International Journal on Cybernetics & Informatics (IJCI) Vol. 10, No.3, June 2021

IOT BASED MONITORING OF FARM USING NODE MCU

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ABSTRACT

Modern agriculture is the outcome of remarkable advancements in digital aids and data. Modern technologies are integrated in agriculture to come forth with new practices in traditional farming methods for the enrichment of healthy agriculture and production. A domain that offers mechanisms and techniques to interconnect a broad spectrum of digital devices to automate the real-life systems is Internet of Things (IoT). This paper proposes an IoT based approach for monitoring the farm using NodeMCU microcontroller. The various agricultural parameters such as temperature, humidity and soil moisture are obtained using sensors. Based on the sensor values, a smart irrigation system is presented that minimizes the usage of water. The sensor values are sent to cloud, thus providing an easy access of information to the farmer for further analysis. The proposed system helps the farmers to treat their farm in a better way to produce quality yield.

KEYWORDS

Smart farming, Internet of Things (IoT), DHT11 Temperature, Humidity Sensor, Soil Moisture Sensor

1. INTRODUCTION

The difficulty faced by the farmers across the world in growing crops is now reducing because of the emerging technologies in agriculture. The major problems are unpredictable weather conditions and shortage of water. The quality of crops in traditional irrigation system depends on the amount of water supplied to the corps. These problems are solved by promoting the use of modern information technology in agriculture. This development in technology acts as a catalyst for the researchers and farmers to apply modern techniques in farming. This also provides opportunity for creating new technology and service development in IOT (internet of things) farming application. Smart irrigation system uses the emerging IoT technologies and sensors to develop a system that automatically supplies water according to environmental conditions like moisture value, temperature, etc.

IoT is network of devices and devices are the things in IoT. The devices consist of embedded sensors. These devices send and receive data to and from the cloud and measurements can be monitored in time. If the soil moisture is detected low in a particular area, then the motor can be turned on. This forms the basis of smart agriculture. IoT is about the power of data and the world is digitally connected and data becomes critical asset. An emerging concept called smart farming refers to managing farms through the use of IoT, drones and AI helps to increase the quality and quantity of production while minimizing the human labor required for production. Data from the devices can guide farmers’ decision and adapt to more quickly changing weather conditions.

K.S.Babai,P.K.Suresh,K.UmaRani et al. (Eds): ICARTEC-2021
pp. 61 - 67, 2021.IJCI – 2021 DOI:10.5121/ijci.2021.100308

Internet of things and wireless technology are becoming a major research concern throughout the world [1]. In the year 1998, the visual representation of individual objects and items were implemented on the internet and termed as IoT.

Kevin Ashton implemented supply chains management using IoT in the year 1999 [2]. Recently, the power and flexibility of IoT has improved and the services are available to common people. IoT finds application in all sectors including as health, robotics and even intelligent education [3]. On the other hand, IoT is used from a strategic angle in agricultural sector. Ubiquitous Computing is another area where ICT has progressed to IoT [4]. Thingspeak is an open web-based IoT source information service, which integrates sensor data, processing in different IoT applications and visualizes and analyzes the data in graphic format over the internet [5-7]. Farming involves several stages such as monitoring of soil and crop, monitoring of environment parameters such as moisture, humidity and temperature etc. The work is aimed to introduce IoT based monitoring of farm which enables farmers to treat the farm from anywhere and produce quality yield.

2. METHODOLOGY

The proposed system uses the components such as NodeMCU, Arduino Nano, sensors like soil moisture and DHT11, solenoid valves, relays. These components are discussed.

2.1. Block Diagram of the proposed system

Figure 1 shows the block diagram of the proposed system. The capacitive soil moisture sensor is placed in the pot containing plant to measure moisture content present in the soil. Similarly, air temperature and humidity, are measured with DHT11 which is humidity and temperature Sensor. A 5V Power relay is used to control the water pump. Whenever the sensor detects a low quantity of moisture in the soil, the motor turns on automatically. Hence, this will automatically irrigate the field. Once the soil becomes wet and goes above the threshold value, the motor turns off. The Thingspeak server helps to monitor all this happening remotely from any part of the world.

