ISSN 2278-3091
Volume 9, No.1.1, 2020
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse3691.12020.pdf
https://doi.org/10.30534/ijatcse/2020/3691.12020

Automated Gardening Portable Plant Using IoT

Siti Nor Zawani Ahmmad[1], Muhamad Mubin Jaafar[2], Farkhana Muchtar[3], Mohd Ismail Yusof[4]
[1]Instrumentation and Control Engineering, Universiti Kuala Lumpur, MITEC, Persiaran Sinaran Ilmu, Bandar Seri Alam, 81750, Johor, Malaysia.
[2]Instrumentation and Control Engineering, Universiti Kuala Lumpur, MITEC, Persiaran Sinaran Ilmu, Bandar Seri Alam, 81750, Johor, Malaysia.
[3]School of Computing, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.
[4]Instrumentation and Control Engineering, Universiti Kuala Lumpur, MITEC, Persiaran Sinaran Ilmu, Bandar Seri Alam, 81750, Johor, Malaysia.

ABSTRACT

Gardening is a good hobby that can boost our health and provide a good profit if applied in large scales. However, gardening is difficult to be practised by people who live in the urban area due to limited time and space for gardening purposes, An automated gardening portable plant is suitable for planting in a limited space and time environment. The automated system is operated to control all the processes and provide the basic requirement needs for plants growth such as moisture and light. Besides, the plant is also portable depending on the suitability of location. The objective of this project was to develop a mechanical gardening portable plant capable of providing an automated watering system with sufficient illumination for the plants. The network of Internet of Things (IoT) used in this project was able to update the information about the status of the sensors. Soil moisture was used to monitor and control the moisture percentage of the soil. Besides, surrounding humidity and temperature sensor were used to analyse the relation of surrounding temperature and humidity over the time. Temperature parameter added to the system to ensure the system will only watering the plants during the suitable condition. Light intensity sensor also being used in this study to monitor the level of intensity exposed to the plant. NodeMCU V3 was used as microcontroller because it has built-in ESP8266 for connection with the internet cloud. Blynk application acts as the GUI for this project. All the information and data from the plant will be updated on the GUI in the smartphone. As the result, an automated system that can control and monitor the selected parameter for the portable plant wirelessly using Blynk apps was successfully developed.

Key words: Automated gardening, Internet of Things, sensor.

1. INTRODUCTION

Nowadays, people who wish to practice gardening at home are facing with limited space as the main problem especially for those who live in an urban area. Additionally, they find it difficult to practice gardening due to the lack of time to maintain the plants particularly those who are usually not always at home. These urbanites rarely can find the time to water the plants regularly on time and to shift the plants in order to expose it to sufficient sunlight. Moreover, they are lacking of knowledge related to how much nutrient needed for their plant to grow well.

To overcome the aforementioned problems, this study has developed an automated gardening system prototype that is portable, equipped with automated watering system and furthermore, capable of providing sufficient illumination for the plants that we named as Automatic Gardening Portable Plant (AGPP) system. AGPP system was equipped with the plant growing LED that can produce sufficient light, thus allowing plants to undergo an appropriate photosynthesis process whether or not it’s placed inside the house or under the roof. This will provide a suitable environment for plant growth. It is also linked with Wi-Fi access where the user can control and monitor the system via smartphone by using Blynk apps.

2. RELATED WORK

The focus of this project was to develop a mechanical gardening portable plant capable of providing an automated watering system with sufficient illumination for the plants. As for this, the discussion in this section provide only examples of automated gardening portable plant and its respective inventors selected at random to depict phases that are involved in the evolution and not aimed to produce a complete list of automated gardening portable plant inventors from previous studies.

Guru at al, [1] have created a project that detected the moisture content in the sand and controlled the water motor automatically. They used a moisture sensor to detect the soil moisture in which the value detected processed by Arduino and passed to farmer’s mobile phone by GSM/GPRS. Low in sand moisture will trigger the pump and the solenoid valve and automatically the plant is watered. They only measured one parameter in this project that was soil moisture.

Meanwhile, Sarika and Sowmya [2] have invented an Intelligent Automatic Irrigation System that using 8051 microcontroller. The system implements soil moisture sensor, humidity sensor and temperature sensor to ensure a suitable environment for plants. It also attached with infrared sensor to detect intruders and fire detection if the field is on fire. The sensor information will be sent to the user through the phone.

