

# Development of Internet of Things (IoT) Application for Garden Irrigation System

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**Abstract:** This project aims to develop a system that is able to irrigate the plant automatically using a smartphone. This is a prototype of an IoT Garden Irrigation System (IoT-GIS) project aims to help people that makes gardening as their hobby, but constantly away from their garden or have to go outstation. By using Blynk apps, this project is able to monitor the soil moisture and also control the water pump automatically or manually. This project is using soil sensors, water pumps and Arduino microcontroller that is connected to the internet via wifi. Based on the observed result, this IoT-GIS project shows that its ability to communicate and control the watering process manually and also automatically. IoT-GIS can detect the soil moisture and activate the pump automatically. Furthermore, the user can view the status of their plant everywhere, and set the timer automatically to watering the plant. This project hopefully can assist gardening hobbyist anywhere in the world.

**Keywords:** Irrigation, Blynk, Arduino, IoT

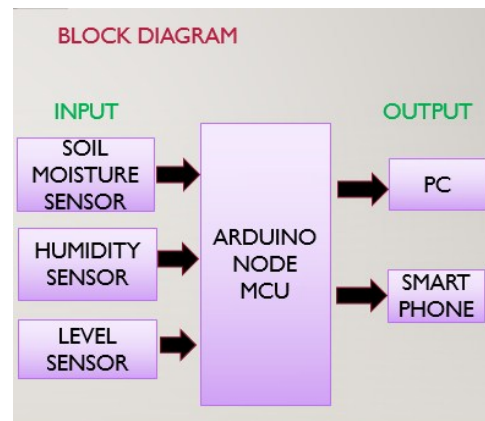
## 1.0 INTRODUCTION

This automatic and remote plant irrigation system project is suitable for the hobbyists who interested to grow and cultivate plants but having a busy schedule and lifestyle. They normally do not have enough time to irrigate their plants as proper schedule. This problem gets worse if they go on long vacation and their plants most probably will wilt and eventually die. Therefore, the project that is able to irrigate plant automatically using a smartphone is most beneficial.

Three comparable projects have been evaluated before the project started. The first project is Aurdino based Automatic Plant Watering by [4]. This journal proposes a smart watering system with smart control and intelligent decision making based on accurate real-time field data. This journal also highlighted on how to monitor the operation of the plant watering system via android application in any smartphone. The main body for the prototype contains an Arduino NodeMCU microcontroller as shown in Figure 1. This project is using three sensors which is a soil moisture sensor, humidity and temperature sensor, and level sensor.

The sensors send the data to the Arduino board which will trigger the water pump to turn on and it will supply the water to the plant. The water pump will turn off when the

moisture level reached the system halts on its own. The water pump will operate and pump the water to the tank if the water level is low. Lastly, the information about the agriculture field will be sent to an Android application on the smartphone.

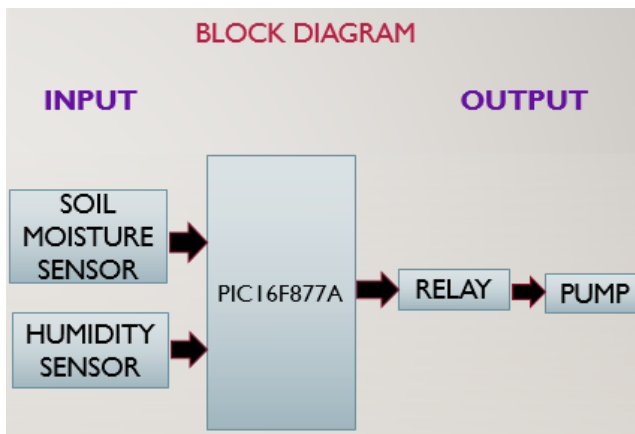


**Figure 1:** Block diagram of Aurdino based Automatic Plant Watering by [4]

The benefit of this system is that it can help to reduce the manpower to watering and monitor the plants. This is because they can just monitor their plants through smartphone and PC. They will get the information about their plants by the android application. Project by [4] can

only view the status of the soil in a smartphone and PC, but they cannot control the system to water their plants remotely. When the sensors detected the moisture of the soil, the water pump will automatically turn on and even at night. If the sensor still detected the moisture of the soil, it will continue watering the plants. It is shown that the system will watering the plants automatically. Unfortunately, the users cannot view the status of the soil remotely. This is because this system is not using the internet of things application. It only uses a microcontroller that can control the water supply to water the plants.

