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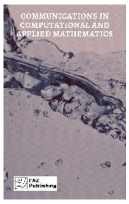

Iot Based Smart Irrigation Control And Monitoring System

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Abstract: The "Internet of things" (IoT) has been rapidly developed and applied to the various sector including automotive, manufacture, industrial, and many more. IoT also refers to connecting to another device through a network without any interactions from the human. In this project, the idea is to design and develop an irrigation system that can be control and monitor by using a mobile phone. The purpose of this work is to help agriculture sector in maintaining the moisture of their plantation automatically. The design system should be able to monitor and controller the watering system automatically by detecting the level of moisture in the soil. At the end of the project, smart irrigation system, with an IoT functionality, is successfully designed and tested. Earlier testing provides some promising result, with system can be either automatically controlled or manually control, remotely using smartphone.

Keywords: Internet of Things, Irrigation System, Relay, Water Pump, Node MCU, Arduino, Blynk

1. Introduction

Irrigation system is the artificial application of water to land for agricultural production [1]-[6]. Nowadays, smart technology is helping users to manage their irrigation more efficiently by integrating the IoT in the system [1]-[5]. Unlike the traditional watering system, smart irrigation systems tailor watering schedules and run times automatically to meet specific landscape needs. This technology help user to reduce the amount of water wasted and ensure their economic cost will be minimized [7]-[16].

To monitor and water the plants every day, people need to visit the plant often. This will use a lot of human energy and wasting much time. With the IoT integration mode, the system can be monitored and controlled through a device and this helps to save the amount of time. The pump will turn off once the sensor probe detects a sufficient level of moisture in the soil. This helps to decrease waste and increase the system efficiency which maximizes capabilities, while at the same time minimizes the daily cost.

Main objective of this project was to review the previous work of IoT based irrigation system. Then, project will be focusing on the design and development of the prototype of an irrigation system with online monitoring and control capability.

However, some limitation has been set to achieve the project goal as listed below;

a. This project integrates the IoT technology to monitor and control the irrigation system.
b. The equipment used for this project is 12V Water Pump, Moist sensor, Relay 5-Pin 5V, Node MCU and Arduino to program the system.
c. The software that will be used to control and monitor the system is Blynk apps.
d. Node MCU developed with ESP8266 Wi-Fi chip as the control board limited the project to function only in remote areas.
e. Size of the water pump is 3.6 W with a capacity of 240 Littre per hour enough to water smaller area with about 9 m^2 wide

The design and development of irrigation system requires some literature work. One of important part in the development of the system is the prototype preparation. The prototype development work can be divided into two parts which are hardware and software.

Smart Irrigation is a system that can sustainably managed, accountable, responsible and can be trusted. The smart irrigator is used to minimize user environmental footprint through efficient water use of water, while at the same provide profitable solution to the enterprise [4],[7]. This allows them to reinvest in new alternative and at the same time able to improve technologies that ensure sustainable and responsible irrigation over time.

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1.1 Controller for Smart Irrigation System

A smart irrigation controller has built-in water saving features including a sensor to adjust to the optimal sprinkler run time based on the local weather conditions [5],[8]. It helps to provide a healthy, beautiful landscape while reducing waste of water. It also reduces costs for the homeowner other than saving uses of water. The examples of the controllers are not only remote control, but they can also be tablet, laptop and even smartphones.

1.2 Smart Irrigation Architecture

The system architecture for Smart Irrigation must fulfill the requirements of measuring soil moisture, processing instrumented data, and monitoring the condition of the system. Fig. 1 below illustrates the smart irrigation system.

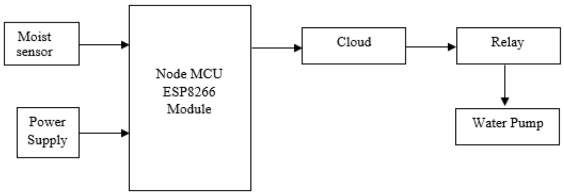

Fig. 1 – System architecture for Smart Irrigation System

1.3 Hardware Requirement

There are many types of Irrigation system and it includes surface irrigation, manual irrigation, localized irrigation, drip irrigation and sprinkler irrigation [8]-[16]. In this project, the system applies the sprinkler irrigation. So, the essential component for the system is controller system [10],[11] such as Node MCU board, water pump and a relay to trigger. Moisture sensors also required to measure the moisture level and send signal.

