IOT BASED SMART AGRICULTURE SYSTEM

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Abstract-
Smart Agriculture System is mainly a real time system which keeps track of the properties of soil including humidity, temperature, soil moisture and pH. With the help of IoT, from any place the field operations can be controlled remotely at any time. It provides an innovative way of life like how an individual controls his electronic equipment with the help of his smart phone. It is also used to use the energy in an efficient manner. The proposed automatic irrigation system is therefore helps in saving the farmer's time, money, and energy. With automated irrigation technology, human intervention can be reduced compared to traditional farm field irrigation approach. The primary focus of the work is reduction of water usage and also to deliver the automated smart fertiliser management system. Various sensors include humidity, temperature, pH and moisture sensors are kept at different places in the field and depends on the values of the sensors, the motors in the field will be controlled. The values obtained are converted to digital form and is given to ESP 32. The moisture and pH levels of the soil are monitored and if the values go beyond the threshold level, the corresponding motors gets turned ON without the intervention of Human.

Keywords: IoT, humidity, temperature, soil moisture and pH

1 .INTRODUCTION

Due to recent technological breakthroughs, the agriculture sector has undergone a significant global upheaval. Many technical solutions are being offered by technologies like AI, IoT, ML, etc. for the agriculture industry [1-3]. The implementation of a smart irrigation system based on IoT utilising the ESP32 is the primary focus of this study. The network of internet-connected objects known as the "Internet of Things" transmits and receives data automatically. The adoption of IoT technology can lead to several advancements in the agricultural sector as opposed to traditional techniques [4-6].

In order to make operations smarter and more efficient in the direction of better production, IOT-based research is enduring in the agricultural sector, and new products are released on a daily basis. Agriculture automation is needed to address these concerns. Hence, a comprehensive system that will handle all factors affecting productivity at all levels must be developed in order to address all of these difficulties. The product's real-time farm data (humidity, temperature, soil moisture, IR and UV index) will be useful to farmers so they can take the required steps to farm wisely by accumulating their storage yields and preserving resources like water and fertilizer. The main goal of this work is to use the ESP32 to construct a smart irrigation system based on IoT [7-8].

This paper discusses the idea of IoT, which is concerned with system automation and goes on to discuss smart agriculture. Thus, automation needs to be used in agriculture to solve these issues. Hence, a comprehensive system that will handle all factors affecting productivity at all levels must be developed in order to rectify all of these difficulties. However due to a number of problems, agriculture cannot be completely automated. Despite the fact that it is only used for research purposes and is not provided to farmers as a product to benefit from the resources, so the topic of this study is the development of smart agriculture utilising IoT devices that farmers can employ.

Agriculture is considered as a primary source of food grains and because people continue to cultivate using traditional methods that provide poor yields of harvests and natural products. Yet, where computerization has been implemented and humans have been replaced by programmed technology, the yield has increased. So, in order to upsurge the harvest, modern science and innovation must be applied in agriculture. The majority of publications suggest using a remote sensor network, which collects data from various types of sensors and uses remote communication to transfer it to the main server.

2. OBJECTIVES

The primary goals of this project are to develop an automated smart fertiliser management system and reduce water usage by using an intelligent irrigation system. In this project, sensor data are used to drive the field-mounted motors. The sensors measure or detect the soil's moisture content, temperature, humidity, and pH level. These values are changed from analogue to digital and then applied to the ESP32. A motor is automatically turned ON without human intervention if the pH and moisture levels of the soil fall below a particular threshold.

3. EXISTING METHODOLOGY

System of Automated Drip Watering is possible to automate irrigation using XBEE logic and mobile technology while simultaneously providing the ability to manually operate it using GSM (phones) from any location. Data is transmitted using XBEE, which sends signals in the form of characters through a tiny chip. The only way to establish communication with the user and system is through GSM.