Jagdeep, Ritula and Daljit [3] proposed a project that will water plants over the time in 2015. The system used underground water as the water source. The system automatically controls the sprinkler water line for watering by switching the solenoid valves. This system interfacing run-time switches with the microcontroller so that the watering duration will be done with the respect of time that have set.

On the other hand, Rane et al. [4] created a project with ARMs as the microcontroller. They applied the radio frequency (RF) as the medium to send and receive data. The project has been applied to the paddy field by using three nodes that communicated with each other. The project also used GSM and GPRS to send information to the user. The parameter measured for this project was soil moisture.

James [5] has patented a watering system that using plant weight as the parameter. The system uses electronic weight to measure the weight of the plants. When the weight is less than the set weight, it will turn on the valve and water the plants. The control module was connected to PC. This system seemed to have a lot of drawbacks since the weight of things is fluctuating over time and as the plants grow, the weight will be different. The user needed to observe and set the set point frequently to ensure that the moisture of soil is suitable for the plants.

Chetana & Rutuja [6] designed an automated watering project by using AVR ATMega16 as the microcontroller. The project parameters were soil moisture, rain, and water level. The system notifies the user when it is raining and the water level from the water source is low. The project used GSM module therefore, massage will be sent to user phone to notify the user. The system also provides manual operation where the user can select manually when to start and stop the watering system.

Drip irrigation control system using fuzzy control and Zigbee wireless sensor network has been introduced by Xinjian [7]. The project used CC2430 for the wireless sensor network nodes, collecting soil moisture data, temperature and light intensity information. Then, it will be sent to the drip irrigation instructions by the wireless network. It communicated every 20 minutes with the monitor. All the sensors were defined by linguistic variables (high/medium/low). The data undergone fuzzy reasoning by "IF-THEN" statements express, and the output determined further action.

Table 1 summarizes previous related work in tabulated form for ease of understanding and provides a quick glimpse of their implementation.

Table 1: Summary of Related Work

Author	Techniques Used	Parameter
[1]	• Arduino as microcontroller • Moisture Sensor • GSM and GPRS module	• Soil Moisture
[2]	• Using 8051 microcontroller • Sense Soil Moisture, Movement, Temperature, Fire and Humidity	• Soil Moisture • Humidity and Temperature
[3]	• Using microcontroller • Watering by Time Interval	• Soil Moisture
[4]	• ARMS as microcontroller • Moisture Sensor • Use RF for Communication	• Soil Moisture
[5]	• Control Module Interact With PC • Sense Weight	• Soil Moisture
[6]	• Using AVR Atmega16 • Sense Moisture, Rain, Water Level • Use GSM Module	• Soil Moisture • Rain • Water Level
[7]	• Using Fuzzy Control • Moisture and Temperature Sensor • Using Zigbee Wireless Sensor Network	• Soil Moisture • Temperature • Light Intensity
Present Study	• Using NodeMCU V3 • Using Blynk Application	• Soil Moisture • Humidity and Temperature • Light Intensity • Water Level

3. DEVELOPMNT OF AGPP SYSTEM

This automation project was constructed using hardware and software. The microcontroller was used as the vital component of the hardware circuit. It is also transmitting the information to the internet. The voltage supply to the circuit was supported by DC power adapter. Moisture sensor is used to measure the soil moisture and acted as the main parameter in this project. A DHT22 sensor is used to measure humidity and temperature of surrounding air. When the soil moisture and temperature level are below the set point, it will turn on the water pump. For light intensity and water level sensor, it will only produce the digital output which is high and low. When the light intensity is low, it will turn on the plant grow LED and the user will be notified through Blynk. Figure 1 shows project overview

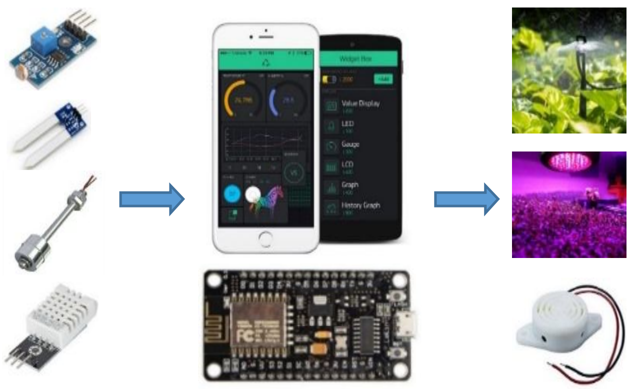


Figure 1: Project Overview

3.1 Workflow of AGGP System

Figure 2 shows the process workflow of this project. The flow starts with defining the project title, objectives, project documentation and the literature review. Next is the development of hardware and software.