1.3.1 Node MCU

The Controller board used in this system is Node MCU. Node MCU is an open source IoT platform. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module [11]. The features of Node MCU are shown in Table 1.

Table 1 - Features of Node MCU[11]

Features	Description
Microcontroller	ESP8266
Communication	UART-CH340
Operating voltage (logic label)	3.3V
Digital I/O pins	16
Analog Input pins	1
Flash memory	4 Mega Bytes
Clock Speed	80MHz
EEPROM	512 KB
Dimensions	2.54mm

1.3.2 Relay Module

Relay is used to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal [11]. The relay used in this system is 5V (Fig. 2) relay to drive a higher voltage output which is 12V water pump. Table 2 shows the features of a relay where each individual pin is described.

Fig. 2 – 5V Relay

Table 2 - Features of Relay

Pin Number	Pin Name	Description
1	Coil end 1	To trigger the relay. One end is connected to 5v and the other to ground
2	Coil end 2	To trigger the relay. One end is connected to 5v and the other to ground
3	COM	Connected to one end that need to be controlled.
4	NC	If the other end connected to NC, the load remains connected before trigger
5	NO	If the other end connected to NO, the load remains connected before trigger

1.3.3 Moisture Sensor

Soil moisture sensor will measure the level of water contained in a material, such as soil on a volumetric or gravimetric basis. To obtain an accurate measurement, a soil temperature sensor is required for calibration in order to obtain accurate measurement. A moisture sensor module used to measure moisture in this system is shown in Fig. 3.

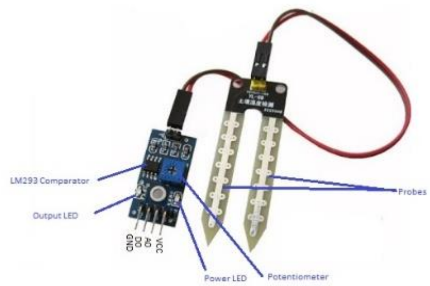

Fig. 3 – Moisture Sensor Module

1.3.4 Water Pump

The water pump functioned to distribute water from tank to soil when necessary. This system used a submersible brush DC pump with a rating of 12V as shown in Fig. 4.

Fig. 4 – Water Pump

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1.4 Software Requirement

Software is also crucial in the development of the system. Arduino IDE software is used to create the coding before uploaded to the Node MCU. Blynk apps will act as a server connecting the hardware and software.

1.4.1 Arduino IDE

Arduino IDE is software that is mainly used for writing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go.

1.4.2 Blynk

Blynk was designed for the Internet of Things. It can control hardware remotely, display and store sensor data, visualized it, and do many other things [13]. It allows the user to create amazing interfaces for projects using various widgets. Below are the features of Blynk.

a. Similar API & UI for all supported hardware & devices
b. Connection to the cloud using Wi-Fi, USB (Serial)
c. Set of easy-to-use Widgets
d. Direct pin manipulation with no code writing
e. Easy to integrate and add new functionality using virtual pins
f. History data monitoring via Super Chart widget
g. Device-to-Device communication using Bridge Widget
h. Sending emails, tweets, push notifications

2. Methodology

The important part in the development of system prototype is the methodology part. Methodology is procedures that are being follows to constructs and develop the complete project. It includes all of the equipment, tools and process used and this involved both software and hardware implementation.

This chapter includes all of the equipment, tools and process used and this involved both of the software and hardware implementation. The workflow will show which process will need to be more focused on, so the project will be going smoothly. This clear work flow process will help in achieving the project objective. Thus, Fig. 5 shows the process algorithm of the irrigation system. In the irrigation system, the water pump and controller receive power from the DC power supply. When sensor detects insufficient water in the soil, it will send a signal to the water pump to turn it ON.

