An Agricultural Robotic Device to Monitor Soil Moisture, Temperature, Humidity and Illumination Using IOT Cloud Visualization

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Abstract: ***Agriculture is major source of food production to the growing demand of human population. In agriculture, irrigation is an essential process that influences crop production. Robots are smart machines that can be programmed and used in many areas such as manufacturing, industry, production lines, agriculture or health, etc. These robots performs hard, dangerous, and accurate work to facilitate our life and to increase the productivity and comfort because they can work 24 hours without rest, and perform some tasks even better than a human, more precisely and in less amount of time. Robots have replaced humans in performing various tasks that human are unable to perform due to physical limitations and disability, extreme environments or size limitation. Smartphone, a small yet powerful device is rapidly changing its traditional ways of human-machine interaction. Smartphones are a more efficient and affordable hand-held devices which can be used to support collaborative activities in a community. It is a result of a huge and remarkable advancement in the field of mobile phones technology. Among all available mobile operating systems Android OS has gained significant popularity.***

Keywords – Microcontroller, Arduino, Things Speak Cloud, Real Time Monitoring Soil Moisture, Temperature, Humidity and Illumination using Sensors and Smart Phone.

I. INTRODUCTION

The discovery of agriculture was the first big step toward a civilized life. “Is a famous quote by Arthur Keith. This emphasizes that the agriculture plays a vital role in the economy of every nation. Since the dawn of history agriculture has been one of the significant earnings of producing food for human utilization. Today more and more lands are being developed for the production of a large variety of crops. India is a country of agriculture and it is backbone of Indian economy. Irrigation is the most important cultural practice and most labor intensive task in daily agriculture sector. Knowing when and how much to water, are two important aspects of irrigation. Automation in irrigation system makes farmers work much easier. In the recent years, environmental issues are prominently increasing with rapid economic and social development. One such issue in agriculture is pesticide spraying. Pesticides are used for preventing, destroying or mitigating any pest. Chemical pesticide spraying is the most powerful process in agricultural fields and greenhouse to protect the plants from the pests. In conventional pesticide dispensing method many human health hazards are involved in spraying potentially toxic chemicals by humans in the agricultural fields and greenhouses. To overcome the drawbacks of existing system, we have developed an efficient system for dispensing pesticides in agricultural fields and greenhouses with advanced features.

Robots are programmable physical machines that have sensors and actuators and are given goals for what they should achieve in the world. Perception algorithms process the sensor inputs, a control program decides how the robot should behave given its goals and current circumstances, and commands are sent to the motors to make the robot act in the world. Some robots are mobile, but others are rooted to a fixed location. A Robot is a microcontroller-based mechatronics system which is reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks & gathers information about its environment (senses) and uses that information (thinks) to follow instructions to do work (acts). Almost all robots are comprised of a movable body, wheels operated by motors, and parts which can be moved made of plastic or metal. The sections are coupled together with joints. The advent of new high-speed technology and the growing computer capacity provided realistic opportunity for new robot controls and realization of new methods of control theory.

This project focused on developing the robotics application with the use of sensorics, wireless control using embedded technology. The robotic control system presented here can be used for agricultural activities and many other sophisticated robot applications including military applications. The robots used in agriculture can reduce manpower and can be operated using remote controls from a distant place. An agricultural **Robot** or an **Agribot,** is a robot deployed for agricultural purposes. The agricultural industry is behind other complementary industries in using robots because the sort of jobs involved in agriculture are not straightforward, and many repetitive tasks are not exactly the same every time. Robots can be used for other horticultural tasks such as pruning, weeding, spraying and monitoring. The farmer can do the spraying operation by himself without engaging labors, thus increasing spraying efficiency.

II. OBJECTIVES

There are mainly four objectives which describes the complete working of this project.

- To develop a cost effective and automated model to monitor and regulate the moisture level of a soil sample mainly aimed to cater to the needs of technologically ignorant rural farmers.

- To identify the impacts of fertilizers and soil nutrients in agriculture.
- To test the feasibility of indigenous sensors (resistance blocks) instead of using commercially available ones.
- Improving the effectiveness of soil protection measures, Temperature, Humidity, Illumination; and Raising public awareness on soil degradation.