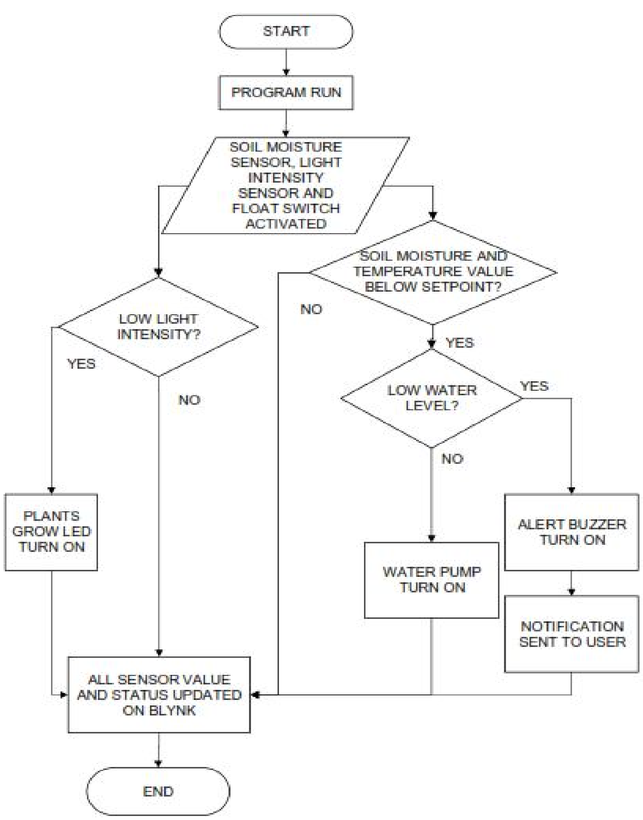


Figure 2: Process Workflow of AGGP System

3.2 Hardware Component

This section discussed the hardware component and design of the electric circuit of the project. Hardware design and development was done from time to time until it is completely functional. The hardware of the plant consists of a structure, planting box and a container for water. PVC pipe was used to construct the structure. Planting box was supported by a wooden board on the structure. The water pump and the water level sensor was attached to the water container lid and the plant grow LED was built as the part of the structure. The tube for water is laid inside the structure, therefore it will look organised. An LDR was located at the top of the plant and the soil moisture and a DHT22 sensor placed in the planting box to ensure it attained the best reading for moisture of soil and surrounding humidity and temperature.

The materials and parts used were chosen to make sure the plant can work well without any problem. All the parts of the plant were placed on a board with wheels so it can be portable.

This project was established from the combination of several electrical components. The components that have been used were NodeMCU V3, DHT22 humidity and temperature sensor, float switch, water pump, soil moisture, light intensity sensor, buzzer and pilot lamp and plant grow LED.

NodeMCU V3. NodeMCU is an open-source firmware and development kit that can help to prototype an IOT product. It has advanced API for hardware IO which can reduce the redundant work for configuration and manipulate the hardware. Code used to program the microcontroller similar to Arduino.

DHT22 Humidity and Temperature Sensor. DHT22 is an output calibrated the digital signal sensor. It is small in size and consumes low power. The sensor can also transmit data up to 20m distance and suited in all kinds of harsh application occasions.

Float switch. For the water level detection, the ordinary float switch was chosen. The water level is not the main parameter to be measured, therefore the float switch will only produce the digital output high and low for the water level.

Water Pump. Water pump acted as the actuator for the soil moisture sensor. It used 12Vdc to operate and attached to the water sprinkler. It is placed on the water supply container and will run when the soil moisture sensor value is below the setpoint value.

