Smart Farmer's Assistance for Crop Protection using IoT

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Abstract— Agriculture, as the backbone of many economies, is highly dependent on weather conditions and vulnerable to unpredictable atmospheric changes. During rainy seasons, crops often suffer from excessive rainfall. To combat this, an automatic roof system has been developed to shield crops from heavy rainfall and safeguarding the rain from further damage. This solution ensures crops are protected during adverse weather conditions, enhancing agricultural resilience and productivity. This project also incorporates water conservation measures. The system uses rain and soil moisture sensors to detect adverse weather conditions. It also captures and stores rainwater for future use in irrigation, animal feeding, and domestic purposes, enhancing resource efficiency. Farmers receive mobile alerts by using the Nodemcu Technology. This approach reduces labor dependency, ensures timely crop protection, and promotes sustainable agricultural practices.

I. INTRODUCTION

Agriculture serves as a cornerstone of India's economy, supporting the livelihoods of a significant portion of the population. However, the sector grapples with challenges such as heavy reliance on monsoon rains and comparatively low productivity levels compared to global standards. In light of these challenges, there is a pressing need for technological innovation and automation within the agricultural sector [1,2].

Heavy rainfall poses a persistent threat to crop yields, particularly amidst the backdrop of climate change-induced weather unpredictability. To mitigate this risk, innovative solutions are imperative to shield crops from the adverse effects of heavy rainfall. Concurrently, efficient water management has emerged as a critical concern, given the increasing strain on limited water resources. In response to these challenges, a proposed system incorporating auto rooftop covers aims to protect crops from heavy rainfall [3,4].

This system utilizes rain sensors to detect precipitation, which then triggers alerts to farmers by using the Nodemcu technology. When the rain is detected, this system will automatically cover the crops and once the rain subsides, it will automatically open. The farmer is notified about the rain detection and opening and closing of the panels

Implemented with WI-FI connectivity and utilizing an Android mobile phone for reporting irrigation details, this proposed system exemplifies the integration of technology into agricultural practices. By leveraging such innovative solutions, farmers can enhance productivity, mitigate risks associated with adverse weather conditions, and contribute to the sustainable development of the agricultural sector.

Problem statement

Farmers worldwide face formidable challenges in protecting their crops from the detrimental effects of adverse weather conditions. Increasingly unpredictable weather patterns, characterized by extreme events such as droughts, floods, storms, and temperature fluctuations, pose significant threats to agricultural productivity and food security. The vulnerability of crops to these weather extremes leads to reduced yields, compromised quality, and economic losses for farmers [5].

Despite advancements in agricultural technology, existing crop protection methods may prove insufficient in mitigating the impacts of climate variability [6]. Moreover, small-scale farmers, in particular, often lack access to affordable and effective solutions. Thus, there is an urgent need to develop innovative and sustainable strategies that enhance crop resilience, minimize weather-induced risks, and ensure the long-term sustainability agricultural systems.

II. LITERATURE SURVEY

Hui Mao, Xiaoheng Zhang,et.al,[7] they examine how extreme weather affects farmers' use of climate-adaptive tech in Shaanxi Province, China. It finds that extreme weather increases farmers' likelihood of adopting these technologies due to heightened risk awareness and better access to credit. Regions with policy incentives show a more pronounced effect of extreme weather on tech adoption.

Muhammad et al.,[8] reviewed about the use of IoT in agriculture and focusing on real-time monitoring of soil moisture, temperature, and nutrient levels for precise irrigation and fertilization. IoT sensors optimizing water usage based on soil and weather conditions, and the integration of drones and satellite imagery for crop health monitoring. The high cost of IoT devices and infrastructure is a barrier for small and medium-sized farms.

Jin, Z., Liu et al.,[9] presented the impact of extreme weather events on agricultural productivity, emphasizing droughts' yield reduction and soil health impacts. Heat stress during critical crop development stages is identified as a significant yield-reducing factor. However, the paper notes a limited discussion on emerging technologies like precision agriculture, remote sensing, and data analytics, which have considerable potential for mitigating extreme weather impacts.

Anjana et al., [10]has presented IoT-enabled weather stations which provides real-time data on weather conditions, helping farmers make informed decisions about crop protection measures. Automated spraying systems that use IoT data to apply pesticides precisely where needed, reducing chemical usage and minimizing environmental impact. IoT systems can help manage bioenergy production from agricultural waste, monitoring parameters such as temperature and gas production to ensure efficient energy generation.

