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Journal homepage: http://publisher.uthm.edu.my/ojs/index.php/jsunr
e-ISSN : 2716-7143

Journal of Sustainable Natural Resources

Building a Smart Gardening System and Plant Monitoring Using IoT

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DOI: https://doi.org/10.30880/jsunr.2021.02.01.001
Received 22 March 2021; Accepted 24 June 2021; Available online 28 June 2021

Abstract: Gardening activities usually required a lot of time and gardeners may face varieties of problems such as sticking to the designated watering schedule. Thus, this paper intends to solve these problems by introducing the Smart Gardening System. By using this system, users will be able to control and monitor the watering schedule and the sufficiency of lights while ensuring that the plants are taken care of accordingly. The smart gardening system is different from the normal gardening products that are already available in the market because of the implementation of Internet of Things (IoT) in the system to facilitate the work for its users. By using this home-based system, users can set the watering and lighting schedule automatically by using the designated application via smartphone. Besides, users will also be notified on the moisture level of soil, light-exposure, and the water level in water tank through the application. This will allow the users to monitor the watering system and only come to refill it when the water tank is empty. This system is an advantage as it can run automatically. From this research, the benefit of smart gardening system is proven via the execution of IoT which requires less human intervention for the system to operate. Moreover, the sensors are used to gather and update all the data that is convenience to the user to keep updated on the parameter and information about the plant in a real time without physical present.

Keywords: Internet of Things, smart gardening system, plant monitoring, prototype, sensors

1. Introduction

The existing method and one of the oldest ways in gardening is the manual method of checking the parameters. Smart gardening system and plant monitoring using IoT technology allows the farmers themselves to verify all the parameters and calculate the readings [1]. This technique focuses on developing devices and tools to manage, display, and alert the users using the advantages of a wireless sensor network system [2]. It aims at making gardening smart using automation and IoT technologies [3]. The cloud computing devices can create a whole system, from sensors to tools that observe field data and human actors on the ground and accurately feed the data to the network [4].

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This idea proposes a novel methodology for smart farming by linking a smart sensing system and smart irrigator system through wireless communication technology [5]. It proposes a low cost and efficient wireless sensor network technique to acquire the soil moisture to take the decision whether the irrigation is enabled or not [6]. It proposes an idea about how automated irrigation system was developed to optimize water use for garden crops. It is designed for IoT based monitoring system to analyze crop environment and the method to improve the efficiency of decision making by analyzing harvest statistics [7]. In this paper, smart gardening is indoor which plants are grown in closed environment. It is used to maintain the optimal conditions of the environment, greenhouse management and data acquisition.

Garden plants require the owner to always be sensitive towards their needs. A set watering routine is important. However, many people forget this watering routine. Busy people always forget to water the plants due to tight schedule. The need for a refreshing area indoor regardless the limit of space, the demand for a place to grow fresh vegetables for daily usage is an unanswered question nowadays [8]. Although the trend of living style now consists of the recreational area where people can get close to the nature, people want a novel gardening model that is enjoyable and appealing for all without the common hassles and mess [9].

The combination advancement of electronic embedded system with IoT, has given the idea of making a smart garden system. This garden will measure the life sustaining element and adjust it automatically. Unsupervised gardening or remote supervision will bring the breath of future to your small garden. The plant needs to be watered with an adequate amount to keep them healthy [10]. Previous research said that, the principal environmental requirements for plant growth include adequate space for root and canopy development, sufficient light, water, oxygen, carbon dioxide, and mineral elements, temperature suitable for essential physiologic processes. Therefore, watering and provide light is an important activity in plant care [11]. Thus, to resolve these problems, an automatic watering and light system proposed. The automatic watering system is designed to be assistive to the user. This automatic system is one of the solutions to do the watering and provide light independently without need human to supervise the system regularly.

This project focuses on the implementation of IoT in the system where users can monitor the condition of the specifications needed for their gardening activities through mobile application. By monitoring the plants condition using IoT, it can help those with packed daily schedule to nourish the growth of their plants. However, growing plants are time consuming as they are sensitive and need a lot of care. One of the issues taking care of plants is watering, where people tend to over watering or forgets to water their plants, hence causing the plants to wilt.

The manual method of watering and monitoring plants is the proper watering schedule where the gardeners need to monitor their plant frequently to ensure the plants receive enough soil moisture and water supply. Combining with the advanced of electronic embedded system, the idea of smart gardening is discussed. In a previous research, the principal environmental requirements for plant growth include adequate space for root and canopy development, sufficient light, water, oxygen, carbon dioxide, mineral elements, and the suitable temperature for the plant's essential physiologic processes. Therefore, watering and providing enough light is very important for plant growth. Thus, to resolve these problems, an automatic watering and light system is proposed. This system is one of the solutions that can operate independently without needing human interventions.