III. PURPOSE

The Proposed system helps formers in many ways. The purpose of this proposed project is to design and implement a multipurpose wirelessly controlled mobile agricultural robot which can perform multiple agriculture related activities on the field, like sprinkling of water or pesticide or fertilizer, weed cutting along with monitoring of environmental parameters like temperature, humidity, raining and illumination level of sunshine. It can be used for spraying any liquid, may it be water for soil irrigation or fertilizer for plant's growth or even pesticides for pest control.

Advantages of Proposed System

The projected system can aim to modify all the activities and eliminates all the drawbacks that the present system of manual operations faces. The necessary options of practicality of the projected system are listed below:

1. Reduces the man power and saves time.
2. Allows for the remote monitoring of weather conditions.
3. Increases agriculture productivity.
4. Speeds up agriculture activities.
5. Environmental friendly system.
6. Wireless connectivity.

IV. SCOPE

The scope of the system is to develop an multipurpose wirelessly controlled mobile agricultural robot. This agricultural robot is designed using a wide range of technologies for the advancement of agricultural automation. This can also makes the agriculture as a zero loss business.

V. LITERATURE SURVEY

In [1], especially vegetables and flowers are cultivated by noting the moisture and temperature suitable to them. This robotic sprinkler makes use of similar concept. The main discoveries in the types of irrigation systems, being. Drip Irrigation, Sprinkler Irrigation, Surface Irrigation so, our project aims to work on the traditional methods of irrigation through modern electronics.

In [2] the authors, Proposed spray or shower Irrigation is vastly improved in water-saving and yield- expanding than other irrigation techniques. the traditional go-stop go driving technique make it difficult to control and get bed irrigation efforts, thus new control way with high effectiveness and low consuming is needed. Because of the difficulty of real examination, virtual reality is used to simulate the controlling and driving system in this thesis.

The key objective [3] was to report on a developed indigenous low cost time based microcontroller based irrigation scheduler who performs user defined functions and outputs commands to derive appropriate actuators (relay, solenoid valves, motor).

In A Remote Measurement and Control System for Greenhouse Based on GSM-SMS [4] the proposed system introduced a GSM-SMS remote measurement and control system for greenhouse based on PC-based database system connected with base station. Base station is developed by using a microcontroller, GSM module, sensors and actuators. In practical operation, the central station receives and sends messages through GSM module. Criterion value of parameters to be measured in every base station is set by central station, and then in base stations parameters including the air temperature, the air humidity.

In [5], R. Suresh et al. (2014) specified about utilizing programmed microcontroller based rain firearm water system framework in which the water system will occur just when there will be extraordinary prerequisite of water that spare a vast amount of water. These frameworks convey a change to administration of field asset where they built up a product stack called Android is utilized for gadgets that incorporate a working framework, middleware and key applications.

VI. SYSTEM ARCHITECTURE

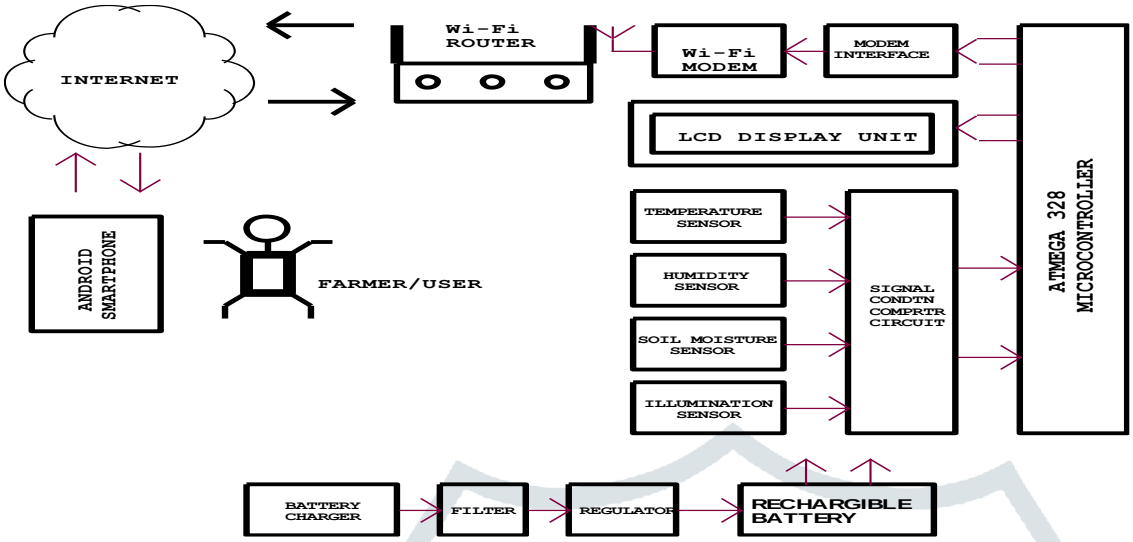

Fig. 1. Design and Development of an IOT based Agriculture Field parameter monitoring using cloud storage and data visualization