III. SYSTEM ARCHITECTURE

3.1 System Architecture Model

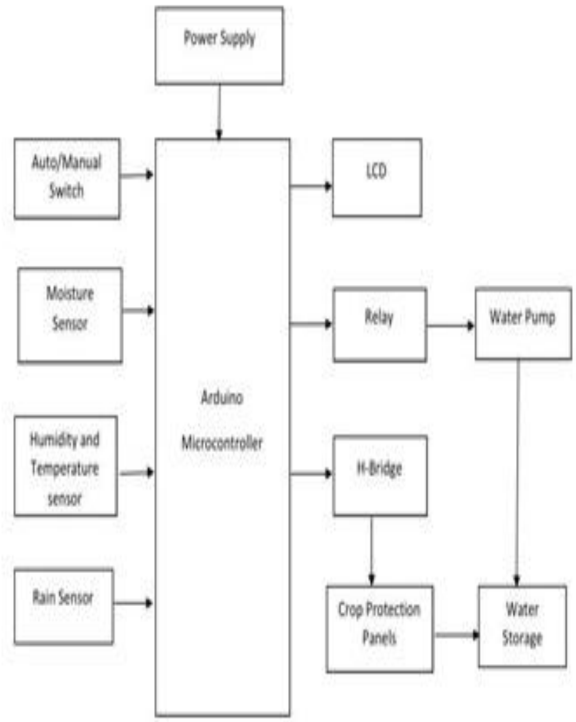

Fig.3.1 Block Diagram of Crop Protection Model

The crop protection model is explained in Figure 3.1 In case of heavy rainfall, the farmer will send a signal or a message to start the operations. As soon as the Nodemcu module receives the signal using Arduino the microcontroller is enabled. The first operation of microcontroller is to activate the dc motor in such a way that it starts rotating in clockwise direction to cover the crops. The required protection is fabricated by four adjustable poles which enables the adjustment of height.

This System works in automated mode i.e., when former doesn’t respond to the request from Nodemcu, it checks the moisture content of the soil using moisture sensor and initiates appropriate action required to protect crop. In this mode all the controlling and monitoring of greenhouse is carried out through internet.

When there is an unconditional rain, the panels provided will be closed automatically to protect the crop. The farmer receives information about the panels closing and opening in the telegram for the farmer. Relay is connected to the pump which starts pumping water when the moisture sensor senses the land as dry. Water storage tank collects rain water which can be used for later purposes. The temperature sensor senses the surrounding temperature of the farm. When it starts raining, the pump motor will stop pumping the water to the field and updates the user using Nodemcu technique. An Alpha numeric LCD is used to display the data.

3.2 System Architecture Flow Chart

The system Architecture flow chart is depicted in Figure 3.2 and also explained about steps involved in the process.