4. PROPOSED SYSTEM

The ESP32, DHT-11, soil moisture sensor, pH sensor, PIR sensor, DC motor, relay, and buzzer are used in the proposed system which is given in Figure 1. The sensors measure or sense the soil's moisture content, temperature, humidity, and pH level. The ESP32 receives these values in digital format, which is then applied. The concerned motor is automatically turned ON and a buzzer will ring if the pH and moisture levels of the soil goes beyond an indicated threshold. The farmer receives an alarm message at the same time. IOT technology allows for remote management of all operations from any location at any time.

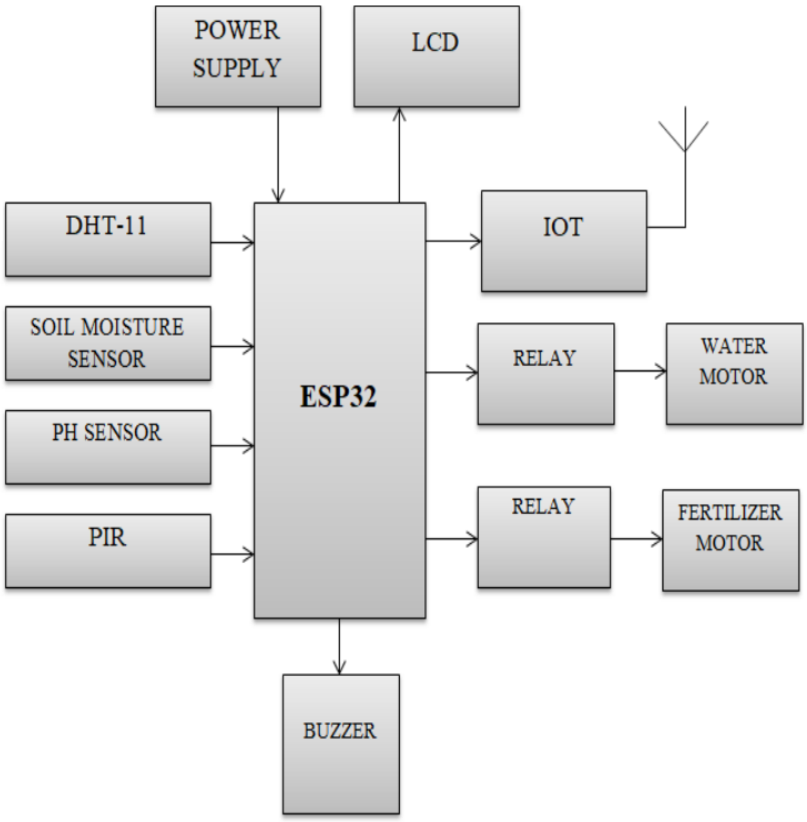

Figure 1: Proposed smart agriculture system Using IOT

The sensor uses a DHT11 temperature, humidity, soil moisture, PIR, and pH sensor and is interfaced to the ESP32. Wireless transmission is used to transfer the sensor data to WIFI module ESP32. The data processing is done by comparing data received from various sensors in the field with the already specified threshold values. The concerned motor is automatically turned ON and a buzzer will ring if the moisture levels of the soil goes beyond an indicated threshold.The fertiliser motor automatically turns ON if the soil pH value drops below the threshold level. Even the ON switch for the motor can be operated by the farmer via a mobile application. After receiving control through a web application or mobile application, the irrigation system was automated. Relays are used to transmit control from a web application to electrical switches that are controlled by an ESP8266 microprocessor. Relay is a control mechanism for low power signal circuits. The web application will be made to enable remote monitoring of the crops and field utilising an internet connection. Processing IDE is used to operate the Microcontroller, and the webpage can interface with it. Android is used to create the mobile application which makes it possible to remotely monitor a controlled area.

5. SOIL MOISTURE SENSOR

In place of a potentiometer, a soil moisture sensor shown in Figure 2 is in the shape of a fork acts as a variable resistor whose resistance changes in proportion to the moisture content of the soil. Its resistance is inversely correlated with the soil's moisture level. More water means more conductivity and less resistance. The conductivity is worse and the resistance is higher in soil with less water. This sensor creates a resistance output voltage band that may be monitored to gauge the soil's moisture content. A soil moisture sensor has two components. They are Electrical Module, Fork shaped conductor. The pins available in soil moisture sensor are: AO pin: The module creates an output voltage in line with the probe resistance and is available at an Analog Output (AO) pin. DO pin: The same signal is given and digitalized using an LM393 High Precision Comparator before being made available at the DO pin. The ACC pin serves as the sensor's power supply. It is advised to supply the sensor with electricity between 3.3 and 5 volts. Gnd pin: This pin is attached to the earth's surface.