VI.I MODULE DESCRIPTION

The block diagram is shown in the figure. It consists of the fallowing modules.

- **ATmega328 Microcontroller:** The microcontroller is the most important unit of this system. A microcontroller is a single chip computer that contains the processor (the CPU), non-volatile memory for the program (Rom or Flash), volatile memory for data input and output (ram), a clock and an i/o control unit, also called a "computer on a chip," billions of microcontroller units (MCUs) are embedded each year in a myriad of products from toys to appliances to automobiles. The ATmega328 is a single chip microcontroller created by Atmel and belongs to the mega AVR series. This Atmel's 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities. The Atmega 328 microcontroller is interfaced with ESP8266 Wi-Fi module on serial port, potential (voltage) transformer, current transformer, temperature sensor and oil level sensor on analog input channels, LCD display, Buzzer drive circuit, Relays & Relay driver circuit on digital I/O port pins, in this project. The program is developed in Arduino IDE and generated hex file can be downloaded to the internal flash program memory of the Atmega 328 microcontroller by using USB port through Arduino IDE's built-in flash programmer tool.

Fig. 2. ATmega328 Microcontroller

- **ESP8266 Wi-Fi Module:** In this system, the ESP 8266 Wi-Fi module is used for connecting this system to the Wi-Fi network for the remote monitoring of data of transformer. It is interfaced with microcontroller for receiving the logic data. ESP8266 is a Wi-Fi networking solution that enables connection of the microcontroller to the Wi-Fi (Figure 3.). Also, it is capable of running separate applications independently. ESP8266 Module has the following specification characteristics: 3.3 power supply, RAM 32K + 80K, processor speed 80-160MHz and 802.11 b/g/n/d/e/i/k/r supports. At full power, the transmitting current consumption can be 170mA but in sleep mode it requires 10uA (Kolban, 2015). The battery power supply for this module may have a solar panel for recharging the battery. Here, we are using the ESP 8266 Wi-Fi module to connect to Wi-Fi network and to send parameter values to Thing speak cloud service for storage & visualization.

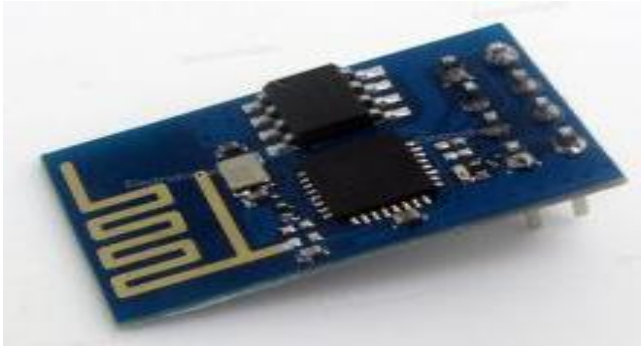

Fig. 3. ESP8266 Wi-Fi Module

- **Temperature Sensor:** The temperature sensor converts the surrounding temperature into an analog electrical signal. The temperature sensor chosen for this project is LM35. It is an industry standard semiconductor transducer, suitable for the temperature range of -50℃ to +150℃. It is a direct voltage o/p device. It produces 10mV/□C of surrounding temperature. The signal from the sensor is fed to signal condition for signal conditioning and standardization. It provides the required gain to the temperature signal. It also facilitates for the calibration of the sensor output signal. This analog signal is then fed to an ADC channel of internal ADC section of the Atmega 328 microcontroller, for converting it into a binary (digital) number for further processing.