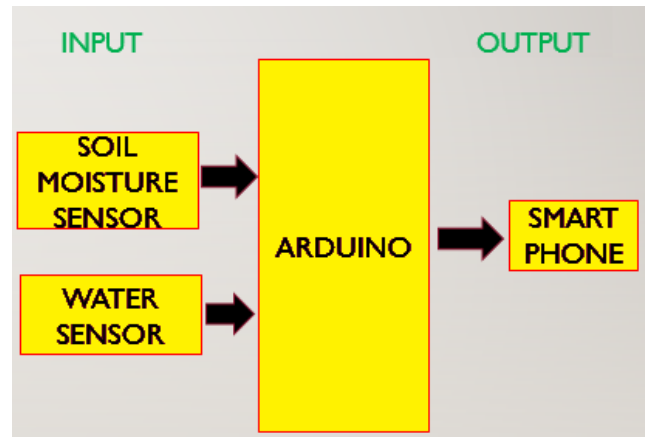
The second project is the Automatic Plant Watering System by [2]. This project using PIC16F877A microcontroller to controls the water supply as shown in Figure 2. Soil moisture sensor has been set at specific dryness level because different plant required a different level of water content at their soil. The sensors will activate and send the information to the PIC Microcontroller. The microcontroller then gives a signal to turn on the water pump using H-Bridge circuit until the sensors are deactivated again. Usage of PIC microcontroller gives this project an advantage because it can easily simulate input signal, monitor, and review the operation of the output. The disadvantage in the system is the absence of timer function since not all plant needs to plant only when its soil is dry.



**Figure 2:** Block diagram of the Automatic Plant Watering System by ([2])

The third project is entitled IoT Planting: Watering System Using Mobile Application for the Elderly by [5]. This project is suitable for elderly who are fascinated in planting the flowers. This project allows the elderly to control the irrigation process using a mobile phone. This project was developed for the elderly using Arduino technology. The HTTP server is used with the web server for monitoring the plant activities. By using Arduino mobile application, the elderly can view their plant via monitoring menu which is real-time communication between the

application and IP-camera. The data will be collected in real time by employing temperature and humidity sensor. The data from each sensor will be sent to the Arduino. Then, the Arduino will send the data by using an HTTP protocol to the PHP server every second. The PHP server acts as an intermediary between the Arduino and MySQL database [5]. The advantage of using this IoT watering system is the user can view the status of the soil through smartphone easily. However, the disadvantage of this system is user unable to activate the water pump remotely when needed.



**Figure 3:** Block diagram of IoT Planting: Watering System Using Mobile Application for the Elderly by [5]

Nowadays, a smartphone is not only used to make a phone call, or sending messages, but it has been improved continuously to help human managing life. This plant watering system will be controlled with a smartphone by using android application. Based on the to plant watering system project by[2,4,5], this project is to design a suitable and simpler way to monitor and control the moisture of plant soil. In this project, the microcontroller is NodeMCU that receives a signal from the soil moisture sensors and control the water pump accordingly. By using an android application known as Blynk, the input, operation, and output of this project can be monitored and controlled remotely via smartphone anytime and anywhere.

## 2.0 DEVELOPMENT OF HARDWARE AND SOFTWARE

This project consists of the development of hardware and software. The hardware includes soil moisture sensors, Arduino module, relays, and water pumps. Arduino is a flexible, community open source, most easily available low-cost programmable hardware platform [1,3,6]. The software comprises of two-part, the programming source code in the Arduino module and Blynk apps in the smartphone for the

operation and control of the project. The hardware shows in Figure 4 below.