Figure 2. Soil moisture sensor

FEATURES OF SOIL MOISTURTE SENSOR

•Ease of installation at depth in augured holes.
•Better stability.
•Waterproof connector to IP68.
•Small salinity sensitivity.
•Slight soil disturbance.

6. DHT 11 SENSOR (Humidity)

The DHT11 shown in Figure 3 is a simple, affordable digital sensor which senses humidity and temperature. It provides a digital signal on the data pin after measuring the air's humidity using a thermistor and a capacitive humidity sensor. The DHT11 Sensor software module captures and stores this data.

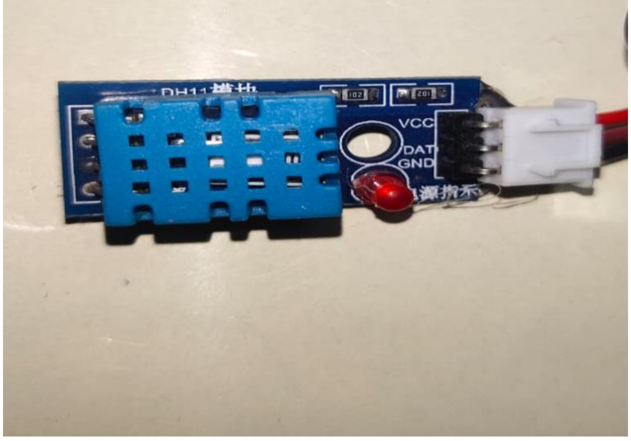

Figure 3. DHT11 sensor

Power supply ranges from 3.5V to 5.5V. Humidity and temperature are serial data output where the humidity ranges from 20 to 90% and with a temperature of 0 to 50 degrees Celsius. Both have 16-bit resolutions. DHT11, a humidity and temperature sensor has an 8-bit microcontroller intended for serial data output which gives information about humidity and temperature and a specific NTC for measuring temperature. The sensor is factory calibrated and makes integrating it with other microcontrollers simple. The sensor has a greater accuracy which measures humidity from 20% to 90% as well as temperature from 0°C to 50°C. For measurement in the above stated range, this sensor would be the best choice. Some of the applications include Environment monitoring, automatic climate control

7. LCD

The most widely employed Character-based LCD shown in Figure 4 is based on the HD44780 controller from Hitachi or a similar device. Alphanumeric and symbol data are shown on the HD44780U dot-matrix LCD Controller. It can be set up to work with a 4- or 8-bit microcontroller to operate a dot-matrix liquid crystal display. A simple system can be interfaced with this controller/driver because it has all the internal components needed to drive LCD, including the character generator, display RAM, and liquid crystal driver.

Figure 4. LCD

8. ARDUINO

This microcontroller has 6 analogue pins and 14 digital I/O pins. The major benefit of utilising Arduino, given in Figure 5, is that it can be customised and tweak the software and the Arduino board to meet our needs. For this, the VCC pin can be connected on the module to 5V.It's easy to do this by attaching the VCC pin to an Arduino's digital pin and switching it between HIGH and LOW as required. Connect the GND as well as VCC pins of the segment to ground and digital pin 7 on an Arduino. Then, connect the AO pin of the module to pin A0 of the Arduino. There are 14 digital I/O pins and 6 analogue pins on this microcontroller. The sensor must first be powered. This may be done by connecting the Arduino's 5V pin to the VCC pin on the module.