2. Materials and Methods

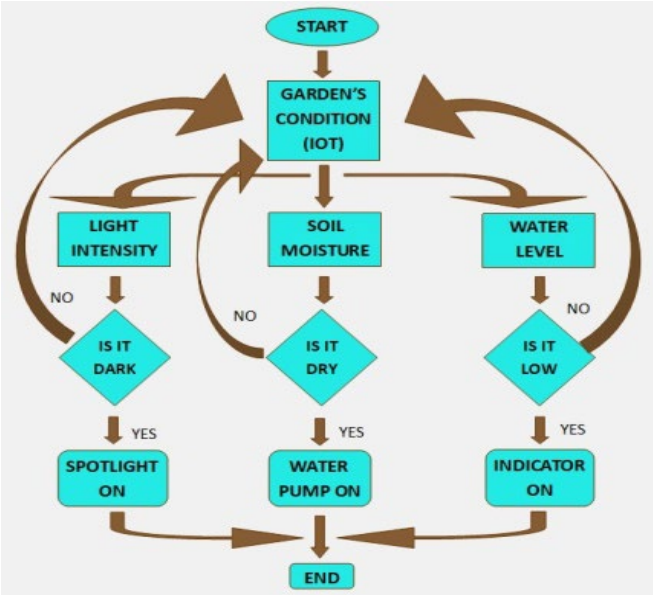

Fig. 1 - Flowchart of smart gardening system

The system is implemented with the use of IoT. This system helps to check and monitor the soil moisture. It displays the soil moisture (high or low). When the soil resistance is equal or more than 500ohm, the watering system will turn on. After that, the soil moisture sensor will detect the soil resistance and update through the apps. Apart from that, user also can control manually. Besides, the user also can check the water level of the water tank through the apps. The ultrasonic sensor will detect the water level of the water tank and show in the apps. When the water level is equal or less than 5cm, the bulb will light up for reminder user to refill water. Lastly, the LDR will detect the light intensity and record the data in the apps. When the light intensity detected is equal or more than 500cd, the spotlight will light up automatically. User also can control manually. The flow chart of this system is visualized in Fig. 1.

The main technology that is developed in designing this project is the implementation of IoT that is used as a foundation to allow data transmission between devices to the built-in mobile application. The objective of this design is to enable users to control and monitor the watering schedule and the sufficiency of lights while the plants are taken care of accordingly. Sensor such as moisture sensor is used to let the users know the condition of the soil to avoid the plants from wilting due to over watering. While the Ph level sensor is used to monitor the Ph level of the soil where users can adjust the amount of compost that they ought to give the plants by considering the current condition of the soil. However, light sensor can measure the illuminance and can measure more than the brightness of a light source.

Modern tool used:

1. Soil Moisture Sensor- Soil moisture sensor measures the water content in soil by measuring the electrical resistance of the soil. The relationship among the measured property and soil moisture is calibrated and it varies depending on the environmental factors such as temperature, soil type, or electric conductivity. In this project, the sensor is used to sense the moisture and transfer the data to smartphone so that controlling action of switching the water pump ON/OFF can be made. Besides that, the watering system operates automatically therefore, once the resistance detected is equal or more than 500ohm, the water pump is automatically switched ON.
2. Light Dependent Resistor (LDR)- The LDR is made from a piece of exposed semiconductor material. In this project, LDR is used to sense the light of the surrounding and it is also operated automatically. The resistance detected is set to be equal to or more than 500ohm for the lights to be turned ON automatically.
3. 5V Relay (1 Way Module)- A relay is an electrically operated switch. Many relays use an electromagnet for it to mechanically operate as a switch. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. In this project, relays are used to control the number of lights and water given to the plants.
4. Ultrasonic Sensor- Ultrasonic sensor measure distance by using ultrasonic waves. The sensors transmit an ultrasonic wave and receive the wave that is being reflected by the targeted object. Therefore, this sensor is used to detect and measure the water level in the water tank and the user will be notified through the mobile application if the water level in the water tank reached its minimum level.
5. BLYNK- IoT is the focus in designing this system. To implement the usage of IoT, Blynk, which is a mobile application is used where it can control the hardware remotely. All data that are detected by the sensors will be displayed on the application to give users access to monitor and control.

