Smart Farming: A Machine Learning and IoT Approach

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Abstract - *Many prime varieties of foods come from agricultural lands. Food is the most important means of survival and is a necessity for every creature. In India, there are a lot of agricultural lands and a lot more farmers who produce a wide variety of crops. There are a lot of unfortunate cases where farmers just couldn't bear the loss of a crop be it due to rainfall, droughts, or fertilizer faults. In this project, we propose a way for agriculture to be made fruitful and lush. This is done by implementing an IoT module that uses many different sensors like temperature, pH, moisture, and even rainfall sensors which detect the changes in these particular factors and process the data onto a Machine learning model. An Algorithm is then used to process and make decisions based on which irrigation is provided to the crops. This method can help to conserve water as well as give the freedom of manipulating the module using an app that controls the module and informs the farmer about it. This method also helps in healthier crop production while being cost-effective.*

Key Words: IoT, Machine learning, Random-forest, Raspberry pi Model 3B, Passive infrared Sensor (PIR), Rainfall sensor, Soil Moisture Sensor, Temperature Sensor (DHT11).

1. INTRODUCTION

This Smart farming, also known as precision agriculture, is an emerging approach that uses upcoming technologies such as machine learning and the internet of things (IoT) to increase the efficiency and productivity of agriculture. By integrating digital technologies into agriculture, farmers can monitor and optimize the use of resources such as water, fertilizer, and pesticides, while also improving crop yield and quality. Machine learning algorithms are used to analyze data collected from various sources such as sensors, weather stations, and drones. These algorithms can identify patterns and provide insights that help farmers make informed decisions about when to plant, irrigate, and harvest their crops. In addition, IoT devices such as soil moisture sensors, temperature sensors, and smart irrigation systems can be used to automate and optimize the farming process. Smart farming has the potential to address many of the challenges facing the agriculture industry, such as food insecurity, climate change, and resource depletion. It can help farmers reduce waste, increase efficiency, and improve sustainability, while also reducing the environmental impact of agriculture. However, implementing smart farming practices can be a complex and costly process. It requires significant investment in technology, data analytics, and infrastructure. Additionally, there may be challenges related to data privacy and security, as well as the need to train farmers and other stakeholders on how to use these technologies effectively. Despite these challenges, the potential benefits of smart farming are significant, and many farmers and agricultural companies are already embracing this approach. With continued advancements in machine learning and IoT technologies, the future of agriculture looks bright, with the promise of increased efficiency, productivity, and sustainability.

1.1 Block diagram

Raspberry Pi is used as the main IoT module to which multiple sensors are connected to obtain the required data as shown in fig1. Moisture sensor is used to obtain information about the wetness present in the soil and will result in switching on the irrigation system incase it is dry. DHT11 sensor is used to measure the temperature and humidity present in the soil and will respond via accordingly incase the threshhold temperature goes up. Rainfall sensor is sensitive to changes in weather and will be active while there is rainfall. PIR sensor is mainly useful in detecting animals / movement via infrared rays and can help in notifying the breach to the owner. Finally all the data is sent via a hotspot to the cloud where the data can be updated in realtime.

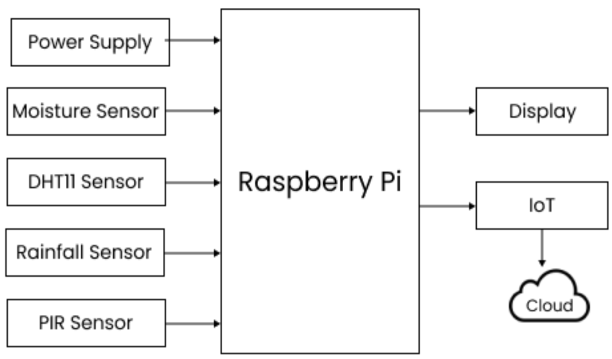

Fig 1: Block Diagram

2. IMPLEMENTATION

2.1 Hardware Implementation

In the hardware implementation (as shown in fig 2) we have used the raspberry pi with various sensors like SMS, DHT11, PIR and rainfall sensor including with buzzer. The PIR sensor given the output in digital format whether the object is detected or normal. And when the temperature is above the 38^o C the buzzer will be activated. The result and sensor data will be displayed in LCD and app which was connected through the network.