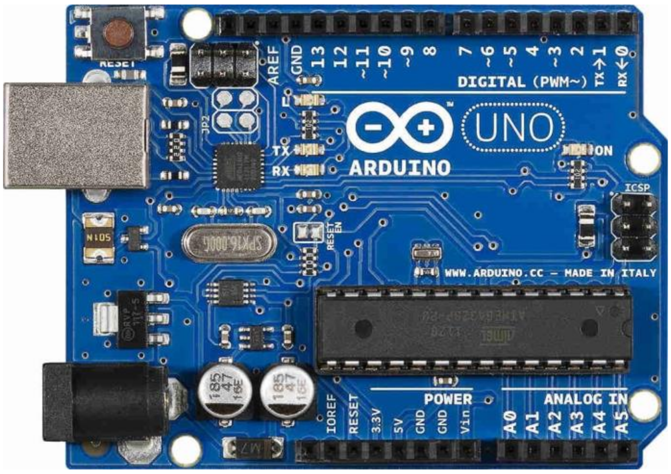

Figure 5. Arduino

ARDUINO IDE 1.8.6

The Integrated Development Environment is a free integrated toolset for creating EMBEDDED applications for PIC as well as DSP microcontrollers. The 32-bit Arduino IDE 1.8.6 is an easy-to-use programme that runs on Windows and has a number of free software components for quick application development and debugging. The coding is written using this Arduino software and is uploaded in the IDE board which works on Linux, Mac OS X and Windows.

9. ESP32 MICROCONTROLLER

The IC created for the demands of a new linked world is the ESP32 board which is given in Figure 6. It is used to host the application orelse responsibilities of Wi-Fi networking is assigned to another application processor. Low volume, simple integration with other items High performance with LWIP Protocol and Free RTOS support supporting the AP, STA, and AP+STA modes Lua programme support, simple development.

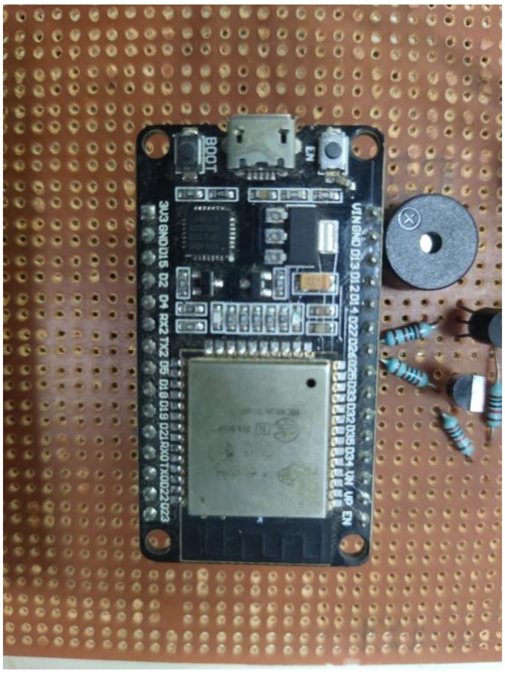

Figure 6. ESP32 Microcontroller

10. PH SENSOR

Figure 7 depicts a pH sensor, one of the most important tools usually employed for water measurements. The amount of acidity and alkalinity present in water and other liquids can be determined with this type of sensor. Typically, a value between 0 and 14 is used to represent the pH scale. When a substance's pH value is seven, it is classified as neutral. Compounds with pH values above seven are supposed to reflect higher levels of alkalinity, whereas substances with pH values below seven are thought to represent higher levels of acidity.

The soil pH sensor measures the current pH of the soil. It is used to determine the pH level, where two probes made of stainless steel are placed upright into the soil. The pH of the soil determines whether it is acidic or alkaline. The pH scale actually determines the concentration of hydrogen ions. Because the hydrogen ion concentration varies widely, a logarithmic scale (pH) is used. Most soils have a pH range of between 3.5 and 10. In areas with greater rainfall, the pH of soils naturally fluctuates from 5 to 7, whereas in drier areas, it ranges from 6.5 to 9.