Moisture and Light Intensity Sensor. Moisture and light intensity sensor is the main input of this project. For moisture sensor, the chosen type was Hygrometer Moisture Detection module. This type of sensor module is for measuring the moisture of the soil. The output can be connected directly to Arduino. The output can be in analog and digital. It is suitable for the project since it can measure the soil moisture in analog in continuous manner. The working voltage for this module is 3.3-5V.

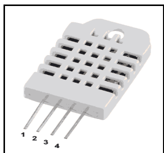
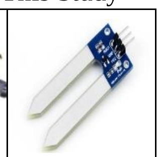
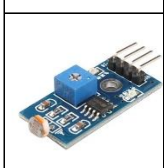
For the light intensity sensor, the Photosensitive Sensor Resistor module was chosen. This light intensity sensor module is for Arduino. The light brightness detection can be adjusted using the potentiometer attached.

Buzzer and Pilot Lamp. Buzzer and Pilot lamp were used as an indicator and alert system of this project. When the water level of supply tank is low, the buzzer will turn on to alert the user. The pilot lamp was used to indicate power supply and certain processes that are running. The buzzer and pilot lamp were selected in DC working voltage.

Plant Grow LED. Plant grow LED is an alternative to replace sunlight to help plants in the photosynthesis process. The plant grow LED will be turned on when the plant surrounding light intensity is low.

Table 2 provides readers with visual illustrations on the types of hardware component used in this study.

Table 2: Hardware Component Used in This Study

			
NodeMCU V3	DHT22 Humidity and Temperature Sensor	Float Switch	Water Pump
			
DHT22 Moisture and Light Intensity Sensor	Buzzer and Pilot Lamp	Plant Grow LED	

3.3 Circuit Diagram

The wiring is an important part to make sure the prototype works perfectly. Selecting the right jumper wire and electronic part of the circuit is also important to ensure that input and output signal and connection can reach the components. If the wire chosen cannot provide the optimum output voltage as the feedback signal to the component, it will become an open loop circuit. Figure 3 shows the prototype schematic diagram. Every electronic connection must follow the datasheet of the components itself in term of their polarity and input/output terminal to avoid wrong data obtained or worse short circuit and can damage the controller board.

The circuit diagram was tested before being attached to the prototype. This can make the troubleshooting and testing processes easier and efficient for hardware and software configuration. Later, if the is no error in the program and the circuit, then, it can be attached to the prototype.

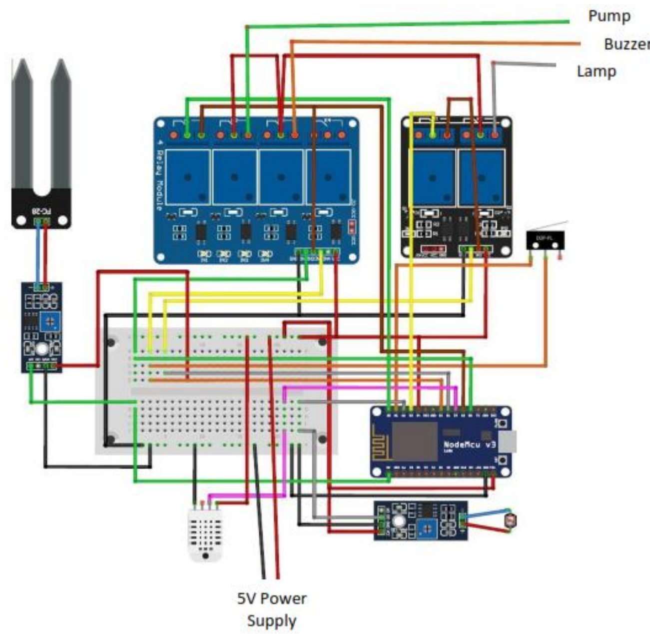


Figure 3: Circuit Diagram

3.4 Software Development

In designing the software of AGPP system, Arduino IDE software and Blynk apps were used.

3.5 Prototype of AGPP System

The design of this project is just as a prototype to gives the rough idea about the system and is as in Figure 4.

Hardware. According to Figure 5, the soil moisture sensor, the air humidity and the temperature sensor were placed in the planting box. This is to make sure that the sensor can attain the accurate data for the soil moisture and the air humidity and temperature of the surrounding. The light intensity sensor was located on the top of the plant so that it can detect the light exposed to the plants without being interrupted by the plant grow LED light.