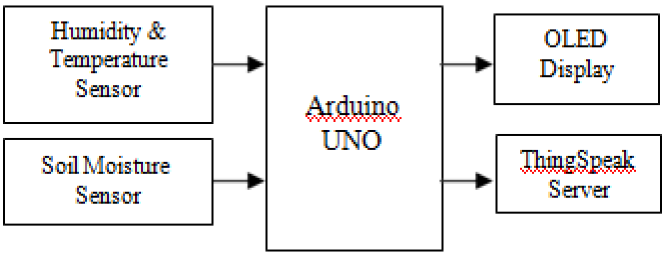


Figure 1 Block diagram of the proposed system

The work flow of IoT consists of three stages namely collect, analyze and act. The first step, collect means to acquire data from sensors which are located in remote locations. This problem is overcome by the use of thingspeak servers. The second step is to analyze the collected data. The data is visualized by monitoring the data in real time. The soil moisture values are compared with certain threshold values to determine if it is in the acceptable level. The third step act corresponds to sending a command based on the analysis. If the soil moisture value is below threshold then the motor could be turned on. Figure 2 shows the connection diagram in which all sensors are connected to the Arduino.

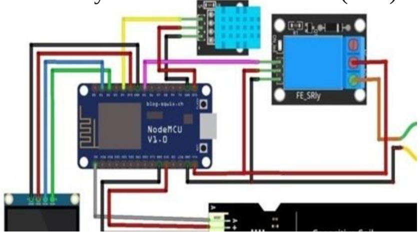


Figure 2 Connection diagram

2.2. Soil Moisture Sensor

Figure 3 shows an analog capacitive soil moisture sensor that measures the soil moisture levels by capacitive sensing. The capacitance varies according to the water contents present in the soil. Depending on the capacitance value, the voltage level varies from a minimum of 1.2V to a maximum of 3.0V. The capacitive soil moisture sensor is primarily used as they are made of a corrosion-resistant material giving it a long service life. The resistance is inversely proportional to the soil moisture: The amount of water in the soil determines conductivity. More water in the soil results in higher conductivity and hence offers lower resistance. The less water in the soil results in poor conductivity and hence the resistance is high.

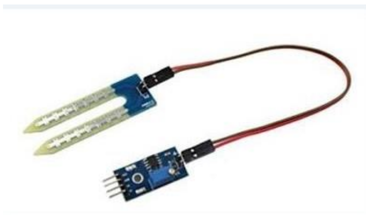


Figure 3 Soil moisture sensor

2.3. DHT11 Humidity and Temperature Sensor

The DHT11, an ultra low-cost digital temperature and humidity sensor is shown in Figure 4. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air. It spits out a digital signal on the data pin. It's fairly simple to use, on the other hand requires careful timing to grab data. The only real downside of this sensor is that the new data can be got from it once every 2 seconds. Hence while using the library, sensor can show reads recorded before 2 seconds. In this project, this sensor is used to measure the air temperature and humidity.

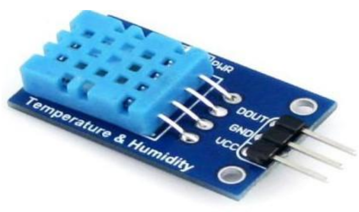


Figure 4 Temperature and Humidity Sensor

2.4. DC 3-6V Submersible Water Pump

The DC 3-6 V submersible water pump is a low cost, small size submersible pump motor as shown in Figure 5. It operates from a 2.5V to approximately 6V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA. The tube pipe is connected to the motor outlet, submerged it in water, and powered it.

Figure 5 Submersible water pump

2.5. Node MCU

Figure 6 shows a Node MCU which is an open-source Lua based firmware and development board specially targeted for IoT based applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which is based on the ESP-12 module. Node MCU works with a clock speed of 80 MHz. A small sized PCB antenna module that fits smartly inside the IoT projects, Flash memory of 4 MB and SRAM of 64Kb are the specifications of Node MCU used. The NodeMCU is available in various package styles. Common to all the designs is the base ESP8266 core. Designs based on the architecture have maintained the standard 30-pin layout. The important consideration in some designs are the use the more common narrow (0.9″) footprint, while others use a wide (1.1″) footprint. As the operating voltage range of ESP8266 is 3V to 3.6V,the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA, which should be more than enough when ESP8266 pulls as much as 80mA during RF transmissions. Power to the ESP8266 NodeMCU is supplied via the on- board MicroB USB connector. Alternatively, if a regulated 5V voltage source is available, the VIN pin can be used to directly supply the ESP8266 and its peripherals.

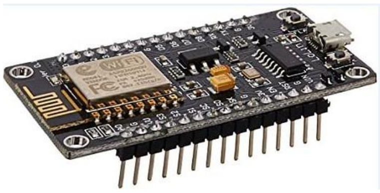


Figure 6 Node MCU

2.6. OLED Display

OLED stands for Organic Light-Emitting Diode that utilizes a technology in which LEDs used produces light by organic molecules as shown in Figure 7. OLED displays are made by placing a series of organic thin films between two conductors. When an electrical current is applied, a bright light is emitted. An OLED display works without a backlight because it emits visible light. Thus, it can display deep black levels and can be thinner and lighter than a liquid crystal display.