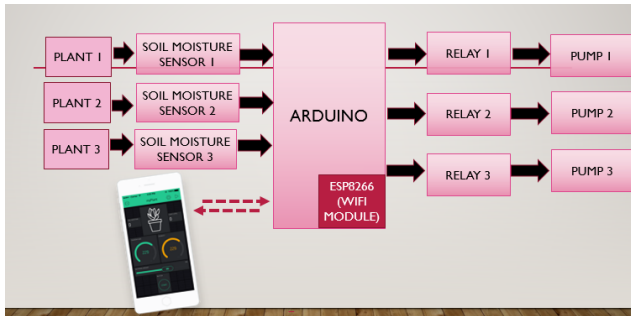


Figure 4: Block diagram of the project

Based on Figure 1, the block diagram consists of input, processor/controller and output. For input, this project uses three soil moisture sensors to detect either the soil is moist or dry. Each sensor detects the soil on each plant. The Arduino will continuously send the information to the smartphone via Wi-Fi module. As a controller, the Arduino received a signal from soil moisture sensors and signal from a smartphone via the Wi-Fi module. The Arduino also send the signal to activate the relays and water pumps. In this case, the relays and water pumps act as an output. Using this project, the users able to see the information on the status of their plants using Blynk apps on the smartphone and interactively control irrigation process anywhere in the world if the internet is available.

The main controller for this project is using NodeMCU ESP8266 that is based on Arduino as shown in Figure 5. NodeMCU is simple open-source hardware to develop IoT product. Its use advance API for configuring and manipulating hardware [8]. NodeMCU has advantages such as the capability to access WiFi in close proximity, USB for serial communication and its extensive features as IoT controller in small size [8]. If the area did not have any WiFi connectivity, GSM Module [11] or GPRS [7] can be used.

Figure 6 shows the input in this project which is FC-28 soil moisture sensor module. The user may set the desired level of soil moisture by adjusting the potentiometer at the sensor module. This sensor consists of an LM393 comparator chip for stable output [10].

The Soil moisture sensor connected with NodeMCU board at pin A0 to get the analog input data. The sensor will trigger the relay when it detected the moisture of the soil. When both led on the sensor is turned on, it shows that the sensor detected the moisture of the soil. However, if there is only one led that turned on, it means that the sensor did not detect the moisture of the soil.

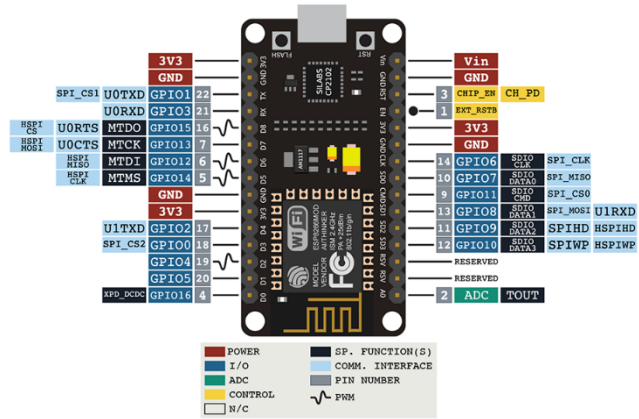


Figure 5: NodeMCU ESP8266

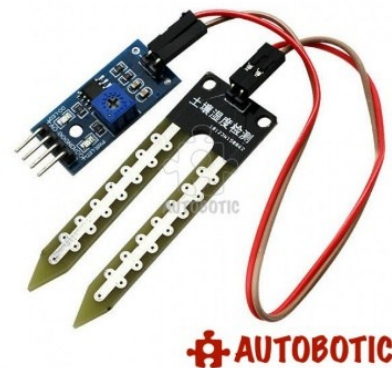


Figure 6: FC-28 soil moisture sensor module

Referring to the block diagram in Figure 4, the output of NodeMCU is connected to 4 channel relay module with opto-isolator (5V) as shown in Figure 7. This relay act as a switch to activate (ON) and deactivate (OFF) the water pump. Each relay has a normally open (NO) and a normally closed (NC) contact. In this module, there are four relays that each provide dry contact outputs. It means that each relay provides a common (COM), Normally Open (NO) and a Normally Closed (NC) terminal. This module supplied power via the pin labeled VCC and ground via the pin labeled GND. In addition, the relays are energized with low inputs to the IN1, IN2, IN3, and IN4 inputs. This project used Normally Open (NO) terminal. In the normally open configuration, when the relay receives a HIGH signal, the switch closes and allows current to flow to the NO terminal. A LOW signal deactivates the relay and stops the current. It means that when the signal is low the relay will turn ON and triggered the motor pump to irrigate the designated plant.