The block diagram shown in Fig. 2 is the connection between hardware and software system for this project. It consists of several main parts which are hardware part such as ultrasonic sensor, load cell and Arduino IDE and software part i.e., Blynk app. Firstly, Blynk apps is installed from the Apps store in the phone and the programming code is set up for Arduino IDE by using Arduino software. This software is connected directly to the Blynk app. By using Blynk app, the system of smart gardening can be monitor and control easily using the hardware used. In this project, user will be able to control and check the light, watering by using smartphone application.

Operation of the system:

1. When the light intensity is less than 500 cd, the spotlight will light up.
2. When the soil moisture is reached 500ohm, the watering system will on.
3. User can also manually control the actuator using the app.
4. The ultrasonic sensor in the water tank will measure the water level, user can check the water level by using the apps, and a bulb will light up for inform the user.

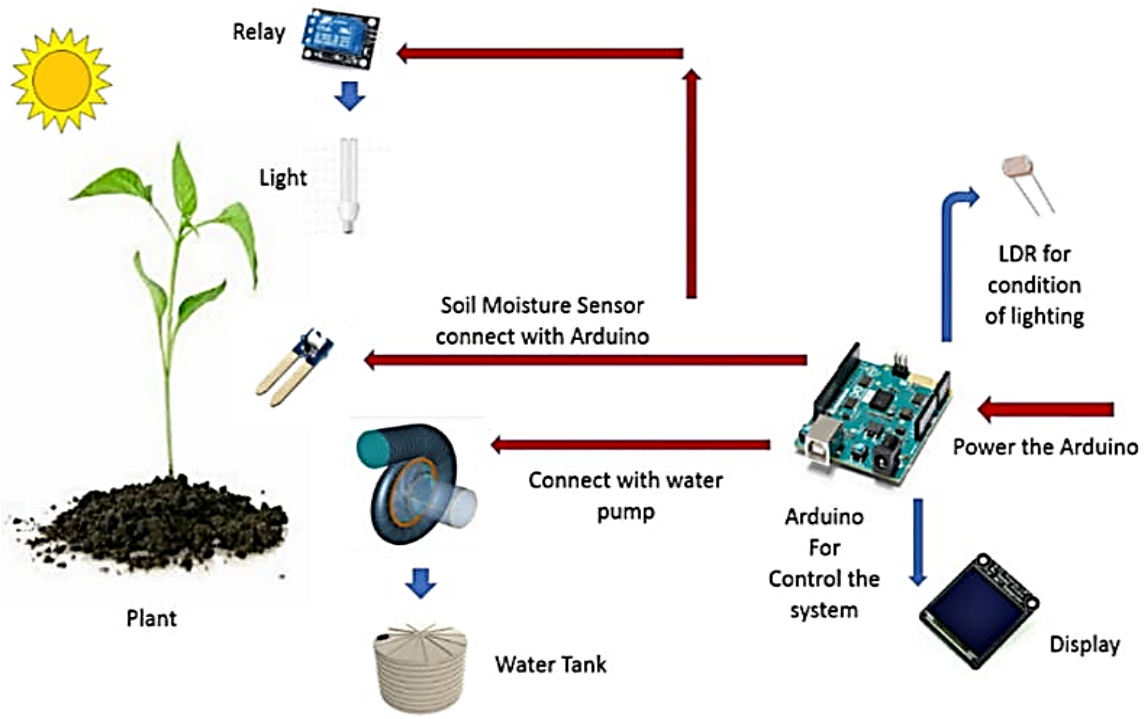

Fig. 2 - Block diagram of smart gardening system

3. Results and Ddiscussion

The data for the Smart Gardening System using IoT, was successfully controlled using Blynk application. This system is designed to monitor the soil moisture, light density, and water level in the tank. User will be notified on the system when the value of the sensor reaches maximum or threshold value. Then the user will be able to control the system anywhere and anytime as long they are connected to the internet. Fig. 3 below shows the interface of watering system, lighting system and water tank's level on smartphone for this project, respectively.

