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Indoor Gardening System (IGS) based Learning

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1. Introduction

Agriculture is the practice of growing plants and raising animals for food, human needed or economic gain using art and science. It can be divided into two categories which are crop farming and livestock farming. Therefore, this project focusing on the life gardening system. There are many importance of plants for human and ecosystem. One of them is they produce food to organisms including human [1]. They also establish the atmosphere during process of photosynthesis and for sure the living can't live without plants.

The purpose of this product is to create and provide a successful sustainable garden using organic methods. This product is targeting on students in primary school which helps them to develop their interest and positive attitudes to agriculture and science, technology, engineering and mathematics (STEM). They will also learn on how to plan, take responsibility and value environment by involving themselves in whole process of planting garden [2]. Besides that, this system is able to expose the students to the electrical and electronic engineering and concept of Internet of Things (IoT) by introducing them to the sensor and system used in indoor gardening system (IGS). Moreover, gardening provides them with skills in order to boost child's development such as locomotors, body management and object control skills.

Sensory stimulation is another aspect of physical development that children can experience in gardening. In fact, water is a crucial part of gardening and playing with a hose or the watering can be a highlight to child enjoyment. Other than that, touching the texture of the soil or the plant leaves is also interesting, as is the smell of the fresh garden and its plants.

The functions of this product are to monitor the status of the plants' temperature, humidity and light brightness [3]. In this project, a water pump is necessary because it pump the water out when there is not enough humidity of the plants. This gardening system is suitable for teaching and learning process because this system provide them with simple modules so that they can plants their own garden. The concept of IoT also be used in this project because IoT has become more and more common in the evolution of technologies. IoT is able to transfer data over a network such as Bluetooth and Wi-Fi without human-to-human or computer-to-computer interaction [4]. It also ease the users because they can monitor the condition of the plants by using smart phone.

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In order to ensure the successfullness of Indoor Gardening System (IGS) development, Arduino is used and automatically provide the needs of the plant like light, water and air by using sensors. Different types of sensors are being used in this project in order to achieve the requirement needs for plant. The placement of sensors in IGS played an essential role for indoor gardening.

2. Methodology

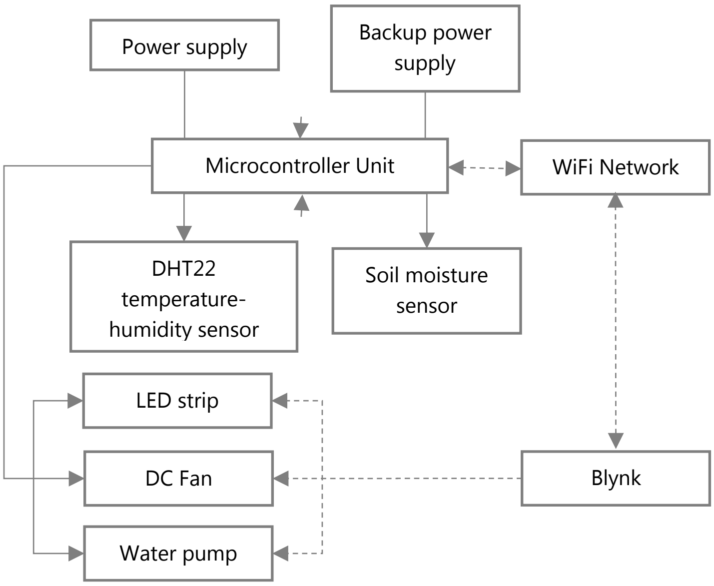


Figure 1: Block system of the IGS system

Figure 1 shows block diagram of the IGS system that consist of NodeMCU microcontroller, soil moisture sensor, DHT22 temperature-humidity sensor, 9V DC fan, 12V waterproof water pump, 12V LED strips, 12V main power supply and electrolyte acid battery.

NodeMCU is an open source hardware of IoT platform, is used as microcontroller of IGS project. It includes firmware which runs on the ESP8266 WiFi SoC from Espressif, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the developing kits. The firmware ESP8266 uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266.

Soil Moisture Sensor used to detect the water level in the soil. The soil moisture sensor module comes with soil moisture sensor probe plate and comparator board. This sensor is used to measure the water content of soil by measuring the dielectric permittivity of the soil. The maximum input value of this sensor is 1025 and the minimum input value is 1. The more input value of the sensor means it is dry and the less input value means it is getting wetter. The coding to activate the water pump is more than 500 input value and when the value is drop below than 500, the Water Pump deactivated.

The DHT22 used in this project is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and DHT22 output calibrated digital signal. It utilizes exclusive digital-signal-collecting-technique and humidity sensing technology, assuring its reliability and stability. Its sensing elements is connected with 8-bit single-chip computer. Small size & low consumption & long transmission distance (20m) enable DHT22 to be suited in all kinds of harsh application occasions. Single-row packaged with four pins, making the connection very convenient.

