Automatic Plant Watering and Monitoring System using NodeMCU

Submitted in partial fulfillment of the requirements
for the degree of

Bachelor of Technology

in

ELECTRONICS AND COMMUNICATION ENGINEERING

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September 23, 2022

Abstract

This paper aims at achieving automation for the purpose of plant monitoring and irrigation system, using Node MCU. Sensors are used for monitoring the environmental conditions surrounding the crop, whose outputs are obtained on an Android based mobile application as well as uploaded on the cloud. The updates of the atmospheric conditions such as temperature, humidity and soil moisture can be fetched from anywhere in the world as the data is shared on the cloud platform (Thingspeak). A record of this data can be maintained which could be used for the future reference, i.e., in the next cropping season, thereby, enhancing the planning and development of crop production.

Chapter 1

INTRODUCTION

India is regarded as the country of orchards and farmers. Around 50% of the population of our country relies on agriculture and related activities in one or the other way to support their livelihood (while 22% solely on agriculture). Agriculture plays an important role by contributing 16% to the country's total GDP. Therefore, agricultural demands should be thoroughly analyzed and managed as their wastage use would affect future needs. Agricultural sector requires a lot of irrigational water. Water supply to the crop fields should be made judicially, as less water leads to crop crash, whereas abundant water supply can even destroy them. Good farming methods can help farmers overcome this problem. Several methods of irrigation have been experimented and adapted to result in minimum wastage of water such as Ditch irrigation, Terraced irrigation, Drip irrigation, Sprinkler System and Rotary System. The most effective among these being drip irrigation, as in this method of irrigation; water is supplied very close to the roots of the plant drop by drop. Loss of water by evaporation and runoff is minimized to a great extent in this method [1].

By using newer technologies such as the Internet of Things and a few sensors to implement drip irrigation, we can develop a system to minimize irrigational wastage of water. This scientific method of controlling water supply can greatly increase the productivity of water, by reducing its wastage. The main objective of this project is to study and develop a worldwide database of atmospheric pattern prevailing in a particular region [2], year after year and to maintain an Automatic system of crop monitoring and watering. This database will prove to be very useful for making future predictions of crop requirements following the beaten track.

The main objective of the proposed paper is to use the INTERNET OF THINGS to achieve the following goals:

- To control the wastage of irrigation water.
- To replace the old time-consuming method of the irrigation system with an efficient automatic system.
- To provide easy access to the parameters affecting the crop fields from anywhere around the globe.

Chapter 2

LITERATURE SURVEY

Since fifty percent of Indian economy depends on agriculture and related activities, many kinds of research and surveys have been done to enhance the technology to make agriculture easy and to increase the productivity of the soil. M. Giri presented a paper in 2013[3], which dealt about drip irrigation system using microcontroller and solenoids, which used valve commutation based on the amount of water content present in the soil. The benefit achieved is the decrease in soil erosion. However, its major drawback was its incapability with real-life constraints. D. Bansal in 2013[4], presented another work on WSN using the microcontroller and GSM module. This technology is used to inform farmers about the environmental and soil condition. However, this technique is not suitable for India, as installing and using GPS in rural areas is difficult due to poor connectivity. Devika CM in 2017[5] used a simple Arduino to introduce automation in watering plants. The drawback of it being that it was restricted in terms of its resource sharing as the information could not be accessed globally. M. Ramu in 2013[6] and S.G Zareen in 2016 [7] presented their work on intelligent irrigation system using microcontroller 8051 and GSM module. Today, we have much better options other than GSM such as cloud computing [8] which will be much beneficial in maintaining a database of the different types of soils present in different regions of India. D. Mishra in 2018 [9] and A. Stesel in 2018[10] used Arduino Uno and Arduino Nano respectively along with the Wi-Fi module to achieve this. However, the complexity of the circuit could be reduced by using a standalone application of Wi-Fi module.

Chapter 3

SYSTEM ARCHITECTURE

The Fig. 1 shown below depicts the system architecture of the proposed project.

