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INTERNET OF THINGS (IoT) APPLICATION FOR DETERMINATION OF SOIL MOISTURE CONTENT TO OPTIMIZE CROP PRODUCTION

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Abstract - *This paper proposes a technique for extensively aiding the agriculture industry by designing a system for detecting the low soil moisture levels in plants. Using this system, the farmer will be duly notified about the water levels of his/her plant while sitting in any part of the world. This will indeed prevent crop failures due to insufficient water supplies to plants and thus will act as a boon for our nation. This system is indeed one of the most feasible projects in terms of cost effectiveness and efficiency. The system detects the water levels with an accuracy of almost 99 percent. Moreover each and every component used in this system is extremely portable, sturdy, readily available and within budget, especially when implemented on a larger scale. Similar work to try and reduce crop failures due to insufficiencies has been reported in where the paper aims at giving Automation solutions for detection and characterization of Nitrogen (N) deficiencies in corn fields and also where the problem of monitoring soil moisture evolution using a wireless network is considered. The main contribution of this paper is to propose a technique to detect the low moisture levels in plants and automatically water them using the motor attached to the system*

Key Words: *Internet of things, soil moisture, Agriculture, Microcontroller, CloudMQTT platform*

1. INTRODUCTION

The Agriculture industry is one of the major industries of any nation. It plays a vital role in the economy as well. Farmers face a wide range of problems some of which include extensive crop failures due to rough weather conditions or sheer negligence as well. Many a times it is hard to tell which plant is not sufficiently being watered and this is one of the leading causes of crop failures.

Although some works related to soil moisture level sensing have been proposed before, this paper aims at particularly creating a system which would not only detect low soil moisture levels in plants but would also automatically water them when the moisture levels are below a threshhold level. The Internet of Things (IoT) is playing vital role in present world specially, the Internet of Things (IoT) is transforming the agriculture industry and enabling farmers to contend with the enormous challenges they face.

New innovative IoT applications are addressing these issues and increasing the quality, quantity, sustainability and cost effectiveness of agricultural production. Now large and local farms can be remotely monitored with monitor sensors that can detect soil moisture, crop growth and livestock feed levels, remotely manage and control their smart connected harvesters and irrigation equipment, and utilize artificial intelligence based analytics to quickly analyze operational data combined with 3rd party information, such as weather services, to provide new insights and improve decision making using Internet of Thing(IoT) .

The ESP-8266 WiFi enabled module with NodeMCU firmware installed on it is used in this system along with a motor attached to the ESP8266 chip to water the plants accordingly. The coding script used is .lua. The basic concept used is that of IoT i.e. The Internet of Things.

This paper elaborates about the components used in the making of this system, explains the step-by-step procedure of how the system was set up and provides the experimental observations and results with conclusions.

2. COMPONENTS USED

This system involves 3 main categories of modules to be used namely:

2.1 Microcontroller- ESP8266 Development board comprising of ESP8266 WiFi enabled chip

The ESP8266 chip was produced by Chinese Manufacturer-Espressif. It is a very low cost WiFi chip with full TCP/IP stack and microcontroller capabilities. (3) The chip can easily be integrated with sensors (through its GPIO pins) due to its powerful processing speed and storage.(4) This chip has minimal external components and is also very small in size which makes it ideal for our system in terms of portability and cost effectiveness.

2.2 Cloud- CloudMQTT platform

MQTT refers to Message Queuing Telemetry Transport. CloudMQTT is one such platform which provides machine-to-machine messaging. It is manages by message servers in the cloud(5). In our system we have used the CloudMQTT platform for communicating the soil moisture level readings of plants from the system to various devices that the user (in this case farmer) uses. These devices could be smartphones,

computers or any other low cost devices having atleast the capability to connect to the internet.

2.3 ESPlorer IDE

ESPlorer is an Integrated Development Environment (IDE) that is essential for any developer making use of the ESP8266 chip. This IDE helps us to succesfully transfer our .lua script code onto the chip.

2.4. NodeMCU firmware

This firmware is an open source IoT platform. It includes firmware that runs on the ESP8266 WiFi chip. This firmware makes use of the lua scripting language. In our system, the code will be sent to the ESP8266 chip only when this firmware is successfully flashed onto the ESP8266 chip.

2.5. A relay motor

This motor will be used to provide water to the plants whenever the moisture levels reach below the threshold.

2.6. Device- PC/Smartphone/Tablet etc

The device could be any, provided it can make use of the internet. This device will be accessed by the user/farmer to get a notification of the plant moisture levels.
Figure 1 shows the Block diagram of Smart Farm Monitoring System.