The plant panel box shown in Figure 6 was also installed with a mini exhaust fan to ensure the part is the box is not overheated. It also has several pilot lamp to show which actuator is currently turn on and a switch for the user to turn on/off the actuator power supply. The buzzer was used to alert the user physically if the float switch detects the low water level in the tank.

Figure 4: Full Design

Figure 5: Moisture and DHT22 sensor location

Figure 6: Panel box

Software. The coding for the major process of the plant which is soil moisture control is shown in Figure 7. A sensor was used to detect the soil moisture. The data of the sensor was set into a suitable range for soil moisture. Then, the value will be shown in the GUI under virtual pin V9. If the sensor data value was less than the required data, the pump will turn on to water the plant.

```
void getData()
{
  int mois = analogRead(sensorPin); Blynk.run();
  mois=map(mois,100,1023,100,0);
  Blynk.virtualWrite(V9, mois); Blynk.run();
      if (mois < requiredMois + 0.5 || mois < requiredMois - 0.5)
{
  digitalWrite(mainPin, ON);
} else {
  digitalWrite(mainPin, OFF);  }
  lastTransmit = millis();
}
```

Figure 7: Coding for soil moisture control

Graphical User Interface (GUI). GUI was developed to ensure that user can monitor and control the system. The interface using IOT function which means the system can be monitor and control wirelessly. Figure 8 shows the GUI for this project.

After watering the plant, the soil moisture will give a reading. The user can set moisture set point value for the plant. The graph shows the signal of pump and lamp. If the pump turns on, the signal will turn to high and turn to low when the pump is off. The graph colour is different for each variable. Next, there are three buttons that acted as a switch for pump, lamp, and buzzer. The function of these buttons are to activate the function of the actuator. If the soil moisture is lower than the set point but the pump button is not activated, the pump will not turn on. This button acts as interlock where it will be useful if the sensor is not working or giving a wrong data value.

There are several indicators to indicate whether power, lamp, pump, and buzzer turned on or not. Besides, there is a value display widget that will display the moisture of soil, surrounding air temperature as well as humidity values.

Figure 8: Gardening GUI

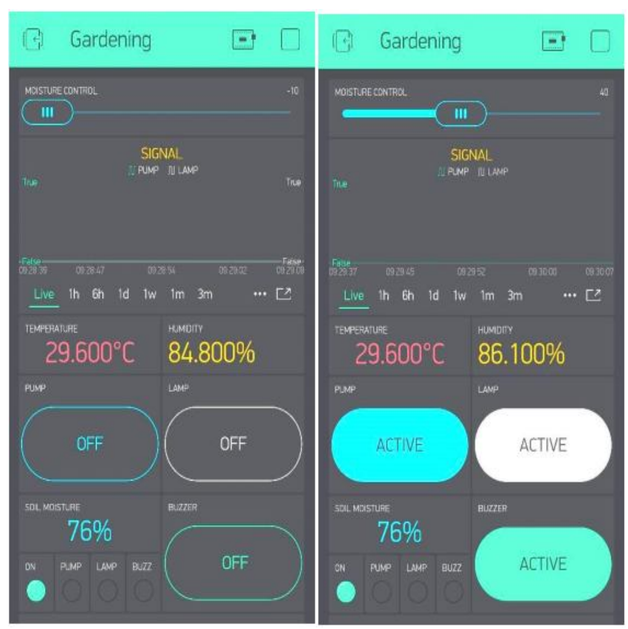


Figure 9: Activation of the plant in the GUI

3.6 System Testing

In this section, a certain condition made intentionally to observe whether the system can working properly or not. The 'ON' LED widget will turn on. The value of soil moisture with the air humidity and temperature value will also be shown. Next, all buttons were activated to allow the actuator to function. Moisture set point value was set using the slider widget. Figure 9 shows GUI when it has successfully connected with the plant and all the buttons were activated.

When the soil moisture is lower than the set point value and surrounding temperature is below 30^{0}C, the pump will turn on. The LED widget for the pump will light up to indicate that pump is running. The signal on the chart will show high if the pump is running. When light intensity is low, lamp LED widget will also turn on. The green line in the signal chart indicates pump signal and white line indicate lamp signal. X-axis for the chart is time (t), therefore the user can know at what time and how long the lamp or pump was turned on by referring to the chart. Figure 10 shows the GUI when pump and lamp are turned on.