Fig. 4. Temperature Sensor

- **Humidity Sensor**: Humidity is the amount of presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries and very vital in agriculture. The sensor element in the HS-100 that responds to changes in relative humidity is a capacitor. Here, the capacitor consists of two conductive electrodes that are separated by a thin film of polymer. The surface of the capacitor used in this type of sensor is also coated to protect it from contamination and condensation. The output of the sensor in the HS-100 is directly proportional to the relative humidity of the atmosphere. The HS-100 has a linear output of 26 milli volts per 1% of relative humidity (RH) from 10 to 95% RH. This analog signal is fed to another ADC channel of the Atmega 328 microcontroller.

Fig. 5. Humidity Sensor

- **Soil Moisture Sensor:** Soil moisture level of the soil is calculated repeatedly to check whether farm requires water or not. The soil moisture is measured using resistive immersion type soil moisture sensor. This sensor produces an analog signal corresponding to wetness of the soil in the nearby area where the sensor is immersed in soil. This signal is amplified in signal conditioning circuit and then fed to another analog input pin of Atmega 328 microcontroller for conversion into digital value.

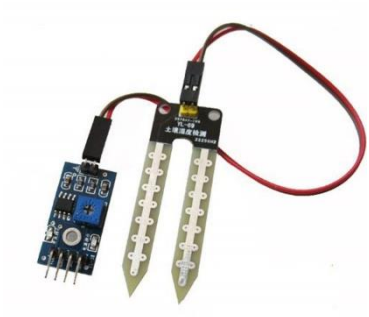

Fig. 6. The Soil Moisture Sensor

- **Illumination Sensor:** The illumination can be sensed by electro optical sensors, either photoconductive cells (light dependent resistor LDR) or by photovoltaic cells. An electro optical sensor is an electronic component that responds in some way or another to either light or the electromagnetic waves in the infrared ultraviolet and x-ray bands close to the visible light band. Photosensitive elements are versatile tools for detecting (radiant energy) light. "Photo conductive cells" also known as 'Photo Resistors' or "Light Dependent Resistors" are one among the photosensitive devices that is mostly used in engineering applications. Here a LDR is used for sensing illumination. The LDR is connected in series with a resistor to form a voltage divider's biasing voltage is applied across this network. The voltage across the resistor depends on the illumination level incident on the LDR. This voltage is fed to one more ADC input channel of the microcontroller.

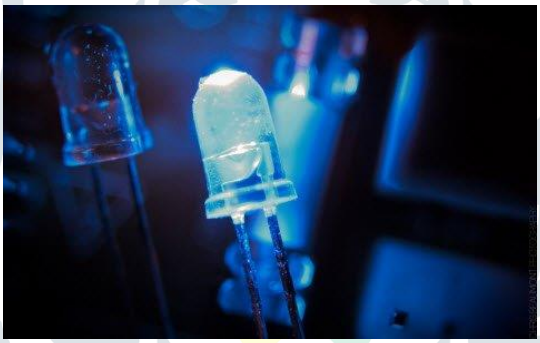

Fig. 7. Illumination Sensor

- **LCD Display Unit:** The system has a LCD display module for displaying various prompts and status information of the system. A 2-line, 16 character type LCD display module is used. The microcontroller sends the signals to LCD module through its port pins. The LCD can be interfaced on 6 pins of any port since 4-bit interface mode is used here. Initially in program, it is configured to work on 4-bit mode, hence requires only 4-bits for data/commands transfer and two handshake signals enable (En) and register select (RS). The write (WR) pin is connected to ground since no read operation from the LCD needs to be done. The microcontroller communicates with the LCD module through ASCII codes.

Fig. 8. LCD Display Unit

- **Power Supply Unit:** The system has a LCD display module for displaying various prompts and status information of the system. A 2-line, 16 character type LCD display module is used. The microcontroller sends the signals to LCD module through its port pins. The LCD can be interfaced on 6 pins of any port since 4-bit interface mode is used here. Initially in program, it is configured to work on 4-bit mode, hence requires only 4-bits for data/commands transfer and two handshake signals enable (En) and register select (RS). The write (WR) pin is connected to ground since no read operation from the LCD needs to be done. The microcontroller communicates with the LCD module through ASCII codes.