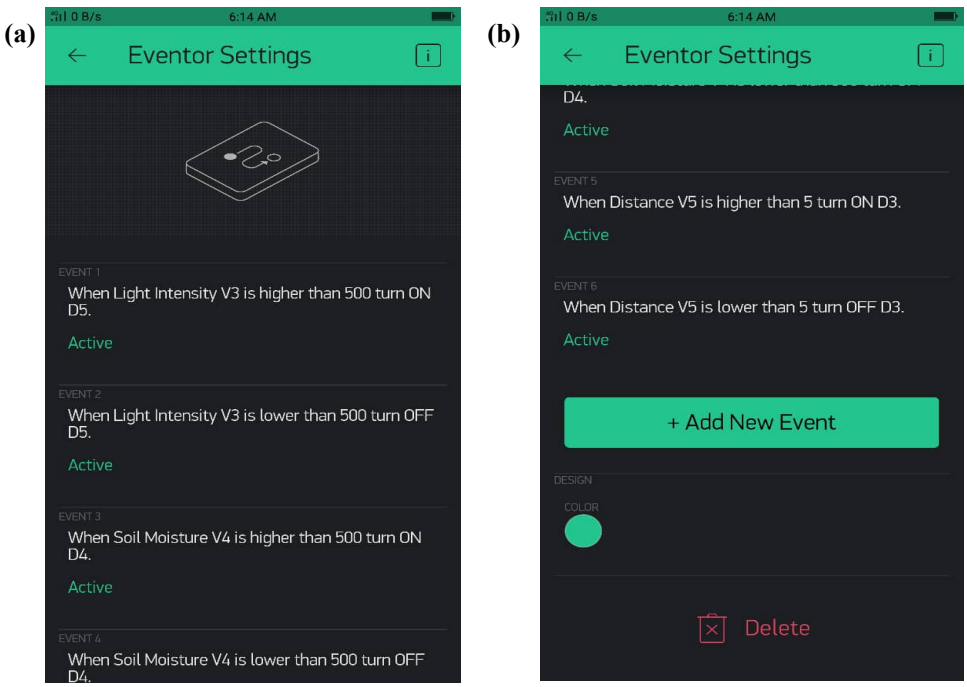

Fig. 3 - User interface (a) interface of soil moisture and light intensity; (b) interface of the water level in the tank

Fig. 4 shows the results obtained when each parameter or condition is occurred.

1. When the soil resistance is equal or more than 500 Ohm, the watering system will on automatically. Apart from that user also can control manually.
2. When the light intensity is equal or lower than 500cd, the spotlight will light up. Apart from that user also can control manually.
3. When the distance between ultrasonic sensor and water level of water tank is more than 5cm, the bulb will light to remain user to refill water.

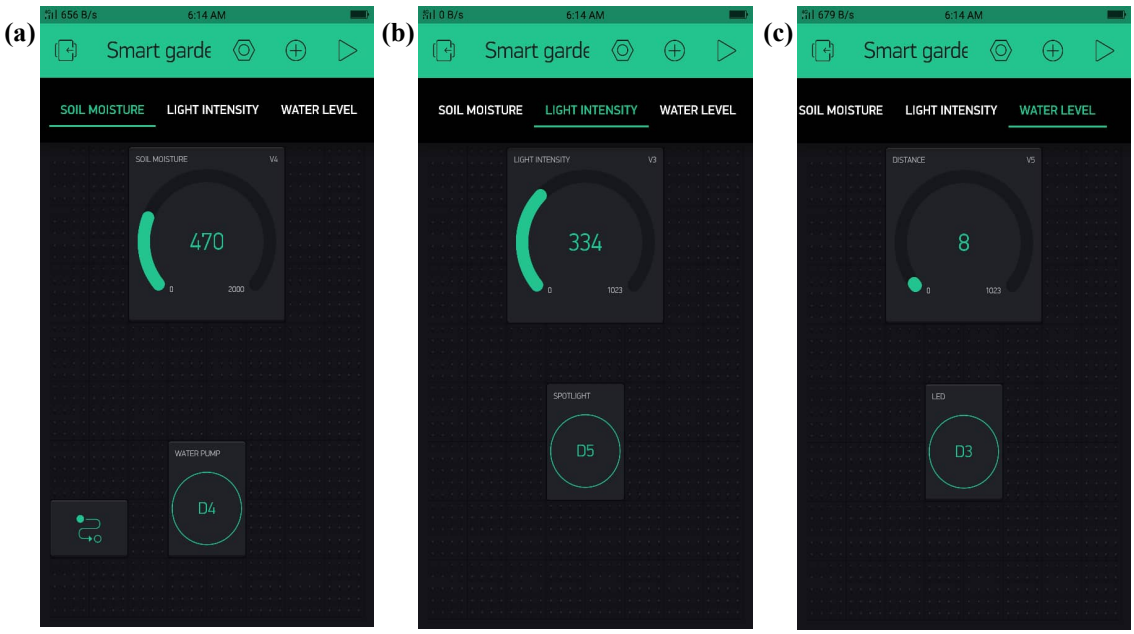

Fig. 4 - (a) condition of the soil resistance; (b) condition of the light intensity; (b) condition of the water level

Based on the results obtained, it can conclude that most of the functions implemented are working well. When the soil resistance is equal or more than 500ohm, the relay will activate the water pump. The data of soil moisture is detected by using soil moisture sensor. The irrigation pipe in this experiment were made using gum to connect the water pipe to the irrigation pipe, and to cover the end of the irrigation pipe to prevent leaking. The open time can be modified through Arduino coding. On the other hand, the user can also manually control the water irrigation system and switch it on or off by using Blynk.