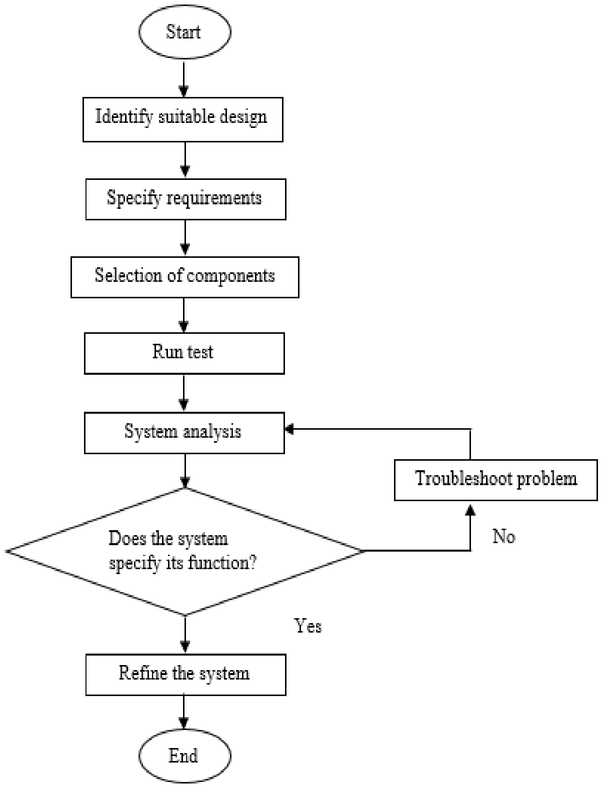

Fig. 5 – Algorithm flowchart of the IoT System

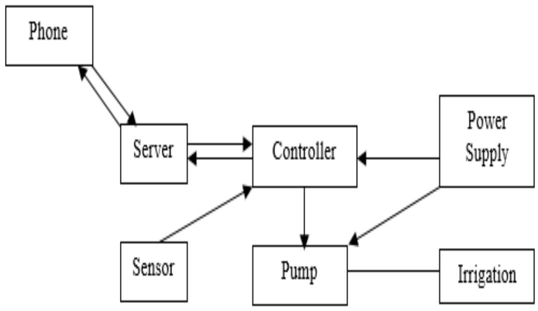

Fig. 6 – Block Diagram of the IoT system

At the same time, controller sends data to the server and user can monitor it through the phone (Fig. 6). Fig. 7 shows the relay is connected to the water pump to give enough supply and act as a switch to allow it to function. Node MCU will act as an interface between the server and the system [14].

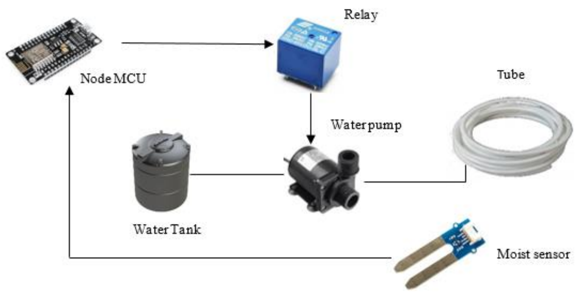

Fig. 7 – Block Diagram of the System Operation [10]

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3. Result and Discussion

3.1 Hardware Setup

The hardware implementation starts with the basic connection of the Node MCU Board by testing the LED connection corresponding with the appropriate coding and Blynk interface. As the Blynk apps is configured, the LED at output Node MCU lighted up when the button at the Blynk is turned on as in Fig. 8. Fig. 9 shows the graph of input and output for the LED testing. When the input is high, the output of the LED is also high.