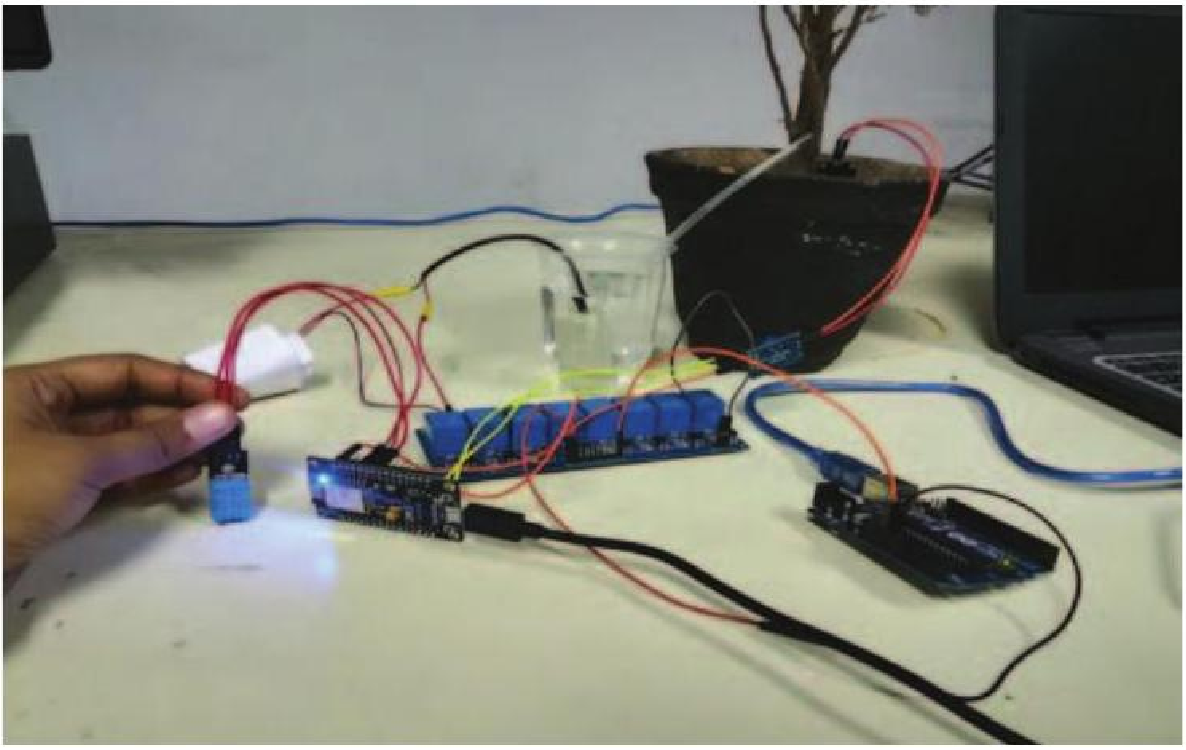


Fig. 1: Prototype of Plant Watering and Monitoring System

Using the system shown above we are able to achieve an automatic control of the dc pump to supply water to the plant. The prototype comprises of the NodeMCU interfaced with relay module. Also, the dht11 and soil moisture sensor have been connected to the NodeMCU which serves as the central unit for the entire system. The mini dc pump receives power supply from a 12 V dc adapter and the relay is given a power supply of 5 V. The technical block diagram of the circuitry has been depicted in Fig. 2.