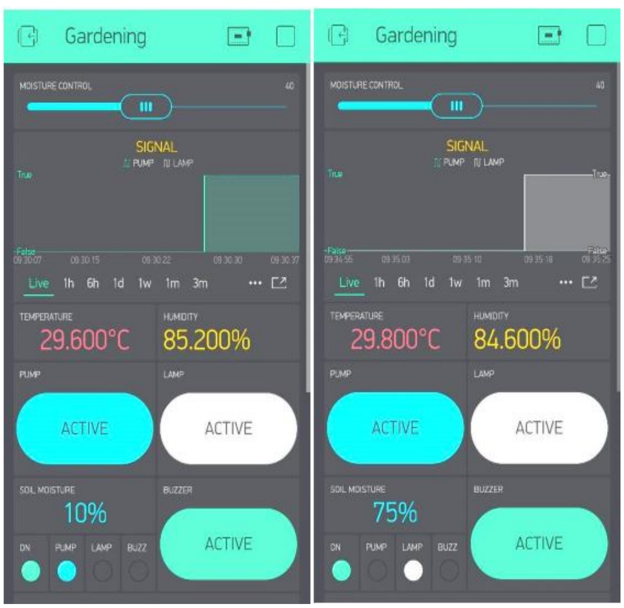


Figure 10: GUI when pump and lamp is turned on

For low water level in the water supply container alert, buzzer and notification to the user were used. When the water level in the container is low, the buzzer will turn on and notification will be sent. The notification is "Hey, water level in the tank is LOW!!!" and LED widget for buzzer will also turn on.

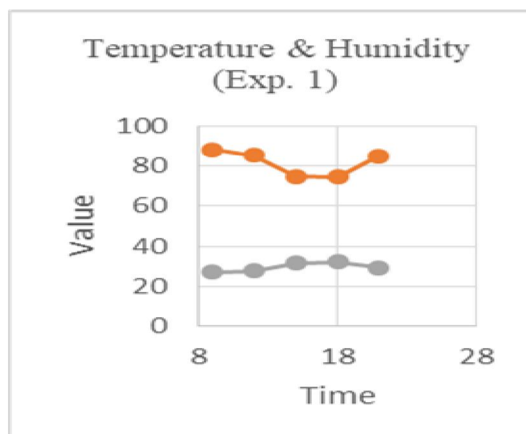
4. ANALYSIS OF RESULTS

From the experiment data, an analysis was done to interpret the collected data. The results showed the relation of surrounding temperature and humidity over time. For temperature based on the experiment results, the range of temperature on 9.00 am was 26^{0}C-30^{0}C and range of humidity was 85%-90%.

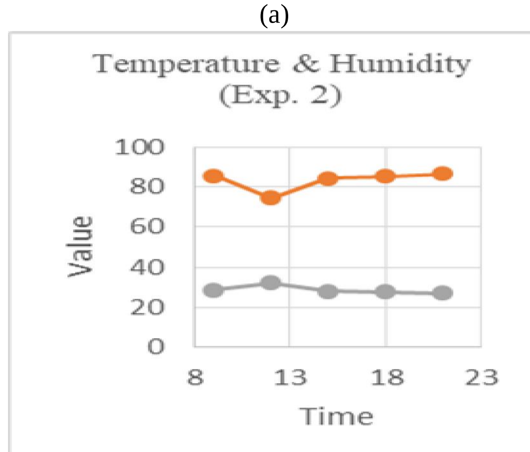
Table 3 tabulates the results from three contrasting experiments measured on the same time schedule but conducted on different days.

