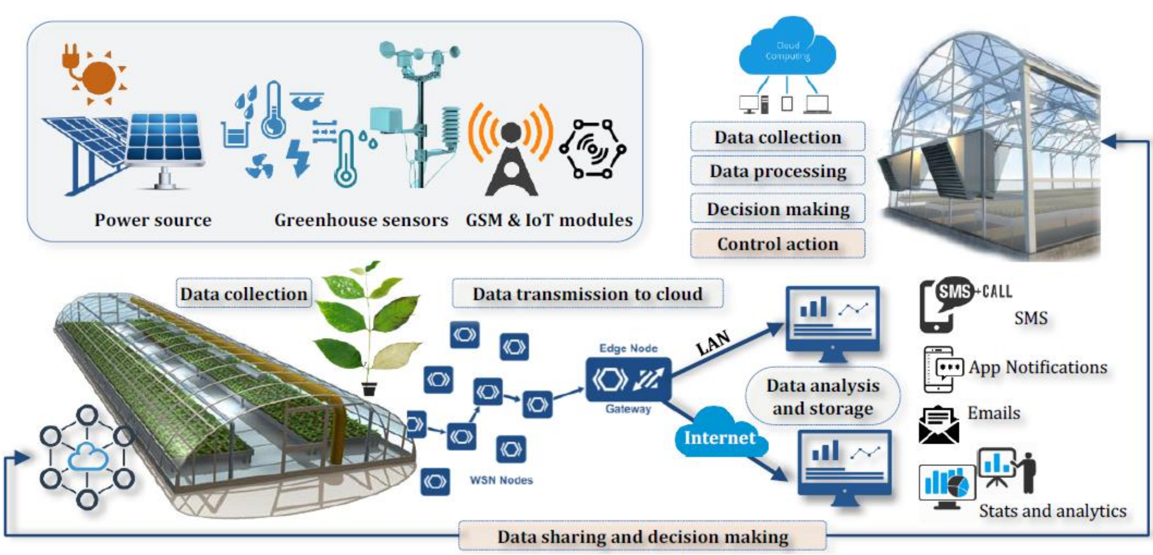

Figure 1. General components of smart greenhouse systems

However, some commercial smart greenhouse systems are expensive and are not suitable for building personalized smart gardening.

3. Proposed System

3.1 Hardware and Software Design

The design of the proposed system is based on open source hardware. Open-source hardware (OSH) usually means that information about the hardware is easily discerned so that others can make it – coupling it closely to the maker movement. Hardware design (i.e. mechanical drawings, schematics, bills of material, PCB layout data, HDL source code and integrated circuit layout data), in addition to the software that drives the hardware, are all released under free/libre terms[10].

Figure 2 is a hardware diagram of the proposed system. NodeMCU is an open source IOT platform[11]. It includes firmware which runs on the ESP8266 wifi SOC. The term "Node MCU" by default refers to the firmware rather than the device kits. ESP8266 module is low cost WiFi module suitable for adding WiFi functionality to an existing microcontroller project via a UART serial connection. Relay module used to control various appliances and equipment with large current output. The relay module controlled directly by microcontroller.