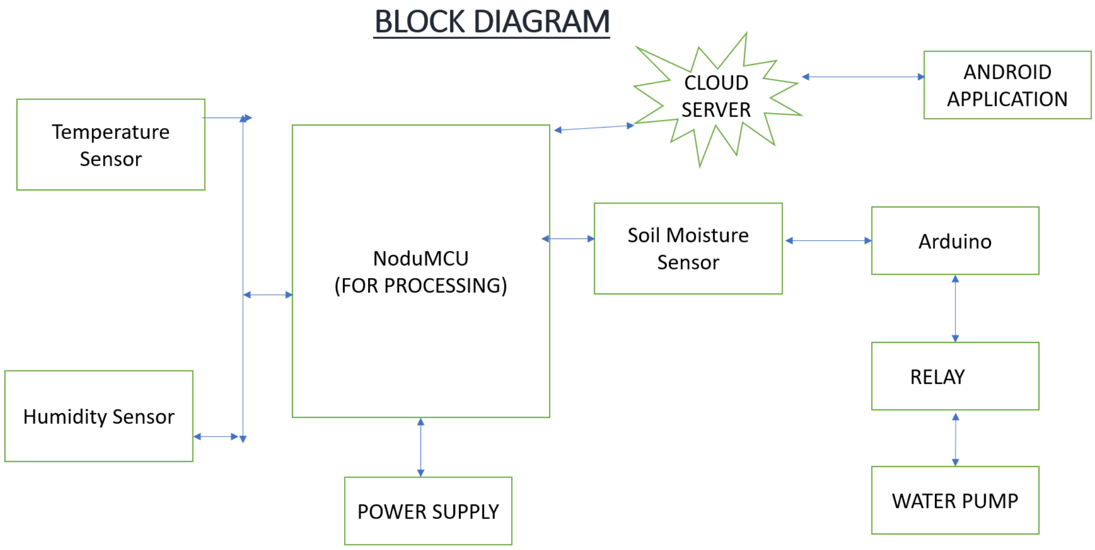


Fig. 2: Technical Block Diagram

3.1 NodeMCU

The Node MCU (Node Micro Controller Unit) is an open source platform for implementing the Internet of Things. Running on System-on-a-Chip (SoC), it is an inexpensive device which is technically named as the ESP8266-12E and helps to prototype IoT project using script lines in Lua. Espressif Systems designs and manufactures NodeMCU. Crucial elements of a computer such as CPU, networking (Wi-Fi), RAM, operating system and SDK are all contained in NodeMCU, thereby making it an extremely useful for all kinds of IoT projects [11]. Summing it all up, we can say that, NodeMCU is much like an Arduino, except that it provides Wi-Fi functionality which is in-built on the board. NodeMCU can be coded in Lua script and C language on the Arduino IDE software. It contains 10 General Purpose Input/output pins for interfacing with devices. A typical NodeMCU along with its pin numbering is shown in Fig. 3.