Fig. 8 – Simple Node MCU Connection

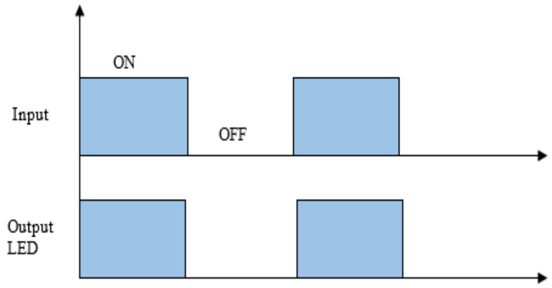

Fig. 9 – Graph Input and Output for LED testing

Using the same circuit connection, a connection test of Relay 5-Pin 5V is conducted. When the button is off, the LED at the relay module is lighted up. A digital multimeter is placed on the terminal of COM and NO1 (Normally Open Relay 1) to check the connection and no 'beep' sound produced showing there is no connection. When the button is switched ON, the LED at relay module light off and 'beep' sound produced from multimeter showing there is a connection. Fig. 10 shows the graph of input and output of the relay. When the input goes high, the output of NO also high.

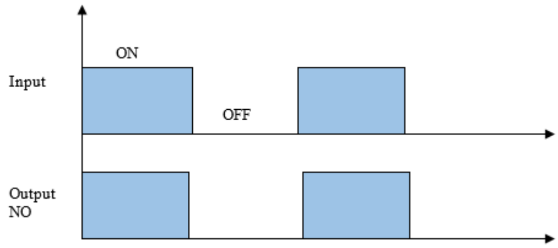

Fig. 10 – Graph Input and Output of Relay

As shown in Fig. 11, when there is no signal sent to the relay, the relay will not be trigger and the red indicates lamp will not turn on. When there is a signal sent to the relay, it will trigger the relay to turn on and the red indicator light will turn as referring to Fig. 12.

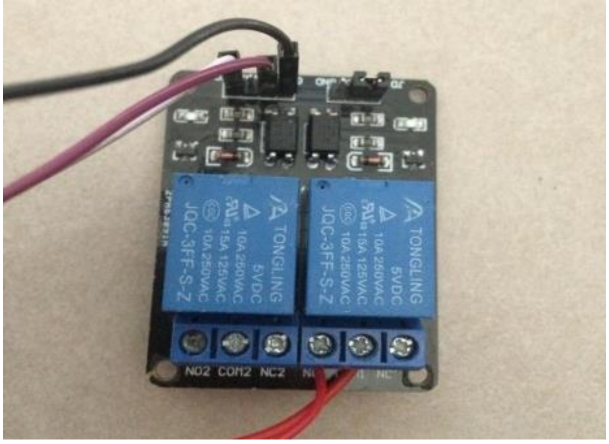

Fig. 11 – Relay with no signal received

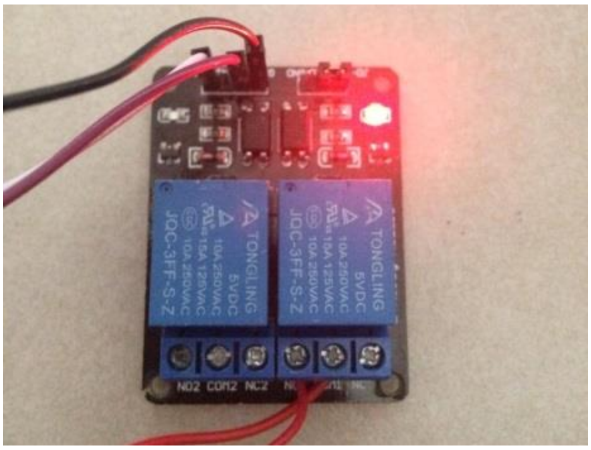

Fig. 12 – Relay with the signal received

The test is conducted for the moisture sensor by connecting 3V to the power supply. There are two LED indicators on the sensor module which are power LED and output LED as in Fig. 13. So, when the sensor is placed on dry soil, only power LED will light up. The output LED will not lighted up because there is no difference in condition to be compared by the comparator. This is shown in Fig. 14. In Fig. 15, both power LED and output LED of the sensor lighted up. This is because the sensor is placed on wet soil and the comparator turned on the output LED.