Table 3: Experiment Results

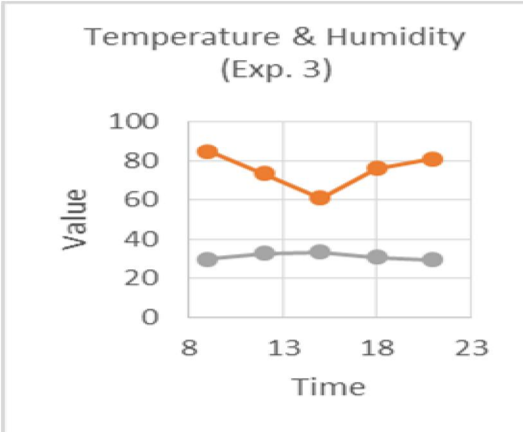
Experiment	Time	Humidity (%)	Temperature (^{0}C)
1	09.00 am	84.9	29.8
	12.00 pm	73.3	32.7
	03.00 pm	60.8	33.4
	06.00 pm	75.9	30.8
	09.00 pm	80.8	29.5
2	09.00 am	85.8	28.6
	12.00 pm	74.5	32.1
	03.00 pm	84.5	27.9
	06.00 pm	85.4	27.6
	09.00 pm	86.7	27.2
3	09.00 am	88.3	26.9
	12.00 pm	85.5	27.8
	03.00 pm	75.0	31.7
	06.00 pm	74.5	32.1
	09.00 pm	85.1	29.3



(a)



(b)



(c)

Figure 11: (a) Experiment 1, (b) Experiment 2, and (c) Experiment 3

A line graph (refer Figure 11a, 11b and 11c) was generated based on data in Table 3. The line graph shows the relation of surrounding air temperature and humidity over time. Based on the table, the range of humidity at temperature 26^0C-30^0C is 80%-90% where it is the suitable condition for watering plants. The data in the table was interpreted as line graph below so it can be seen clearly.

We can see once the temperature was increased, the surrounding humidity was proportionally decreased. It can be concluded that, instead of setting the AGPP system to watering plants based on all three parameters which were soil moisture, surrounding temperature and air humidity, the plant can be set to water plants based on only two parameters which were either soil moisture and surrounding temperature or soil moisture and air humidity.

5. CONCLUSION

The objectives of this paper have been achieved. An automated gardening portable plant has been developed that will benefit urbanites to care for their plants. AGPP is efficient and reliable automatic watering system that is also capable to provide sufficient light without much effort.

The prototype was constructed and produced under short period time and using low-cost device and equipment. To increase the efficiency and accuracy of this project, whoever want to pursue or implement the system in real life may need to use high accuracy soil moisture sensor for a better control. Besides, the structural strength of the plant can also be improved using thicker pipe or steel so the structure can support more planting box. Other than that, instead of pumping water from a container, water supply for the plant can be taken directly from house pipe and control it using solenoid valve.

Arduino can be used in this project as the microcontroller and can perform better as it has more analog input for the sensor. The plant data can be read and control accurately with more analog input. For the power supply, higher output power supply unit needs to be used to make sure the whole system acquire sufficient power supply to run properly.

For future work, it can be much better if implementing more type of sensors such as pH sensor and the nutrient sensor for plants. With this, the health of plants can also be monitored. The project can be modified and upgraded according to current time requirements.

REFERENCES

1. S.G. Manoj Guru, P. Naveen, R. Vinodh Raja & V. Srirenga Nachiyar (2017). **Smart Irrigation System Using Arduino**. SSRG *International Journal of Electronics and Communication Engineering*, 182-185.
2. T. Sarika & P. Sowmya (2016). **Intelligent Automatic Irrigation System**. *International Journal of Computer Science and Information Technologies*, 141-143.
3. R.T Jagdeep, S. Daljit (2015). **Microcontroller Based Automatic Sprinkler Irrigation System**. *International Journal of Modern Engineering Research*, 47-51.
4. R. Deweshvree, P. R. Indurkar, D.M. Khatri (2015). **Review Paper Based on Automatic Irrigation System Based on RF Module**. *IJAICT* Volume 1, Issue 9, 736-738.
5. James Marsh (2013). Automated Plant Watering System. United States Patent, US008584397B1.
6. A. Chetana, Kestikar & M.B. Rutuja (2012). **Automated Wireless Watering System** (AWWS). *International Journal of Applied Information Systems*, 40-46.
7. X. Xiang (2011). **Design of Fuzzy Drip Irrigation Control System Based on ZigBee Wireless Sensor Network**. IFIP *International Federation for Information Processing*, 495-501. https://doi.org/10.1007/978-3-642-18333-1_58