**Figure 7:** 4 channel relay module with opto-isolator (5V)

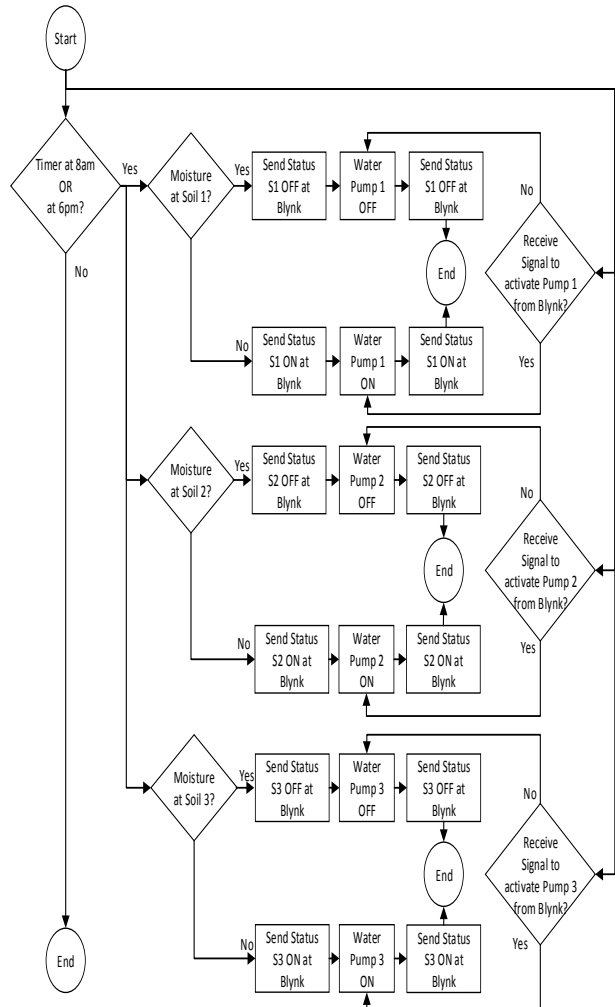
The output of the relay is connected to the water pump. The R385 DC12V diaphragm water pump is used to pump the water when the sensor detects the dryness of the soil as shown in Figure 8. One relay connected for each of the motor pump 1 (M1), motor pump 2 (M2) and motor pump 3 (M3). This project uses three water pumps to simulates three different types of plant and their respective irrigation requirement and needs. The 10V power supply is supplied to the motor to activate the motor. Initially, this prototype project using a 12V power supply, however when the motor pump activated, the water flows too fast thus the sensor cannot detect the moisture of the soil accurately. To solve this problem, the power supply is set to be 10V and it shows that the sensor can function well and detected the moisture of the soil precisely.



**Figure 8:** R385 DC12V Diaphragm Water Pump

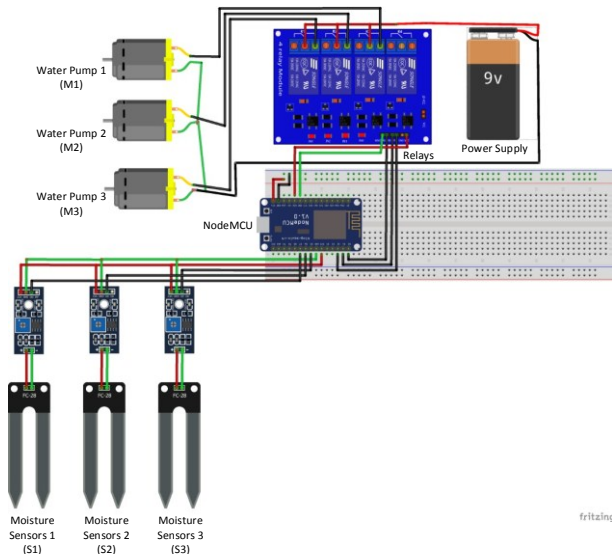
The workflow of this project explains in the flowchart as shown in Figure , users have an option to set the timer to water their plants. For example, if the user sets the timer at 8 am, if the sensor detects the soil is dry at the specific time, it will send the data to the Blynk apps and at the same time, the water pump will automatically turn on, and also send the status to the Blynk. However, if the sensor detects the moisture in the soil at a specific time, then the water pump will not activate.