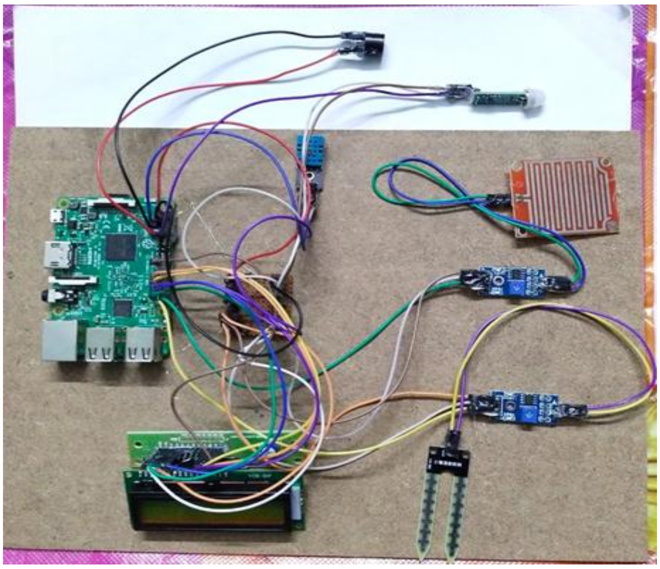

Fig 2: Hardware Implementation

2.1.1 Hardware Requirements

a) **Raspberry Pi:**

Raspberry Pi, on the other hand, is a single-board computer that is widely used in IoT applications. It has a range of GPIO (General Purpose Input Output) pins that can be used to connect to various sensors and devices. Raspberry Pi's working principle involves executing code on a microcontroller that processes input data from various sensors and sends output signals to other devices over a network. It is a credit card-sized computer that can perform various computing tasks. It uses a small and efficient ARM processor and runs on various operating systems. It has multiple interfaces like USB, HDMI, Ethernet, GPIO, and more that can be used to connect various devices and peripherals. The USB interface can be used to connect external storage devices, keyboards, and mice. HDMI interface is used to connect the Raspberry Pi to a display or TV. The Ethernet interface is used to connect to the internet or a local network. The GPIO (General Purpose Input/Output) interface is a set of pins that can be used to connect various sensors and other devices like LED lights, motors, and more.

Fig 3: Raspberry pi

Other interfaces include the camera interface, which is used to connect a camera module to the Raspberry Pi, and the audio interface, which is used to connect audio devices. These interfaces make the Raspberry Pi a versatile platform for various projects, from home automation to robotics and more.

b) **Sensors:**

1. **Soil moisture sensor:**

The insertion of moisture sensor in the soil, it predicts the percentage of moisture and water content present in the soil. The ADC is used in connecting the soil moisture sensor to the raspberry pi in which the output is presented in digital format whether it is WET or DRY displayed on LCD. The sensor consists of potentiometer to set the desired moisture threshold value, if the values measured by sensor is more than the threshold then the digital output goes high an LED indicates the output. Similarly, when it is less than the threshold value then the output remains low.

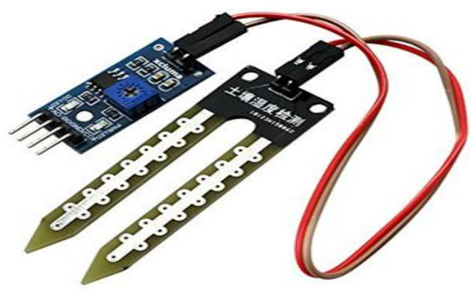

Fig 4: Soil Moisture Sensor

2. **Humidity & Temperature Sensor**

This sensor is used to detect the temperature change in the surroundings and is activated when the temperature is above 38^{o}C. This sensor consists of 3 pins namely VCC where the power supply is given, Data pin is connected to raspberry pi which passes the change in temperature, GND.

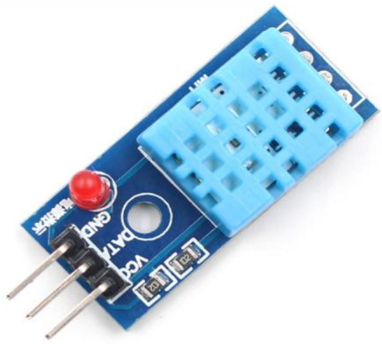

Fig 5: DHT11 Sensor

3. Rainfall sensor

This sensor is used to measure the amount of precipitation or rainfall in specific area.

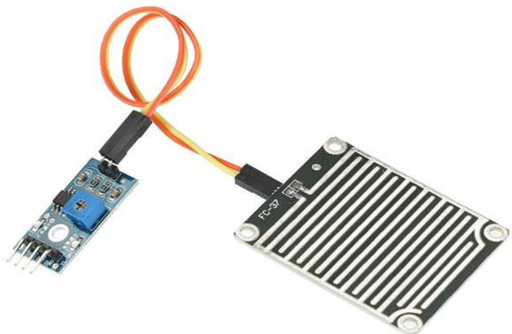

Fig 6: Rainfall sensor

4. PIR Sensor

The sensor is used to sense the motion and detection of an object. And also measures the infrared lights which are radiating from the objects. The below figure (as shown in fig7) show the typical pin configuration in which the 3 pins are defined as VCC, OUT, GND.