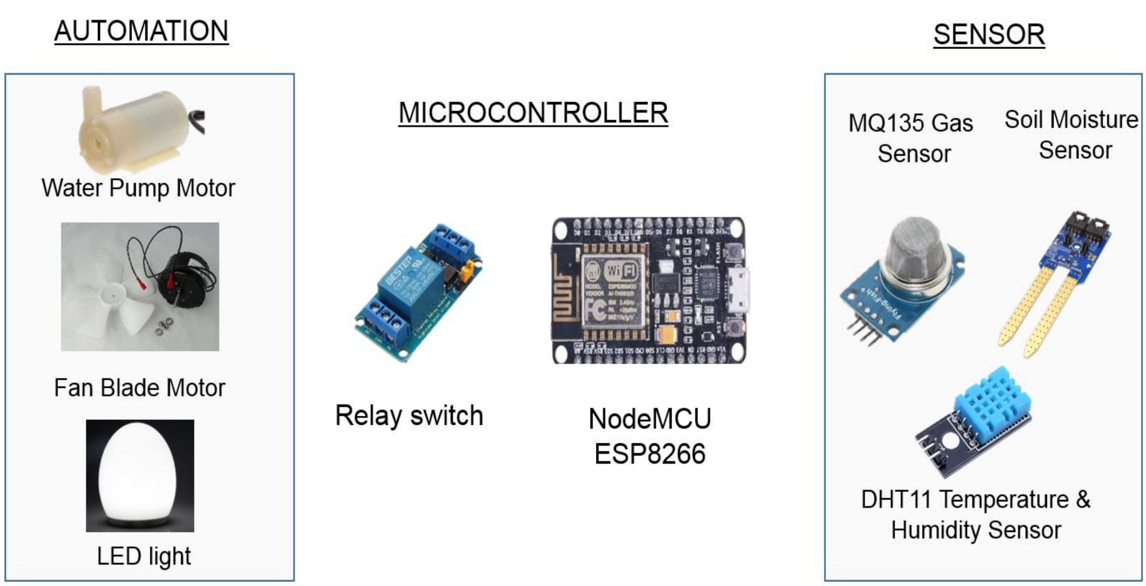

Figure 2. Hardware configuration

Various environmental conditions are required for plant growth. IoT sensors measure this data. Air quality sensor that detects a wide range of gases and smoke. This sensor has high sensitivity to Ammonia, Sulfide, smoke and other harmful gases. Soil Moisture Sensor Measure dielectric permittivity of the surround the medium. The controller will trigger the output (water pump) based on the reading of the water content in the soil either its is too dry or at optimum moisture. DHT11 Sensor used detect the relative humidity of the plant's surrounding. The sensor will send signal to the controller. The controller will trigger the output in two condition. If the condition is too dry the controller will trigger and activate the fan and if the condition is too humid the controller will trigger the LED lamp to on. The humidity measurement range is 20% to 90% while temperature measurement range is -20 to 60 degrees Celsius.

Several software development environments have been adopted to implement automated gardening and monitoring systems. Android Studio is an official Integrated development environment for Google's Android operation, built on JetBrains' IntelliJ IDEA software and designed especially for Android Development. Google Firebase is a Real-time database to ensure the availability of the data present and prevent from the risk of downtime. Dash Pusher is hosted service accessible to add real-time data and able to function to website and mobile applications.

Figure 3 is the block diagram of the development for this research. This system is divided into three main part which is input device, the microcontroller and the output device. The input will be the data collected from sensor and the output is the range or benchmarking table of healthy environment for the growth of plants. Second main output is the automation system which work based on special condition for example the water pump pumping the water to plants when the reading show it need a watering.

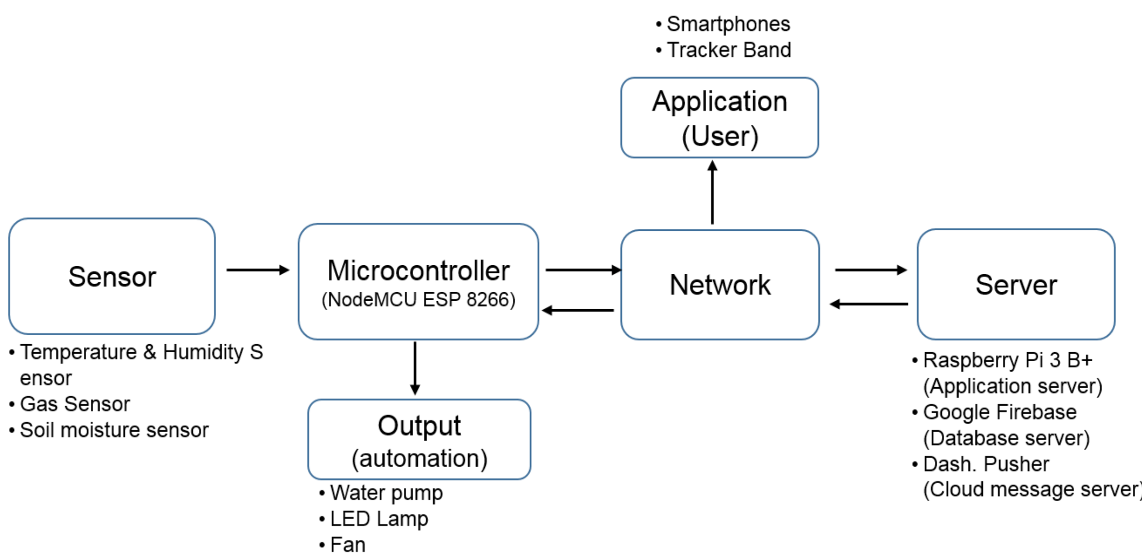

Figure 3. System block diagram

Sensor acts as the input devices which is DHT11 as temperature and humidity Sensor. This sensor will detect the temperature and humidity of the surroundings. Next, Soil Moisture Sensor will be used to detect the moisture of the soil while MQ135 gas sensor used to detect any harmful gas or smoke particle. All those data then will be transmitted into the NodeMCU ESP8266 for the microcontroller to process those data.