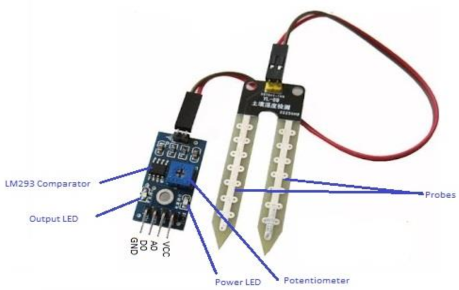

Fig. 13 – Moisture Sensor Module

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Fig. 14 – Moisture Sensor Module on Dry Soil

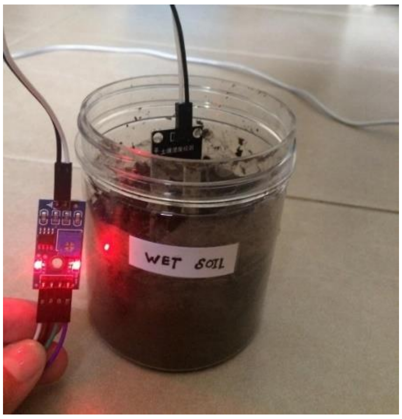

Fig. 15 – Moisture Sensor Module on Wet Soil

The water pump used is 12V. The connection of water pump and the relay is shown in Fig. 16. The water pump need external supply as the 5V relay is not enough to power up the output [16].

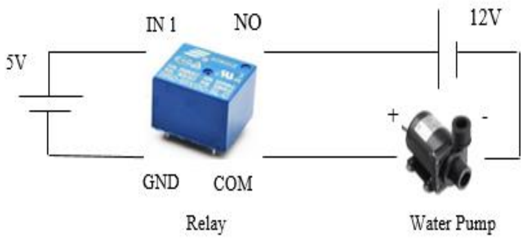

Fig. 16 – Connection of Water pump and Relay

After every component of the system is tested, all of the components are assembled to form a complete system of the Irrigation System. This can be observed in Fig. 17.

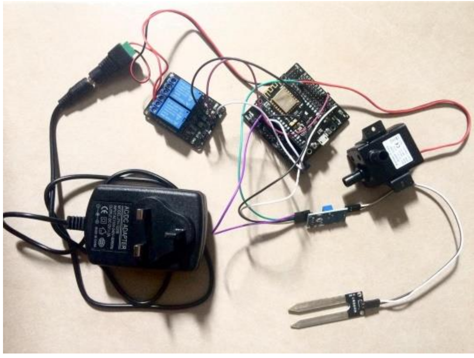

Fig. 17 – Completely Assembled of Component of Irrigation System

3.2 Software

Fig. 18 shows the Blynk interface via smartphone for LED testing. The button for LED is ON shows that the led in that circuit is ON in real time. For the user to turn OFF the led, they just can easily click on the button and the actual led in the circuit will turn OFF. This graphical interface is user friendly because the user can easily monitor the led and control it by switching OFF/ON the button through this interface.

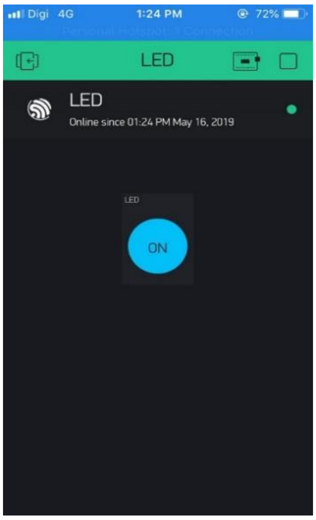

Fig. 18 – Blynk Interface for user

After the Blynk interface for LED testing is successful, the Blynk interface continues with the Irrigation System. Gauge widget is added to monitor the level of moisture. The pin in the gauge setting is set to ‘Analog A0’ as the moist sensor is connected to A0 pin of the Node MCU. Super chart is also added to enable the user to monitor the condition of the system in live or within weeks or months as shown in Fig. 19. The super chart will be Dryness vs. Time on the axis (Fig. 20). It will store the data and the user can monitor it through Blynk. The button remains in the system as it enables the user to turn on and turn off the water pump. Fig. 21 shows the Blynk interface during the dry condition. The level of moisture on the gauge is zero while the level of dryness in the super chart is high. In this condition, water pump will turn on until the sensor detects enough level of water.