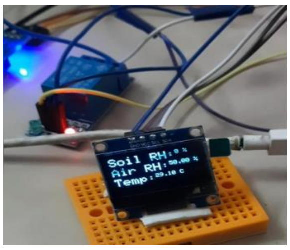


Figure 7 OLED display

2.7. ThingSpeak Server

ThingSpeak is an IoT analytics platform service that allows aggregating, visualizing and analyzing live data streams in the cloud which is shown in Figure 8. ThingSpeak provides instant visualizations of data posted by devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak the online analysis is performed and the data is processed as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics. Some of the key capabilities of ThingSpeak include the ability to (i) Easily configure devices to send data to ThingSpeak using popular IoT protocols, (ii) visualize the sensor data in real-time and (iii) aggregate data on-demand from third-party sources. It utilizes the power of MATLAB to make sense of the IoT data. IoT analytics can be run automatically based on schedules or events. IoT systems can be prototyped and built without setting up servers or developing web software.

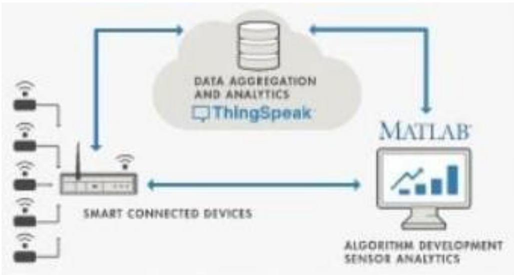


Figure 8 ThingSpeak server

3. RESULTS AND DISCUSSION

The experimental setup of IoT based monitoring of farm using NodeMCU is set up. The soil moisture sensor measures the moisture level in the soil and applied to analog to digital converter. The digital output from analog to digital converter is applied to Arduino board and displayed on the OLED display as shown in Figure 8. It is evident from Fig. 8 that the soil is dry and the moisture level shown in the display is zero.

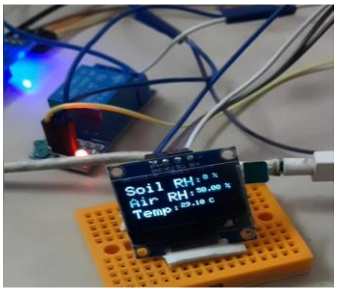
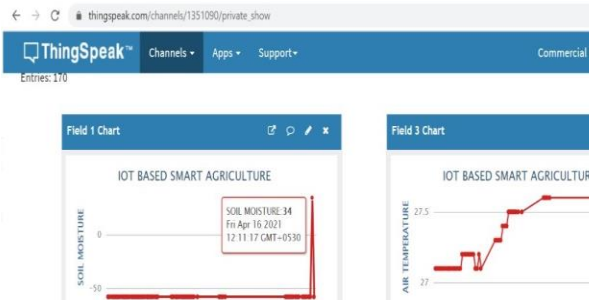


Figure 9 Soil moisture level when soil is dry

Value from the sensor is read by NodeMCU and this microcontroller posts the information to the cloud server. When the soil moisture value goes below a certain threshold value, the motor is automatically turned ON by the relay. The plant is now watered as shown in Figure 9 and whenever the moisture value reaches the threshold level as shown in Figure 10, the relay automatically switches OFF the motor.

Figure 8 Watering of plant

Figure 10 Soil moisture level after watering plant



(a)

(b)

Figure 11 Plot of (a) Soil moisture and temperature (b) air humidity and motor status observed on a day

The user should login to the Thingspeak cloud by using their unique username and password. Once logged in, the user can see the plot of the sensor reading observed on a particular day graphically as shown in Figure 11. The sensor data is analyzed and appropriate action such as turning the motor ON or OFF is taking from anywhere

4. CONCLUSION

Smart Farming is farming management that uses data technologies to improve the efficiency and quality of farm output. In this paper, an IoT based farm monitoring using NodeMCU is presented. The data collected from different sensors are analyzed with ThingSpeak and appropriate action is taken based on the analysis. The advantage is that data collection, analysis and action can be done from any part of the world using ThingSpeak server. This proposed system could be a great help for the farmers to adapt to the given climatic conditions which will help to maximize yieldrate and minimize the wastage of water.

ACKNOWLEDGEMENTS

The authors thank the management of Sri Sairam Engineering College and department of Electronics and Communication Engineering for their support and inspiration to complete this work.

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