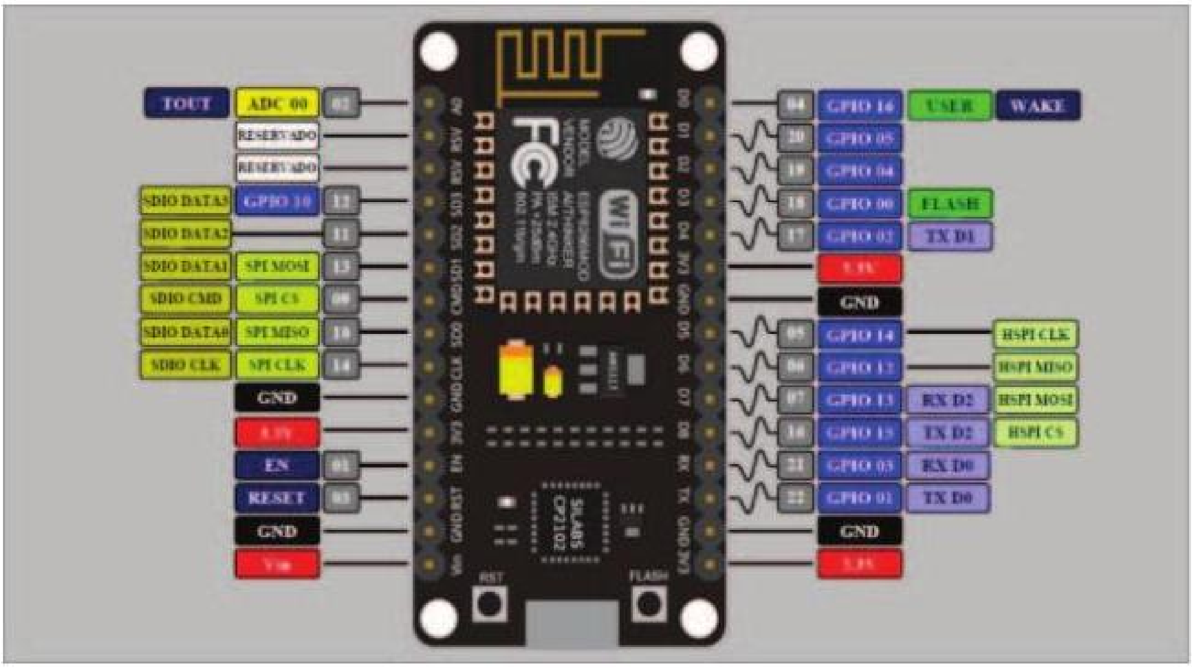


Fig. 3: Node MCU

3.2 Relay

The relay is an electrically controlled device which performs the actions of a switch. Relays can be broadly classified into two types namely electromechanical relays (EMR) and solid state relays (SSR) here we have used the former one. Contacts in EMR are opened and closed with the help of magnetic force whereas in SSR switching is completely electronic and no contacts are present. The principle behind its working is that of an Electromagnet operating as a switch mechanically. Generally, we use relays where it is important to control another circuit using a different low power signal or where multiple circuits are to be controlled using one signal [12]. Here we are using a single pole double throw relay. Because of its internal configuration, SPDT has quite many applications, it has two different configuration terminals and a common terminal: one of which is normally closed while the other being normally open. Therefore SPDT is capable of performing the action of switching between two circuits i.e. when no voltage is being applied to the coil, current is received by one of the circuits whereas the other doesn't and vice versa when the coil is energized. In general, control circuit handling smaller currents are switched by relays. In addition, with the help of amplification even larger voltage and amperes can be controlled by it.

3.3 DHT 11

The dht11 sensor, a combination of temperature and humidity sensor generally gives digital or analog output. This technology is quite dependable and gives accurate results for a longer period of time [13]. This sensor comes under the set of those measurement devices which have a negative temperature coefficient. It is connected to the NodeMCU, which obtain the output from the sensor and displays that on the output screen. The electrical resistance in between the two electrodes is used to detect the water vapor. The electrode along with the substrate which is responsible for holding moisture when in contact with the surface acts as the humidity sensing component. The substrate releases ion which results in a rise in conductivity between the electrodes as soon as water vapor is absorbed by it. The result calibrated by the dht11 sensor is quite accurate. The relation between the electrical resistance rise or drop and Relative humidity is inversely proportional thus we can say that as the electrical resistance increases the relative humidity decreases and vice versa. The DHT11 sensor has a lot of applications owing to its small size and lower power, also it has a wide range for the transmission of the signal which is up to 20 m. The product which we have used is a 4 pin single row pin package thereby making it appropriate for the breadboard connections. The dht11 sensor is available in two alternatives, either the sensor or the module [14]. Fig. 4 shows DHT 11 sensor.
Specifications:

- Temperature range: 0 to 50°C error of ±2°C
- Humidity: 20-90% RH ±5%RH
- Interface: digital