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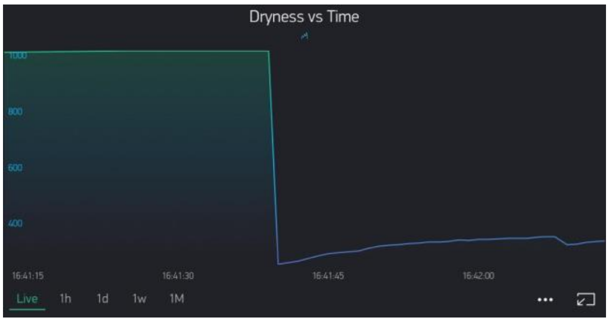

Fig. 19 – Super Chart Dryness vs. Time

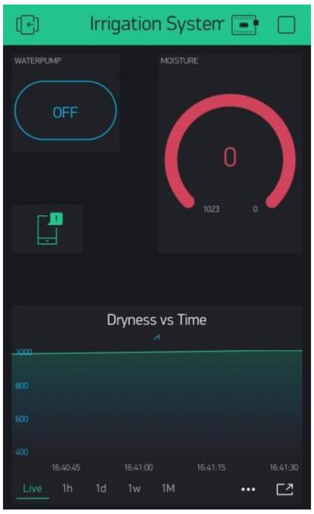

Fig. 20 – Blynk Interface during Dry Condition

Fig. 21 shows the Blynk interface during the wet condition. The level of moisture on the gauge is 677 which is a higher value. The dryness chart also plotted low indicates that the sensor has detected sufficient water and stops the water pump immediately.

Fig. 21 – Blynk Interface during Wet Condition

3.3 Prototype

For the prototype, a clear glass container with area 8'x 7' x 6' is used as the body of project. Some succulent plant was planted as the sample of the project. A container with a hook is placed at the side as the water tank along with a water pump attached. Node MCU board and the relay is placed in a waterproof case to avoid getting wet. the moist sensor is placed on the soil in the container. Complete prototype is shown in Fig. 22.

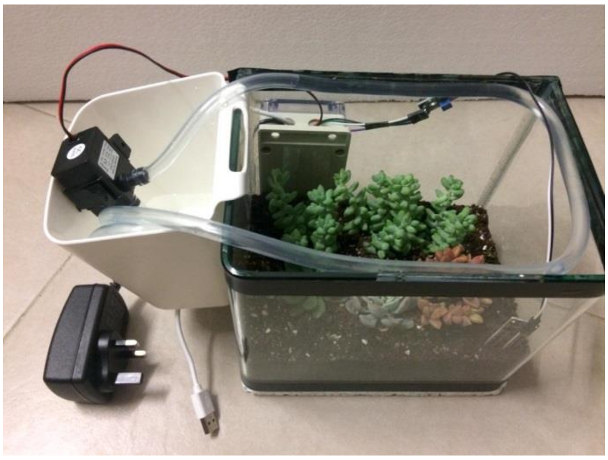

Fig. 22 – Complete Prototype of the Irrigation System

4. Conclusion

This objective of this work achieved successfully. In the system, Node MCU is connected to the water pump in order to enable the user to control the system through Wi-Fi and Blynk, acting as the server system. During the testing, the water pump turns on automatically once it detects a low level of moisture on the soil and turn off when it detects a sufficient level of moisture. From the Blynk, the level of moisture can be monitored and the button for the water pump can be controlled.

However, there is some improvement can be made to the system. Instead of using Node MCU as the controller board, RIG Cell Lite from REKA also recommended as the best option in IoT world because of its capability working on the remote area. With RIG Cell Lite, it allows the user to control the system with a wider range of distance due to the 3G system. While with the Node MCU board controller, the connection is limited to only hotspot area only. Other than that, the prototype can be improved by an increase in capacity onto a larger scale system.

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