As the process part, NodeMCU received the input data from the input sensors and transmitted those data to the server application which is situated on both cloud (Google Firebase) and physical (Raspberry Pi 3 B+). Both server application will updated the collected data into application. Algorithm is implemented to measure the correct input value for the input value to display in the application. The output part consists of DC Motor Water Pump, Fan Cooling Motor and LED lamp. These outputs devices will react towards the given set of parameters of data collected by the sensors.

As for the network connection, when the microcontroller collect data from the sensor it will transmit the data to the specified database setup inside Arduino ide via wireless medium such Wi-Fi. Vice versa, the automation system in listen state which controlled by the NodeMCU and relay switch to turn it on or off. The continuously state allowing the system to run and react fast according to the reading got from the real-time database.

3.2 Implementation of Proposed System

Figure 4 shows an end-to-end diagram including the Arduino connection of the proposed system. Microcontroller (NodeMCU) send data to the database server Firebase in which also synchronous with the android application on mobile phone. Dash.pusher as the push notification host listen to any value sent to the firebase.

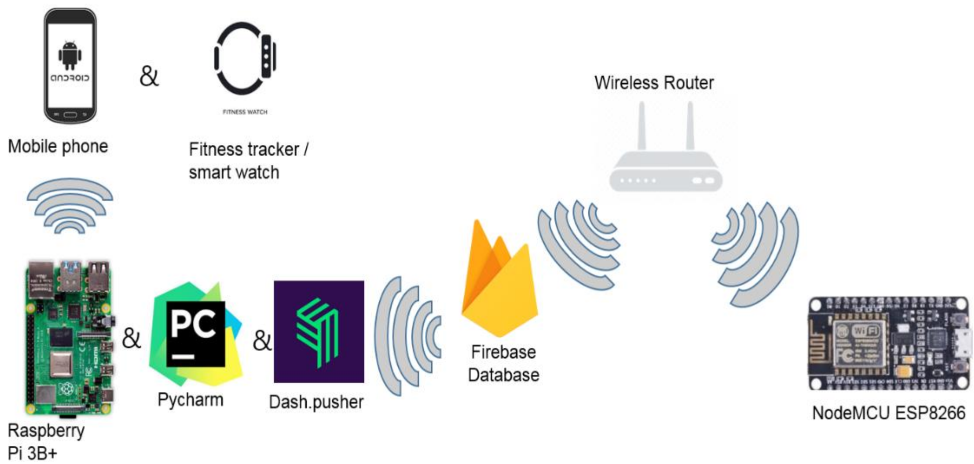

Figure 4. End-to-end diagram of proposed system

Figure 5 shows the Dash.pusher connection. Meanwhile, the raspberry pi 3 b+ worked as the application server by using Cron command (Linux utilities programs) run the python file that developed using Pycharm. A condition statement such if else write inside the python coding work as a trigger to send the message to the android phone by using Dash.pusher as the host for the message. The android phone connected to the fitness band in which allowing the user to get the notification in their fitness band without looking at their phone or when their phone on silent.

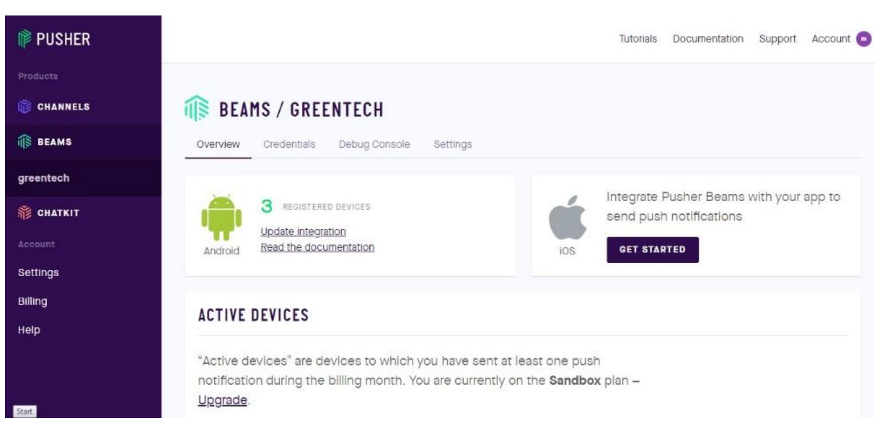

Figure 5. Dash.Pusher connection

In figure 6, we can see mobile application and service prototype. The test was conducted in a general indoor space. Data measured in real time by various sensors notifies the smartphone or smart watch as needed. Automatic indoor gardening was implemented by operating the fan when indoor air quality was deteriorated or the humidity was above the proper value. It was also confirmed that water was supplied through the automatic water pump according to the measured value of the soil sensor.