VII. EXPERIMENTAL RESULTS

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Fig. 9. Testing the Moisture of the Soil

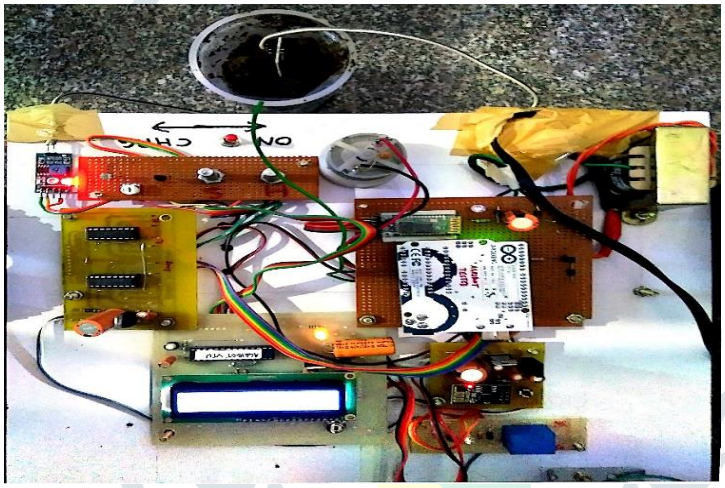

Fig. 10. Testing Soil Moisture, Temperature, Humidity and Illumination System with the Arduino Board

Fig. 11. Results of Soil Moisture, Temperature, Humidity and Illumination on LCD Display

VIII. RESULTS AND DISCUSSION

Soil moisture sensor is connected to an Arduino which is in turn interfaced with android application using Wi-Fi shield. Soil moisture is continuously being monitored by the sensor and the output values are stored in database. The output values are fetched from database. After fetching the moisture readings from database we are going to display the moisture readings which includes timestamp and moisture content it with the look-up table. If it is in the range 0-100 then sensor is in air, if moisture content is in the range from 100-300 dry, if moisture content ranges from 300-700 humid or optimal, if it ranges from 700-1000, it is excess. From the below figures of graphs we can see that the results obtained from 5 sample inputs of Soil Moisture, Temperatures, Humidity and Illumination.