Fig 7: PIR Sensor

c) LCD (16x2)

It is an alphanumeric LCD, which stands for "Liquid Crystal Display". The number 16*2 represents that it has display the words in 16 characters within the 2 rows . The significance of LCD was voltage is operating from 4.7V to 5.3V and Current is utilized 1mA (with no backlight).

Fig 8: LCD (16x2)

2.2 Software Implementation

Random forest Algorithm

The class that is produced by Random Forest, an ensemble classifier (methods that create numerous classifiers and aggregate their findings), is the class produced by the average of the classes produced by individual decision trees. Number of variables and number of trees are the two parameters generated by RANDOM FOREST for internal structure. Random forest calculates the variable's relevance by examining the OOB score while leaving the other variables alone.Because unimportant variables are typically found near the bottom of each tree and important features tend to be at the top.

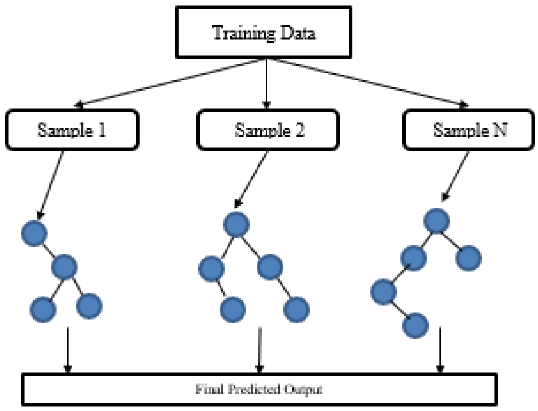

Fig 9: Block diagram of Random Forest

2.3 Result:

The hardware setup consists of 4 different sensors and a buzzer for notification connected to Raspberry Pi 3 Model B through different GPIO pins. A Led screen is setup for displaying the changes in parameters. The setup is powered via a Universal Type A adapter and will be providing data via a hotspot on the users mobile phone.

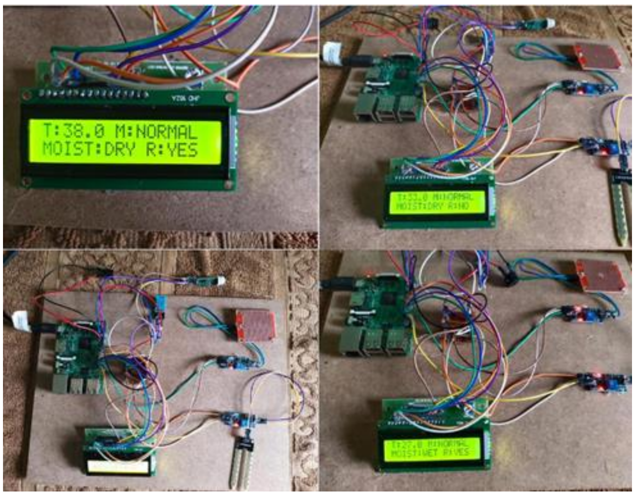

Fig 10: Hardware result on LCD

Once the hardware is connected to the phone via a hotspot, open the application on the phone which consists of different fields. Changes made to the sensors in form of heat, moisture, movement etc will immediately reflect on the app and will provide real time changes smoothly.

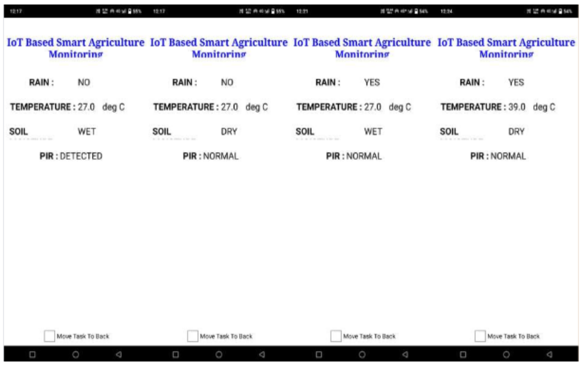

Fig -11: Software Result

3. CONCLUSIONS

Although IoT in agriculture has its fair share of challenges, smart farming has a bright future going ahead.There are truckload of applications in smart farming, most of which are enabled by IoT. Many of these help the farming sector in improving the crop quality, reducing the crop losses and lowering the costs. The proposed system has high efficiency and accuracy in fetching the live data through the four sensors used. Thus , this project focuses on understanding real-time changes and helps in understanding smart farming better.To increase yield and to secure proper conditions, we can implement the project on a bigger scale with more sensors for different parameters. The application can also be made more farmer friendly and provide data on a lot of different things in a presentable manner. The models can be more accurately trained for better predictions.

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