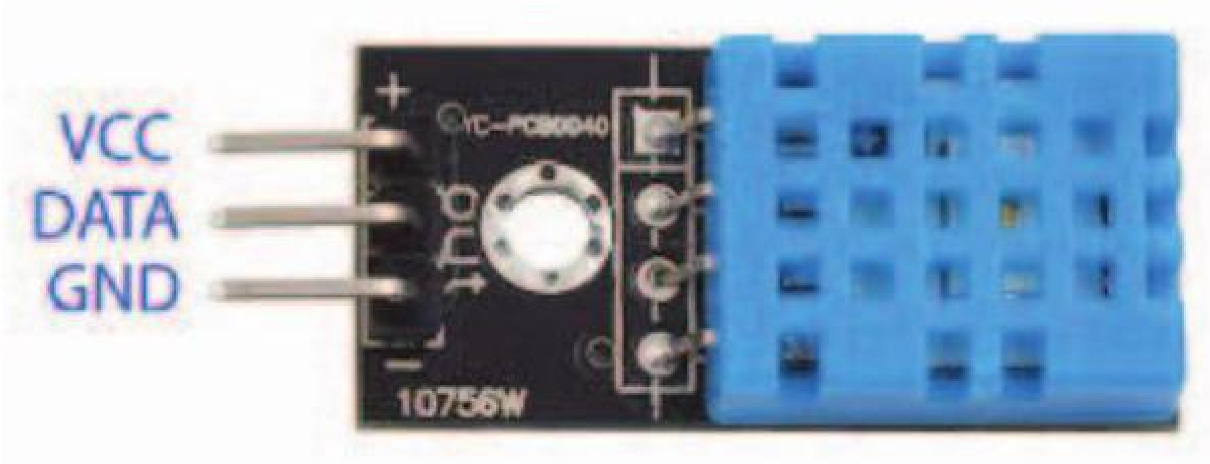


Fig. 4: DHT 11 sensor

3.4 Soil Moisture Sensor

The soil moisture sensor is used to calibrate the water or moisture content of the soil. Depending upon when the soil has more water content or less water content, the output of the module is at a low level and high level respectively. The parameter used by the moisture sensor to measure the dielectric permittivity of the surrounding is capacitance. The voltage generated is in proportion with the dielectric permittivity which is further indirectly related to the soil moisture content. In the case of soil, the dielectric permittivity is closely related to the content of moisture present in it. It then measures the average content of water over the complete body of the sensor. The sensitivity at extreme edges is negligible although we see an influence region of about 2 cm on the flat surface. It is generally used in greenhouses to control water supply and other enhanced bottle Biology experiments to monitor the content of water in the soil. Hence, it has been widely used in agriculture, land irrigation to calibrate the necessary content of soil moisture for a variety of plant families, botanical Gardening and also to measure the loss of water due to plant uptake/evaporation duration [15]. The relationship existing between the measured parameter and moisture of the soil must be estimated by using the topp equation and may differ owing to the environmental factors which are the type of soil, temperature or electric conductivity. Here, the difference between the set value (adequate moisture value) and the measured value of the soil moisture is the main parameter which allows the water supply system to be switched on and off. Fig. 5 shows a typical soil moisture sensor and the specifications of the same has been mentioned below.

Specifications:

- Working voltage: 5 V
- Working current: < 20 mA
- Interface: Analog
- Working Temperature: 10°C ~ 30°C

Fig. 5: Soil moisture sensor

3.5 Mini-DC Pump

A pump is basically a device which uses mechanical action to transfer fluid (liquids). The mechanism used in a pump is mainly reciprocating or rotary and in order to do this mechanical work, they also consume some energy. Pumps are available in varying sizes ranging from smaller pumps used for medical purposes to larger ones used in industries [16]. Fig. 6 depicts the Mini-DC Pump which has been used. Here we have used a mini dc pump which runs on 12 volt dc supply. Pumps can be operated manually or using electricity. Some are also operated using engines and power generated from the wind.

Fig. 6: Mini-DC pump

3.6 SOFTWARES USED

3.6.1 Arduino IDE Software

Arduino is basically a combination of hardware and software which works as an Open source (easily accessible by people over the internet). The Hardware part comprises a circuit board embedded with a microcontroller which is Programmable whereas the software is an IDE where we can write and upload code [17]. The languages supported by it are C and C + + using special rules of coding structure. As the Arduino IDE is compatible with a number of different circuit boards, here we have integrated the IDE with NodeMCU board.