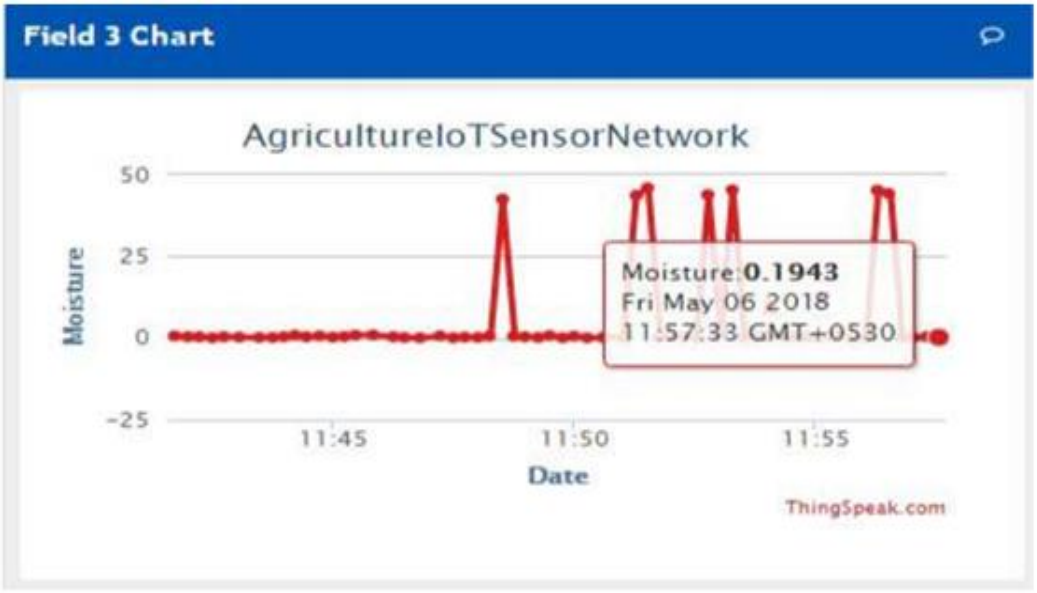

Fig. 12. Soil Moisture Results

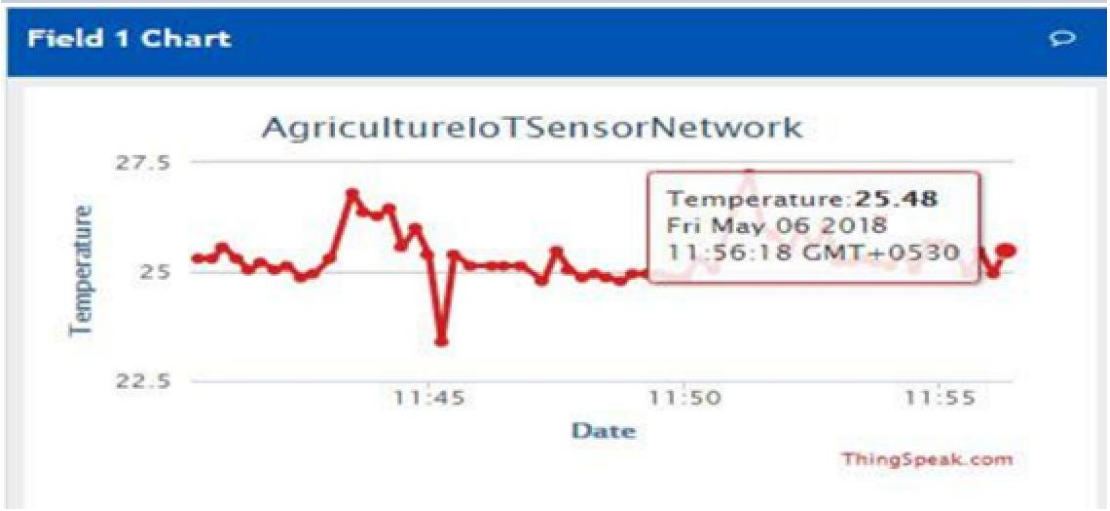

Fig. 13. Temperature Results

Fig. 14. Illumination Results

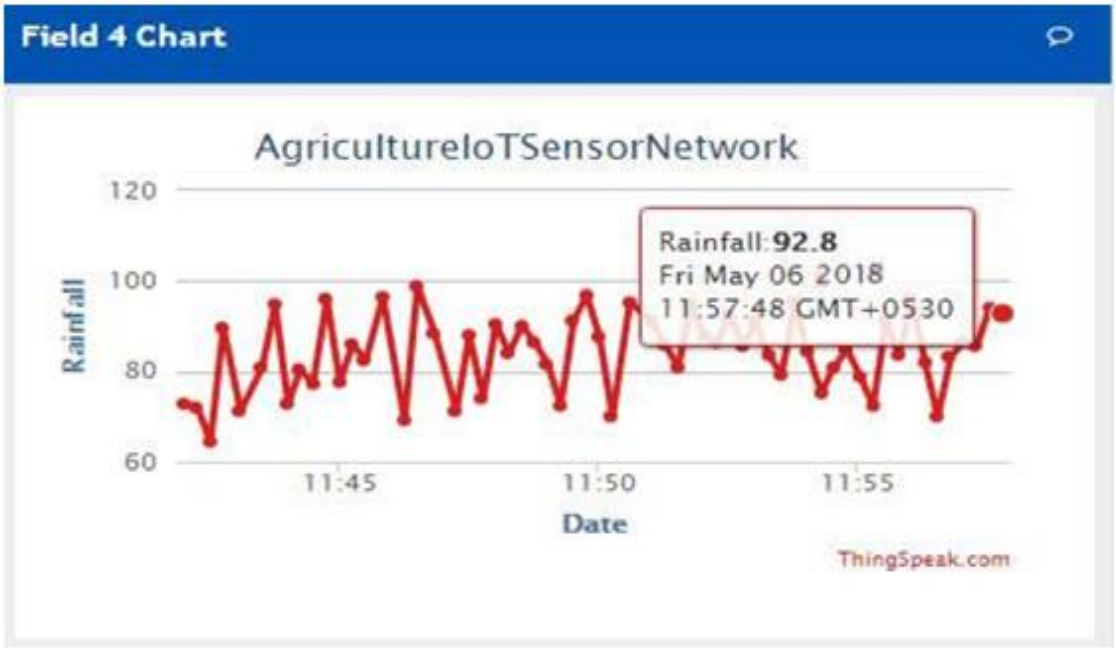

Fig. 15. Humidity Results

IX CONCLUSION

We have designed an Agricultural Robotic device which is IOT based that contains the different sensors to monitor the Temperature, Soil Moisture, Humidity and Illumination level of the soil. This device is very helpful for the farmers because there is no loss of money. He can yield the crops based on the parameter monitored results and helps the increase in agricultural production.

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