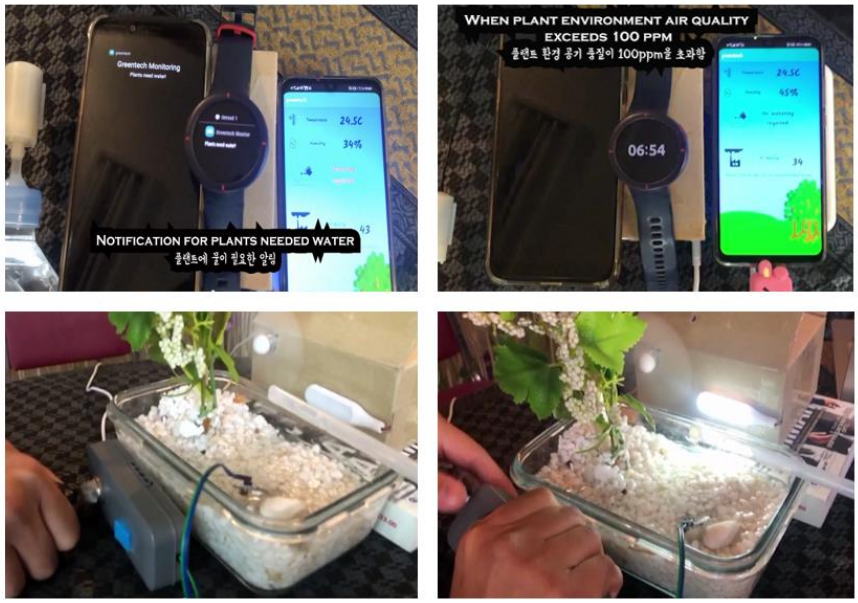

Figure 6. Service prototype

4. Conclusion

Data monitoring of the system has been developed successfully. This system provides real-time data and status of the output. The sensor will monitor the system and the controller will controller the all the system's decision and activities automatically.

This project was successfully conducted. However, improvisation can be done to enhance this research such as

- Addition of pH sensor to detect the acidity of the soil in order to see the types of the soil suitable for the plant.
- Implementation of fertilizer pump so that the fertilizer can be used in plant.
- Dissemination of green computing techniques where IoT devices shall consume less amount of energy thus increase their life expectancy and increase the productivity.
- Interoperability between IoT devices where devices should be capable to communicate with others from different genre so as the overall system.

Acknowledgment

This work was supported by the Semyung University Research Grant of 2019.

References

[1] N. Sulaiman and M. Sadli, "An IoT-based Smart Garden with Weather Station System," in *Proc. 9th IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE)*, pp. 38-43, 2019. DOI:10.1109/ISCAIE.2019.8743837

[2] M. Bacco, P. Barsocchi, E. Ferro, A. Gotta, and M. Ruggeri, "The Digitisation of Agriculture: a Survey of Research Activities on Smart Farming," Array, Vol. 3-4, September–December 2019.

DOI: https://doi.org/10.1016/j.array.2019.100009
[3] D. Atia and H. El-madany, "Analysis and design of greenhouse temperature control using adaptive neuro-fuzzy inference system," Journal of Electrical Systems and Information Technology, Vol. 4, No. 1, pp.34-48, May 2017. DOI: https://doi.org/10.1016/j.jesit.2016.10.014
[4] H.S. Park, C.K. Park and, Y.S. Hong, "Smart Plants Management System based on Internet," The Journal of the Institute of Internet, Broadcasting and Communication(JIIBC), Vol. 15, No. 5, pp.193-199, October 2015. DOI: http://dx.doi.org/10.7236/JIIBC.2015.15.5.193
[5] A. Mateen, Q. Zhu, and S. Afsar, "IoT based real time agriculture farming," The International Journal of Advanced Smart Convergence, Vol. 8, No. 4, pp.16-25, 2019. DOI: http://dx.doi.org/10.7236/IJASC.2019.8.4.16
[6] R. Shamshiri, F. Kalantari, K. Ting, K. Thorp4, I. Hameed, C. Weltzien, D. Ahmad, and Z. Shad, "Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture," International Journal of Agricultural and Biological Engineering, Vol. 11, No. 1, pp. 1-22, January 2018. DOI: 10.25165/j.ijabe.20181101.3210
[7] Growtronix, http://Growtronix.com
[8] V. Balas, R. Kumar, and R. Srivastava, "Recent Trends and Advances in Artificial Intelligence and Internet of Things," Intelligent Systems Reference Library, Vol. 172, pp.507-520, 2020.
[9] PlantHive, http://www.planthive.com/
[10] Open-source hardware, https://en.wikipedia.org/wiki/Open-source_hardware
[11] NodeMCU, https://en.wikipedia.org/wiki/NodeMCU