3.6.2 BLYNK Application

Blynk is basically a platform compatible with iOS and a number of Android Apps to control Arduino, Raspberry Pi and other such devices across the World Wide Web [18]. It is a mobile application where we can graphically interface our projects by easily selecting different widgets. The main advantage of Blynk is that it is not hardware dependent and can be linked using internet over Wi-Fi or Ethernet. Here we have used gauge or meter as a widget to display the parameters such as temperature, moisture, and humidity. However, the display can also be in the form of graph or in digital format.

Flow Chart

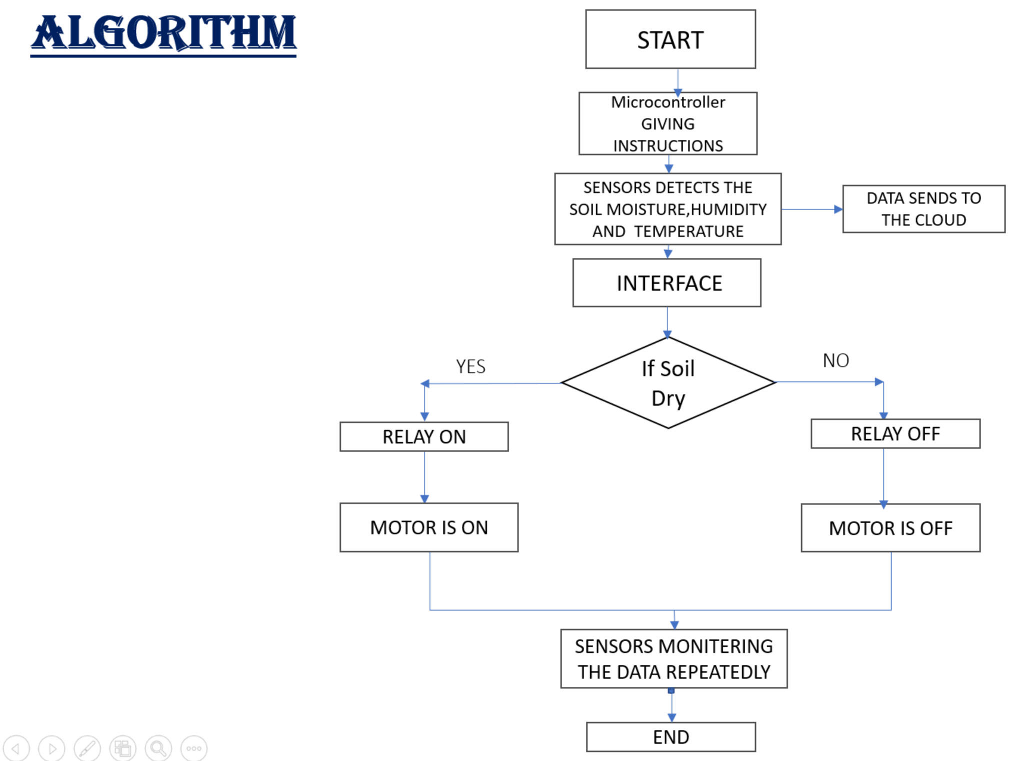


Fig. 7: Flow Chart of the process

Chapter 4

EXPERIMENTAL RESULTS

Experimental Results have been obtained after the successful implementation of the circuitry. Fig. 8 shows the output sensed by the sensors on the Blynk application installed on the Smartphone of the user. It monitors the humidity and temperature of the surroundings and moisture content of the soil. The screenshots of the Blynk app as well as of the graph obtained on Thingspeak have been shown in order to validate the results obtained.