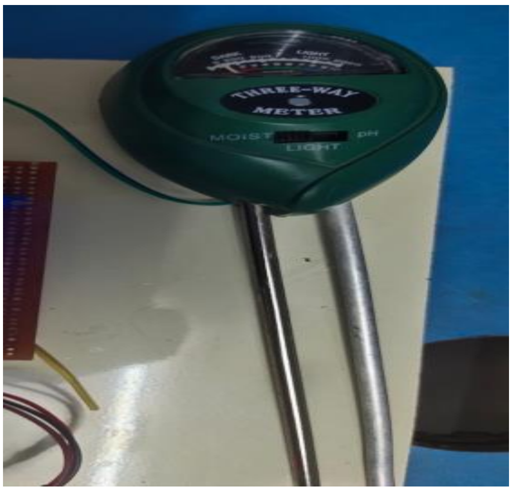

Figure 7. pH sensor

The natural soil ‘s pH is determined by the rock type from where it was formed as well as the weathering processes that occurred on it, including climate, vegetation, topography, and time. These actions usually cause a pH decrease over time (increase in acidity). Rain is another key factor that is suspected to be causing the increase in soil acidity. The volume of nutrients that are accessible to plants and the pH of the soil can both be changed by certain fertilisers.

The quantity of nutrients and compounds that are soluble in soil water depends on the pH of the soil. While some nutrients are more readily available in acidic environments, others are more readily available in alkaline environments. But, when soil pH is close to neutral, the majority of mineral nutrients are easily accessible to plants. Very acidic soil development may lead to poor plant growth due to aluminium and manganese toxicity or calcium and magnesium insufficiency. Zinc, copper, boron, and manganese shortages are possible issues in alkaline soils.

11. PIR sensor

PIR is an electrical sensor that senses the changes in infrared light at a certain distance and reacts by emitting a signal when it does. PIR has a configurable sensing range, an ambient light sensor, and an operating voltage of 5V DC.

12. LM358

The operational amplifier (Op-Amp), LM358 shown in Figure 8, is used as a voltage comparator by the IR sensor. The comparator will relate the photodiode's series resistor voltage to the predetermined threshold voltage in pin 2 and pin3 respectively and voltage drop across the series resistor of a photodiode gives the Threshold voltage of Op-amp.

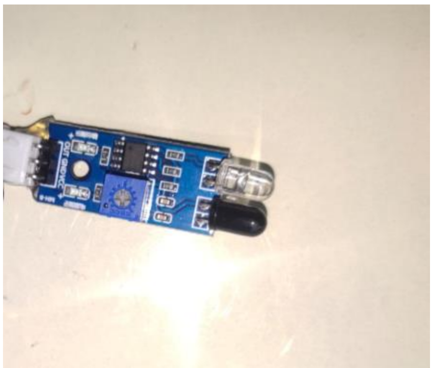

Figure 8. LM358

The VCC pin receives a 5 VDC supply input, and the module's GND terminal receives the supply's negative side. The output LED stays off if no object is found within the IR receiver's detection range. The LED lights up when an object is found inside the IR sensor's detection range. It has applications like Wheel encoder, Industrial safety devices and Obstacle Detection.

13. DC MOTOR

A DC motor is a particular kind of electric motor that rotates and produces mechanical energy using Direct Current (DC) electricity. The majority of types make use of the magnetic field's forces. Nearly all varieties of DC motors have an electromechanical or electronic system that occasionally permits a portion of the motor's current to reverse direction. Since they could be driven by the direct-current lighting power distribution networks that already existed, DC motors were the first type of motor that was widely employed. A DC motor's speed can be varied widely by changing either the supply voltage or the amount of current flowing through its field windings. The universal motor, a small brushed motor used in portable power tools and appliances, can be run on direct current. Larger DC motors are being used for electric vehicle propulsion, elevator and hoist propulsion, and drives for steel rolling mills. Power electronics have made it possible for AC motors to replace DC motors in a number of applications.

14. BUZZER

As seen in Figure 9, a buzzer is an auditory signalling device that is mechanical, electromechanical, or piezoelectric (piezo for short). Common uses for buzzers and beepers include timers, alarm clocks, and confirmation of human input such mouse or keyboard clicks. An audio signal converter that produces sound signals is a buzzer. DC volts are usually used to power it. It is generally as a sound source in alarm clocks, computers, printers, and other electronic devices.