Temperature, humidity and soil moisture can be control and maintain using fan, LED strip and water pump, respectively. 9V DC fan is an 80mm brushless dc fan with the air volume at 38.88cfm and maximum rotation speed at 4000rpm operating at 9V. This DC fan is used to cool down the temperature around the plant. The 12V waterproof LED strip light contains 60 LED silicone, that glow ultra-bright white light and consume 14.4W of power and 1A of current. The LED strip used to promoting photosynthesis for the plant and control the humidity around the plant. While, waterproof water pump works automatically based on the soil moisture reading, by the concept of water suction which drain the water through its inlet and released it through the outlet with the cable attached to it.

Main power supply by 25W - 400W power pupply AC110-220V to DC12V 5A-20.8A LED transformer adapter, while lead-acid battery electrolyte used as backup power supply, that has the average of 10 hours of battery life.

2.1 Circuit Board Development

IGS have a main power supply for microcontroller and the output of water pump, LED strip, DC fan and equipped with a 12V electrolyte acid battery acid as a backup battery for the case of failure of main power supply. Minimum and maximum of output voltage of 12V main power supply are 11.42V and 13.26V, respectively, with ± 10% of variable controller voltage range.

This 12V main power supply also used to supply the voltage to three voltage regulator circuit. The voltage regulator schematic circuits have three values; which area two 12 V circuits (used for LED strip and water pump) and a 9 V circuit (used for DC fan), as shown in Figure 2 and 3, respectively. While, the developed voltage regulator circuit is shown in Figure 4.

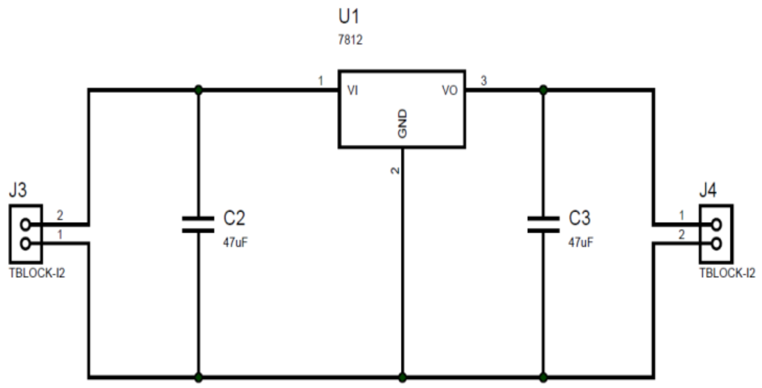


Figure 2: 12V voltage regulator circuit schematic diagram

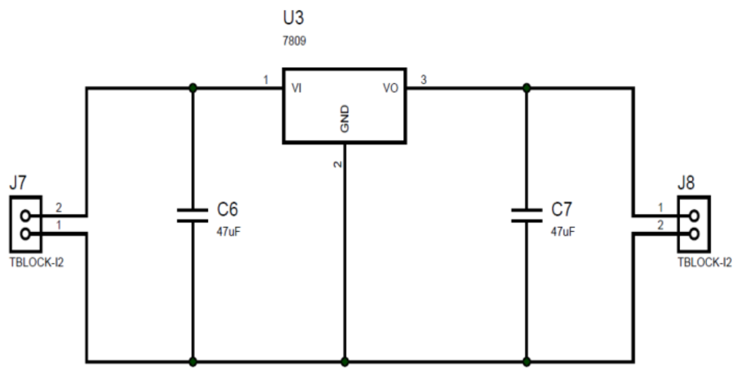


Figure 3: 9V voltage regulator circuit schematic diagram

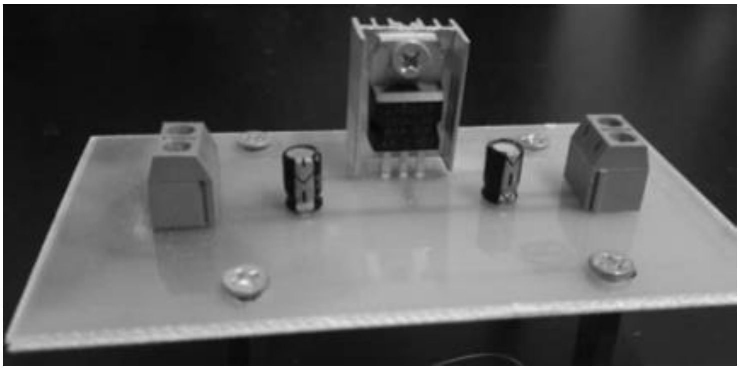


Figure 4: Voltage regulator circuits

3. Results and Analysis

This section showing the actual results based on the testing on the IGS. System is tested and focused on the sensors and power supply that used to support the system. Figure 5 shows the diagram of the completed product.