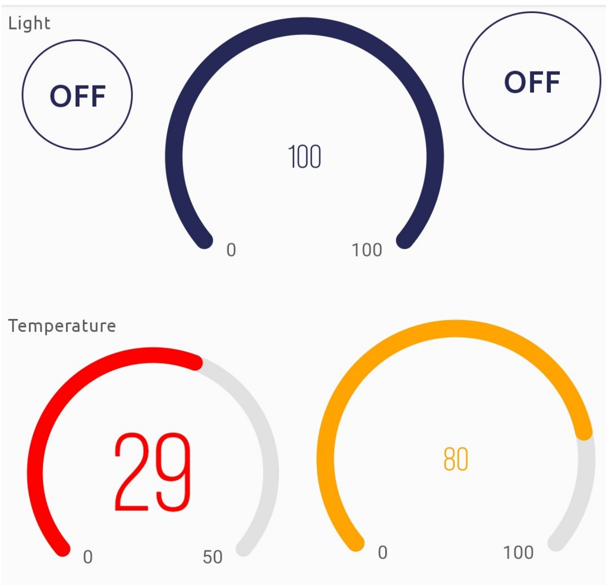
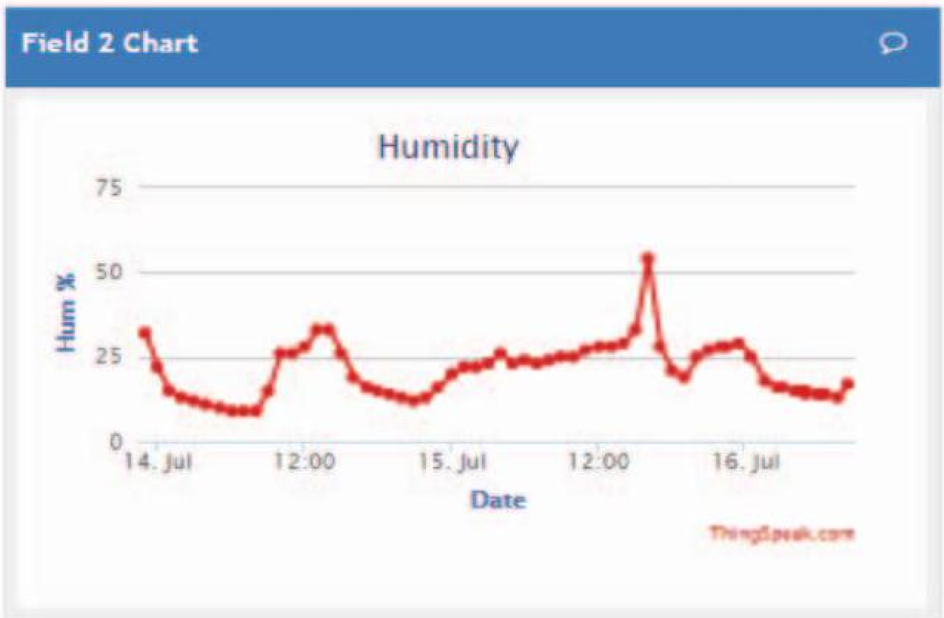


Fig. 8: Experimental Result

Fig. 8: Output on BLYNK application in gauge format Fig. 9 shows the output displayed on the cloud platform. It monitors the humidity and temperature of the sur-

roundings and moisture content of the soil. The different parameters recorded and uploaded on the cloud can be used to create a database which will provide a complete detail about the favorable conditions required for a crop in a particular region.

(a)



(b)

Output obtained (a) Temperature Output (b) Humidity Output

Chapter 5

CONCLUSION

Thus, the purpose of "Automatic Plant Watering and Monitoring System" is rightly served by providing ease to farmers. It will also be very helpful in saving wastage of water as it uses automatic drip irrigation method. Therefore, rigorous labor required for watering the fields can be reduced to a great extent giving some relief to the farmers. Also, the database stored on the cloud can anytime be used to predict future water requirements. This will prove to be of a great help for farmers as they would be well equipped with the information.

We have tested the system and carefully and closely observed the results achieved thereafter. All the hardware components have been integrated to develop the system. The working of each and every module has been reasoned out with utter carefulness and they have been placed in such a way that they contribute towards getting the best results from the system.

As shown in Fig. 10, the data stored over the years on the cloud can also be used for future reference to provide an approximate database for monitoring water consumption at different stages of the crop in a particular cropping season.

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