This project will always sense the moisture status in the soil at all time and send the status to Blynk. Therefore, the user can easily monitor the status of their plants and easily give instruction from smartphone to irrigate their plants anytime at anywhere.

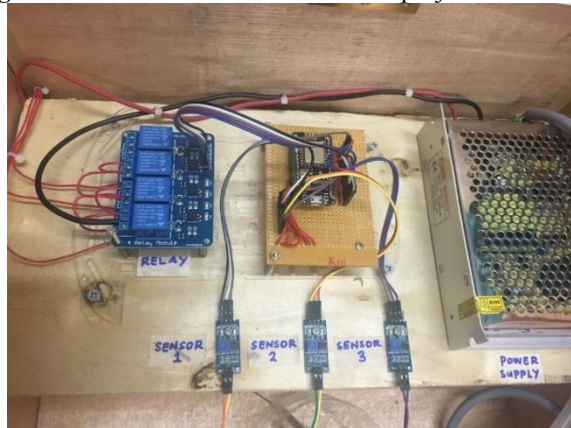


**Figure 9:** Flowchart of the project

Figure 10 shows the complete hardware interfacing between the NodeMCU unit, sensors, relays, power supply, and water pumps. While Figure 11 and Figure 12 shows the actual project hardware connection and construction.



**Figure 10:** Hardware connection of the project



**Figure 11:** Actual project hardware connection and construction (NodeMCU, Sensors, and Relays).



**Figure 12:** Actual project hardware connection and construction (Motor/Water Pumps and water tank).

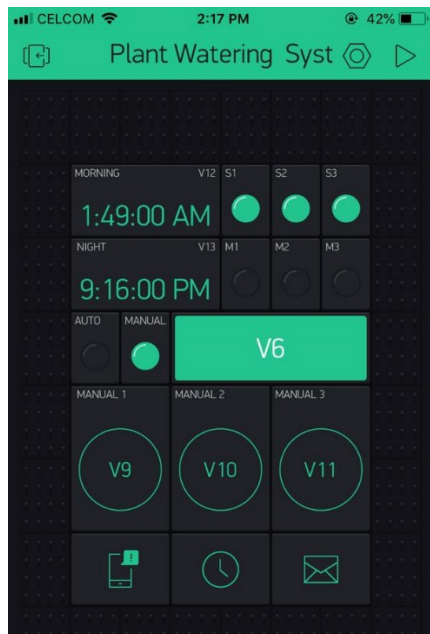
This prototype project consists of three different plants. As shown in Table 1, for plant 1, it consists of soil moisture sensor 1 (S1) as the input. When the sensor is at 0V, which means the soil is dry, the water pump 1 (M1) will ON. It is observed that when the sensor 1 (S1) is at 5V, which means the soil is moist, and the water pump will OFF. For plant 2, it also consists of a sensor 2 (S2) which is a soil moisture sensor. When the sensor is at 0V, the water pump 2 (M2) will ON and when the sensor is at 5V, the water pump 2 (M2) will OFF. The same system observed to be applied at the plant 3 consist of sensor 3 (S3) and pump 3 (M3), which is when the sensor is at 0V, the water pump will turn ON and the water pump 3 (M3) will OFF if the sensor is at 5V.