Moreover, the ultrasonic sensor is used to detect the water level of the water tank. In the apps will show the distance between sensor and the water level. When the distance is equal or more than 5 cm, the LED at the circuit will light up for remind the user to top up water. The parameter for high or low water level can change in the Arduino coding.

In the addition, the Light Dependent Resistor is used to sense the light intensity in the surrounding of the plant. LDR is placed on the sideboard and top, while the spotlight on the top of the plant. Some distance between the LDR and spotlight must be kept making sure the sensitive of the LDR can operate well. When the light intensity is equal or lower than 500cd, the spotlight will light up. Besides, the light intensity of the surrounding will show in the apps. User also can switch on or off the spotlight by using apps. User can also check and control the condition of plant by using the apps. So that, user can save time for take care their plant.

4. Conclusion

In a nutshell, this project was successfully carried out and completed with most of the results achieved as expected. Although there are some limitations, especially on the equality of the water given, this project did achieve the main objective in which a smart and user-friendly gardening system by using IoT is being developed to solve real life problems such as lacking time and space. This smart gardening system was built based on the use of IoT and emphasize its practicality and functionality. This smart gardening system enables users to set the parameter to automatically taking care of the plant and monitor the condition in the farm, such as the watering system. Users only need to switch on the app in their smartphone and all the condition are on their fingertips. After doing all the testing and optimization, most of the tasks were performed well without major issues. In short, the overall progress is good and most of the difficulties and problems faced during the process were overcome and the smart key system is working as expected. For

enhancement, the implementation of various sensors such as temperature sensor or install the surveillance camera that can operate in 360̊ to monitor the plant by using IoT technology to enhance the production of the plant growth.

Acknowledgement

The authors would like to thank to Pn Nur Zaitasha Mahmudin and teams from Jabatan Pertanian for her comments and advices. This work was financially supported through research Industry-International Incentive grant Universiti Teknologi Malaysia under Vot number 4B622.

References

[1] Lakshmisudha, K., Hegde, S., Kale, N., Iyer, S., (2011). Smart Precision Based Agriculture Using Sensors, International Journal of Computer Applications, 146(11).

[2] Gondchawar, N., Kawitkar, R. S., (2016). IoT Based Smart Agriculture, International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 5(6).

[3] Gayatri, M. K., Jayasakthi, J., Anandhamala, G. S., (2015). Providing Smart Agriculture Solutions to Farmers for Better Yielding Using IoT, IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015).

[4] Dwarkani, C., Ram, G. R., Jagannathan, S., Priyatharshini, R., (2015). Smart Farming System Using Sensors for Agricultural Task Automation, IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development (TIAR 2015).

[5] Nandurkar, S. R., Thool, V. R., Thool, R. C., (2014). Design and Development of Precision Agriculture System Using Wireless Sensor Network, IEEE International Conference on Automation, Control, Energy and Systems (ACES).

[6] Gutiérrez, J., Villa-Medina, J. F., Nieto-Garibay, A., PortaGándara, M. A., (2013). Automated Irrigation System Using a Wireless Sensor Network and GPRS Module, IEEE Transactions on Instrumentation and Measurements, pp. 0018-9456.

[7] Jhuria, M., Kumar, A., Borse, R., (2013). Image Processing for Smart Farming: Detection of Disease and Fruit Grading", IEEE Second International Conference on Image Information Processing (ICIIP).

[8] Liu, C., Ren, W., Zhang, B., Lv, C., (2011). The application of soil temperature measurement by lm35 temperature sensors, International Conference on Electronic and Mechanical Engineering and Information Technology, 88(1), pp. 1825–1828.

[9] Chaudhary, D. D., Nayse, S. P., Waghmare, L. M., (2011). Application of wireless sensor networks for greenhouse parameter control in precision agriculture, International Journal of Wireless & Mobile Networks (IJWMN), 3(1).

[10] Mirabella, O., Brischetto, M., (2011). A Hybrid Wired/Wireless Networking Infrastructure for Greenhouse Management, IEEE Transactions on Instrumentation and Measurement, 60(2), pp 398-407.

[11] Wang, Q., Terzis, A., Szalay, A., (2010). A Novel Soil Measuring Wireless Sensor Network, IEEE Transactions on Instrumentation and Measurement, 412–415.