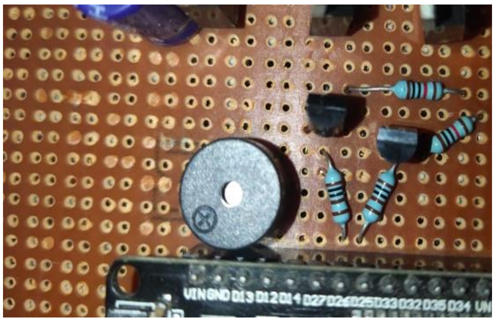

Figure 9.Buzzer

15. RELAY

Electrical switches known as relays use electromagnetism to transform weak electrical inputs into stronger currents. Electrical inputs cause electromagnets to establish new circuits or break down the ones they already have, leading to these changes. The use of electromechanical relays is widespread. Before learning how this relay operates, let's take a closer look inside. Although there are many different designs for relays, they always work in the same way. An electromagnet, a mechanically moveable contact, switching points, and a spring make up an electromechanical relay. A copper wire is wound around a metal core to create an electromagnet.As indicated, the coil's two ends are attached to the relay's two pins. To connect a high amperage load, two additional connections, referred to as switching points, are typically fitted. The common contact connects the switching points by acting as a second contact. Normal open (NO), normally closed (NC), and common (COM) contacts are the three types of these connections. Relays can be powered by both AC and DC. At each current zero state for AC relays, the coil demagnetizes, increasing the likelihood that the circuit will remain closed. Continuous magnetism is included into AC relays, a novel technology that avoids the aforementioned issue. Examples of such systems are shaded coil mechanisms and electronic circuit arrangements.

16.ARDUINO IDE 1.8.6

The Integrated Development Environment, a free integrated toolset used for creating EMBEDDED applications for Microchip's PIC and DSP microcontrollers. The 32-bit Arduino IDE 1.8.6 is an easy-to-use programme that runs on Windows and has a number of free software components for quick application development and debugging.

RESULTS

Figure 10 shows the sensors are sensing the required data and transmits the data to the app through MCU which helps the farmer to monitor parameters like humidity, temperature, moisture content in the soil and pH in an automated manner.

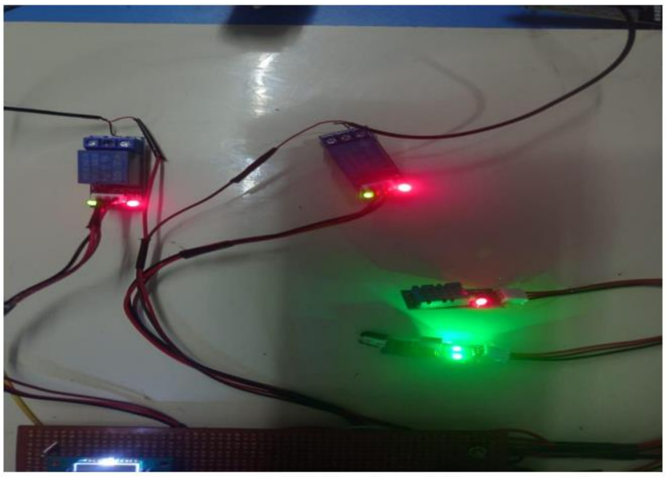

Figure 10. Sensors

The parameters can be monitored and controlled through MOBILE APP called Blynk App. The farmer can even turn on the motor through mobile application which is shown in Figure 11.