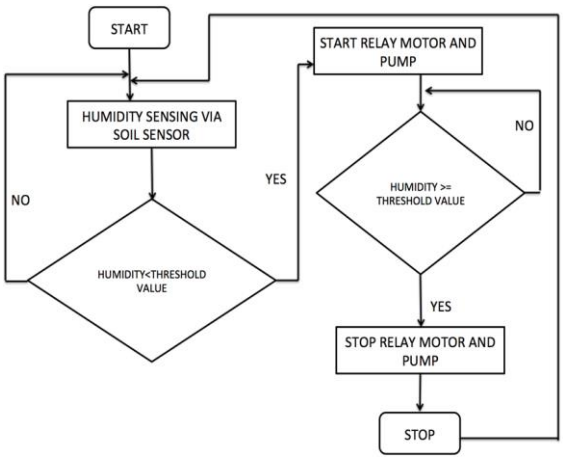

Fig-1: Block diagram of Smart Farm Monitoring System

3. METHODOLOGY PROPOSED

The steps that will be used in succefully making all circuit connections and transferring the code onto the system are briefly explained as follows:

1. The connection are extremely simple and are made as shown in the circuit below
2. The NodeMCU firmware has to be installed onto the chip while plugging in the GPIO pin to the negative voltage.
3. GPIO pin is removed from the negative voltage and the program code written in lua script is sent onto the ESP8266 chip via the ESPlorer IDE.
4. One GPIO pin is connected to the soil sensor. The other GPIO pin shall be connected to the motor, which will be used to provide water to the plants from a small reservoir.
5. Set up the cloud MQTT server (www.cloudmqtt.com) and create an instance, which will send our moisture level data onto the cloud. This can be received on the user's devices and hence they shall be aware of the moisture levels in their plants sitting in any part of the world.
6. On reaching a level below the threshold the motor would automatically be switched on and the plants would get watered. On reaching the threshold moisture level the motor would be turned off.

Circuit connections are shown in Figure 2.

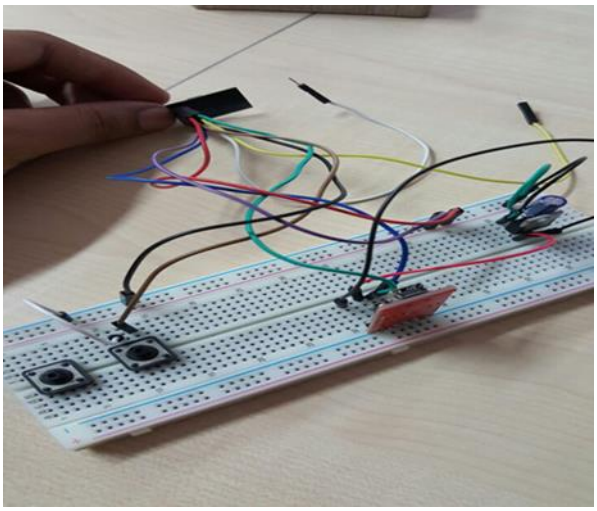

Fig-2: show the circuit connections

4. OBSERVATIONS AND RESULTS

The soil sensor measures the values based on the resistance of the soil. The soil moisture level values vary between 0 and 1024, 0 being extremely moist (in ideal conditions) and 1024 being extremely dry (ideal condition). These numbers are digitized voltages where 0=0V and 1024=5V. The soil sensor system was placed in a large number of plants having dry, moderately moist, and extremely moist soils. The ranges of values of the soil sensor are shown in Figure 3. Tabe 1 shows the ranges of soil moisture sensor during the experiment.

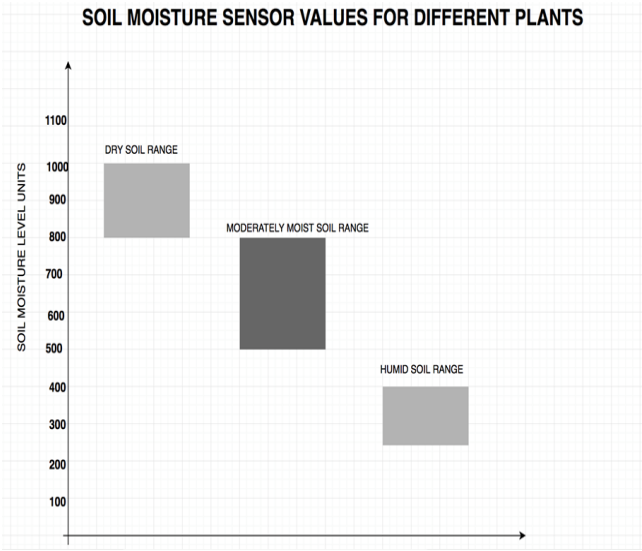

Fig-3: Ranges of values of the soil sensor are shown

Table -1: Ranges of soil moisture sensor during the experiment

TYPE OF SOIL	READING RANGE BY SOIL MOISTURE SENSOR
Dry soil sample	948-952
Moderately moist soil sample	607- 610
Very humid soil sample	258-261

The soils sensor is approximately 95 percent accurate. Even the slightest changes in the water level were easily reflected in the readings of the sensor.

The threshold value for the motor to be switched on can be set depending on the needs of the respective plant. For plants having high water needs the threshold value should be 350-400 units and for plants not requiring too much water the threshold value could be increased to 450-500 digitized units.

5. CONCLUSIONS

This paper successfully gives a technique for helping the farmers by creating a system for detecting low soil moisture levels in plants and automatically watering them. This system makes use of the concept of Internet Of Things (IoT) and the MQTT protocol. The accuracy of the proposed system is almost 95 percent and can be a huge boon for the agriculture industry when implemented on a large scale.

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BIOGRAPHIES

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