**Table 1:** Operational test result of the hardware

PLANTS	INPUT	SOIL MOISTURE LEVEL	OUTPUT (WATER PUMP)
1	SOIL MOISTURE SENSOR 1	LOW	PUMP 1 ON
		HIGH	PUMP 1 OFF
2	SOIL MOISTURE SENSOR 2	LOW	PUMP 2 ON
		HIGH	PUMP 2 OFF
3	SOIL MOISTURE SENSOR 3	LOW	PUMP 3 ON
		HIGH	PUMP 3 OFF

The result from hardware will be transferred via the internet to the Blynk apps at the smartphone (Lekjaroen et al., 2016) the testing automatic timer for morning and evening/night has been set to be at 1:49 AM and 9:16 PM.

### 3.0 RESULTS



**Figure 13:** Operational status of the hardware displays by Blynk apps at the smartphone.

It was observed that the Soil at plant 1 (S1), plant 2 (S2), and plant 3 (S3) LED is ON means that the soil is not dry. During this state, the motor pump 1 (M1), pump 2 (M2), pump 3 (M3) OFF means that the pump is not activated. Since the time is 2:17 PM, the Auto LED is OFF because current time is not the same as the automatic timer. The Manual LED is ON means that the system is ready to accept input from the user. The user may push the Manual 1 (V9) button to manually activate M1 to watering the plant 1, M2 to watering the plant 2 and M3 to watering plant 3. This testing result shows in Figure 13.

#### 4.0 DISCUSSION

Based on the observed result in Table 1 and Figure 13, this project shows that its ability to communicate and control the watering process manually and automatically. The previous project by (Kumar et al., 2017) was using an intelligent decision to monitor accurately the data of soil moisture, humidity, and level sensor, then the information is sent to PC and Smart Phone. The Internet of Thing (IoT) Planting as mention by (Lekjaroen et al., 2016) is a concept of IoT by using Arduino to process the input of soil moisture sensor and a water sensor, this project is connected to the internet via web server then can be displayed as a smartphone. According to (Kumar et al., 2017) and (Lekjaroen et al., 2016), the user can only view the status of the soil in a smartphone but can't water the system remotely. Comparing IoT-GIS project with (Kumar et al., 2017) and (Lekjaroen et al., 2016), IoT-GIS users can set the timer to watering their plants whenever they wanted. Hence, this

system can help them to take care of their plants when they are far away from their plants.

Another previous project is by (Gupta et al., 2016), the controller of the project is using PIC16F877A that detect the soil and humidity, then automatically pump the water at certain condition. According to (Gupta et al., 2016), the system will be watering the plant automatically, but the user can't see the status of the soil. Comparing IoT-GIS with (Gupta et al., 2016), IoT-GIS users can view the status of the soil because the system involved the internet of things by using NodeMCU that consist of Wi-Fi module inside it. Users will get the notification through Blynk application about the condition of their plants. From the Blynk apps, users can control and monitor their plants even from far away from their plants.

Comparing IoT-GIS project with (Kumar et al., 2017), (Lekjaroen et al., 2016) and (Gupta et al., 2016), this project is much more versatile because can detect the soil moisture and activate the pump automatically, furthermore the user can view the status of their plant everywhere, furthermore can set the timer to automatically watering the plant. Using this approach, it will benefit not only gardening hobbyist but can also be upgraded to be used by a farmer to control their farm remotely.

#### 5.0 CONCLUSION

As conclusion, Automatic Irrigation System that uses Blynk application as a platform to control and monitor the plants can be widely used by the consumers that having trouble with watering their plants every day. This system will help to save human labor and it can prevent from inconsistent watering the plants that may cause the mineral loss in the soil. On the other hand, this system will help people to get information about the moisture of the soil of their plants through the Blynk application. Users will get the notification and they can simply control their plants on the phone even if they are far away from their plants. In addition, this system is easy to handle and users can set the timer according to their preferred schedule. This system can also be implemented in a large field area. When there is more than one plant to monitor and handle, they might forget to activate the water pump. But with this system, users do not have to worry about their garden if they are leaving for

some emergency cases since they can easily get the information of their plants through Blynk application. This project can water the plant automatically using Arduino. Users can set the timer on the Blynk apps to watering their plants. Besides, this project can monitor the soil moisture of the soil using soil moisture sensor and lastly, users can get the information on the soil sensor using Blynk apps. Finally, it can be concluded that all the objectives of this project were successfully achieved.

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