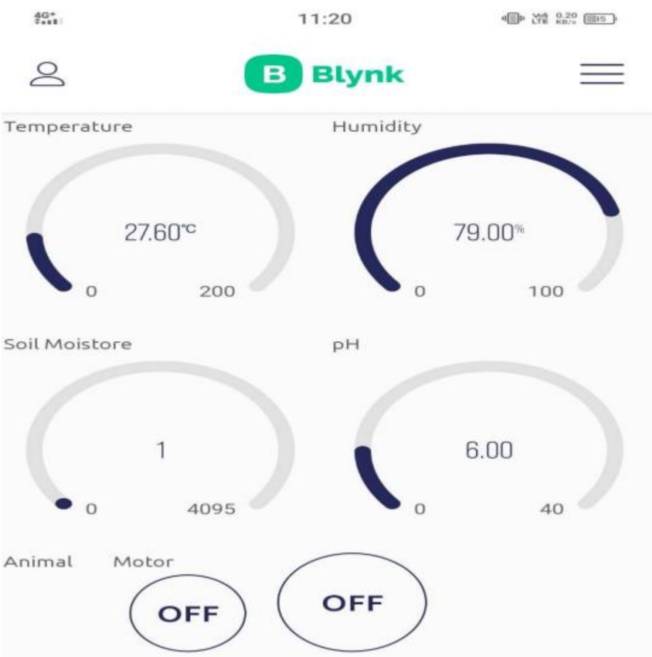

Figure 11. Mobile Application showing the soil parameters

The Monitor displays the different parameters like soil humidity, moisture, temperature and pH of the soil which is given in Figure 12.

Figure 12. LCD Monitor

Figure 13 shows the prototype model of the Smart Agriculture system using IoT

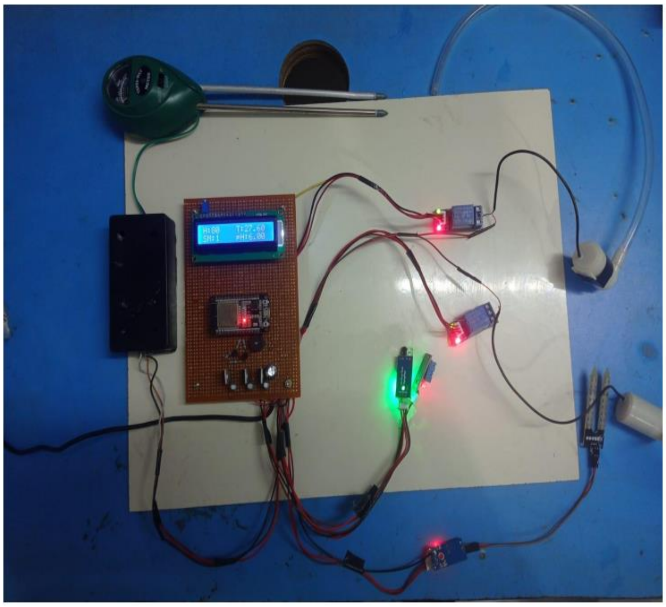

Figure 13. Prototype of the Smart Agriculture system using IoT

A small flower pot is shown as the demo in which humidity, temperature, pH and soil moisture of the soil are measured which is shown in Figure 14. The sensors in the IoT - based Smart Agriculture System detect and sense the soil's temperature, humidity, and pH level. The ESP32 receives these values in digital format, which is then applied. The concerned motor is automatically turned ON and a buzzer emits a sound, which causes the crop to be irrigated automatically when the PH and moisture levels of the soil fall to a certain level. The farmer receives an alarm message at the same time. IOT technology allows for remote management of all operations from any location at any time.

Figure 14.Overall Model of the proposed System

CONCLUSION

The sensors in the Internet of Things-based Smart Agriculture System detect and sense the soil's temperature, humidity, and pH level. The ESP32 receives these values in digital format, which is then applied. The concerned motor is automatically turned ON and a buzzer emits a sound, which causes the crop to be irrigated automatically when the PH and moisture levels of the soil fall to a particular level. The farmer receives an alarm message at the same time. IOT technology allows for remote management of all operations from any location at any time.The System is highly accurate and efficient at retrieving real-time data on soil pH, soil moisture, and temperature. By adopting an automatic irrigation system and an automated smart fertiliser management system, the IoT-based smart agriculture system that is suggested in this research will help to reduce water use. Future development will concentrate more on enhancing the system's sensors to collect additional data, particularly in relation to pest control, enhance security, and integrate a GPS module to further develop this agriculture IoT technology into a fully functional, precision-ready device.

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