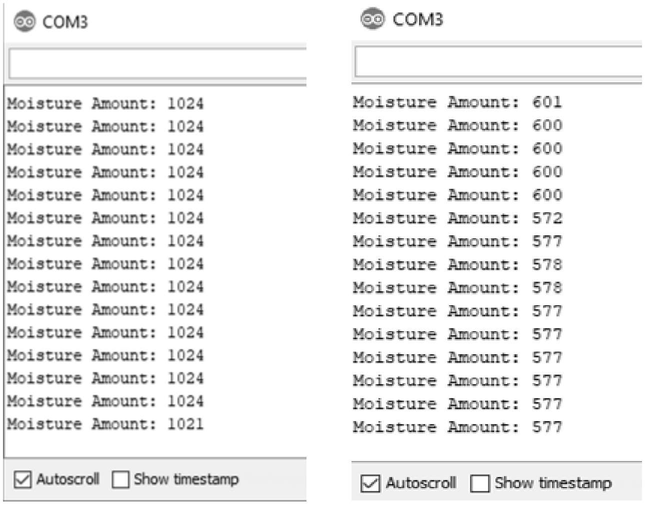
Figure 5: Product prototype

3.1 Soil Moisture Testing

Calibration is conducted to ensure the minimum and maximum value to detect the moisture. Soil moisture sensor connected to the NodeMCU microcontroller with the voltage supply for the soil moisture sensor module is 3.3V. Figure 6 shows the soil moisture sensor reading for dry and wet soil condition are around 1020 and 590, thus water pump is automatically turn on once the reading of soil moisture sensor value is more than 600.

3.2 DHT22 Temperature-Humidity Sensor Testing

The result for the temperature and humidity are displayed at two different display which is OLED I2C display module (Figure 7) and Blynk application (Figure 8). This sensor is tested at the room temperature, in order to verify the reading of DHT22 temperature and humidity sensor.



(a) (b)

Figure 6: Reading of soil moisture sensor module in (a) dry and; (b) wet soil condition

Figure 7: The temperature and humidity reading displayed on OLED I2C

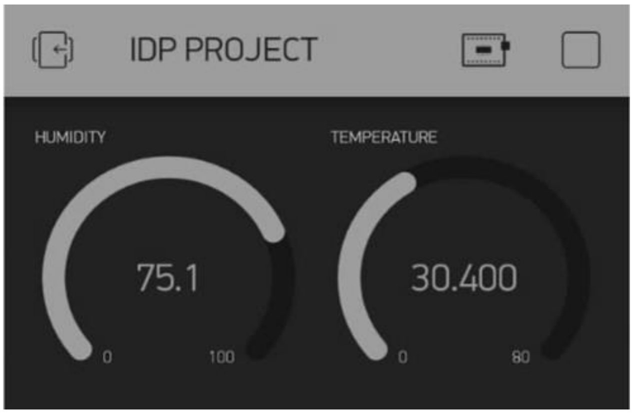


Figure 8: The temperature and humidity reading displayed on Blynk application

3.3 Blynk Testing

All the system is fully control by IoT platform. Blynk app is used to control and monitor the IGS. Blynk app is used to turn on the fan and LED strip while the water pump is automated turn on depend on the soil moisture sensor reading. Once the water pump is turn on Blynk notification is transmitted to notify the user. Soil moisture sensor reading, temperature and humidity can be monitor on the Blynk app.

Figure 9 and 10, show the features of Blank app control panel, thus user are able to turn on or off the DC fan and LED strip by just clicking on the push button. The DC fan and LED strip are controlled by user automatically, based on the information of temperature and humidity.

Figure 9: On/off push button of the DC fan

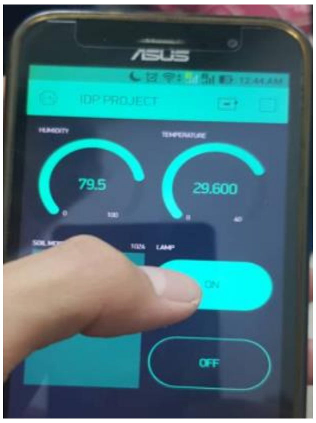


Figure 10: On/off push button of the LED strip

The condition of soil in grow bed can be monitored in Blynk as shown in Figure 11. Once the level of soil moisture sensor is increasing more then 600, it automatically turn on water pump. Monitoring is importance to ensure the plant is in good condition.

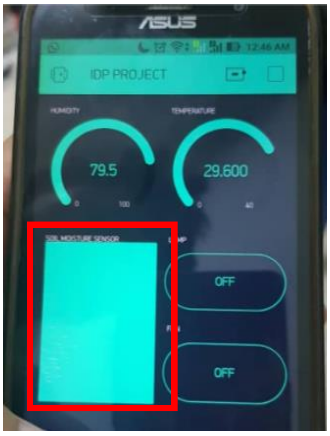


Figure 11: Soil moisture sensor reading displayed on Blynk app

4. Conclusion

IGS provides children lots of benefits in term of additional skills for survival, promoting organic gardening and also works as learning tool. This system also introduce the students to electronic components which are used to monitor the condition of the garden. Moreover, apart from practical skills in agriculture, gardens also act as living laboratory for the study of environmental issues and life sciences. With the help of learning modules, everyone can have their own garden and start to have something to take care of.

Since this project is focusing on the aquaponic method, it is recommended that further aspect may use hydroponics to grow the plants. Hydroponic method will provide direct nutrients to plants [5]. Other recommendation is to reduce the power consumption of this system to make is as eco-friendly system.

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