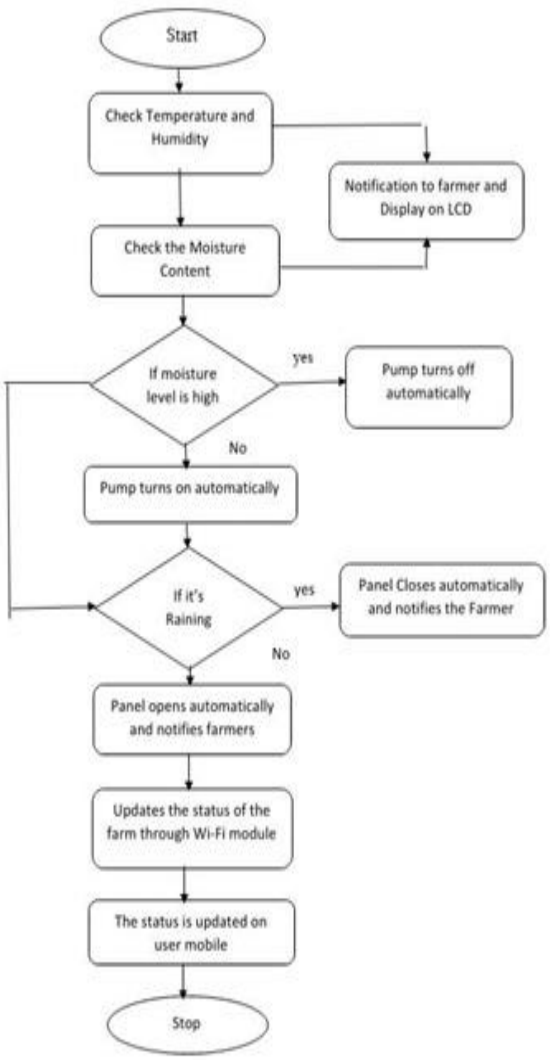

Fig.3.2 Flow Chart of Crop Protection Model

Step 1: Start, the process is Automatic.
Step 2: Input as Check Temperature and Humidity and Check the Moisture Content of the Soil.
Step 3: The values are Displayed on the LCD.
Step 4: If the Moisture Level is High, then the pump does not turn ON, else the pump turns ON automatically.
Step 5: If it's Raining, then the Panel closes automatically and notifies the farmer, else, panels open automatically and notifies the farmer.
Step 6: Update the Status of farm through Wi-Fi module, then the status is updated on the user in the mobile.
Step 7: Stop.

IV. HARDWARE COMPONENTS

The hardware components are

1. NodeMcu:
2. LCD
3. Arduino UNO
4. Rain Sensor
5. Soil Moisture Sensor
6. Water Pump
7. Relay

3.3.1 NodeMcu

The following Figure 3.3.1 NodeMCU 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 Expressive Systems, and hardware which is based on the ESP-32 module.

Fig. 3.3.1. NodeMcu

3.3.2 LCD

An LCD, or Liquid Crystal Display as given in Figure 3.3.2, is a type of electronic screen that uses liquid crystals to display text and graphics. It consists of a grid of pixels that can be controlled individually to produce images. Alphanumeric LCDs specifically can display both letters and numbers, making them useful for various applications like digital clocks and instrumentation. In the context of the automated crop protection system, the alphanumeric LCD serves as a real-time display interface for monitoring soil moisture, temperature, and system status.

Fig.3.3.2 LCD

3.3.3 Arduino UNO

The Arduino UNO as depicted in Figure 3.3.3 is a standard board of Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board.

It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits.

The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

Fig.3.3.3. Arduino UNO

3.3.4 Rain Sensor

A rain sensor as given in Figure 3.3.4 is a device designed to detect the presence of rainfall and trigger specific actions or systems based on this detection. Typically used in outdoor automation and irrigation systems, rain sensors help conserve water by preventing unnecessary watering of plants and lawns during rainy weather. These sensors work by detecting the presence of water droplets on their surface, usually through the use of conductivity or optical methods.

Fig.3.3.4. Rain Sensor

3.3.5 Soil Moisture Sensor

A soil moisture sensor as given in Figure 3.3.5 is a useful tool for measuring the level of moisture or water content in soil, helping gardeners and farmers determine when and how much to water their plants. These sensors typically consist of probes or electrodes that are inserted into the soil, where they detect the presence and conductivity of water. When the soil is dry, the sensor sends a signal indicating the need for watering, while a moist soil reduces conductivity and alters the signal.

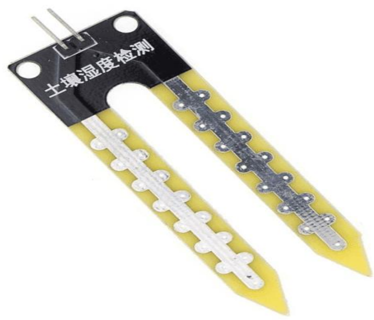

Fig. 3.3.5. Soil Moisture Sensor

3.3.6 Water Pump

A water pump as shown in Figure 3.3.6 is a mechanical device used to move water from one place to another. In agricultural settings, water pumps are often used to deliver water from sources such as wells, rivers, or reservoirs to irrigate crops. Water pumps play a crucial role in ensuring that crops receive an adequate and consistent water supply, which is essential for healthy growth and optimal yields.

Fig. 3.3.6 Water pump

3.3.7 Relay

A relay as shown in Figure 3.3.7 is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

Fig.3.3.7 Relay

V. RESULT AND DISCUSSIONS

The main objective of this system is to protect and enhance crop growth during the rainy season, as heavy rainfall will reduce yields. The project work carried out is shown in Figure 4.1. A rain sensor detects rainfall and, in the event of heavy rain, automatically closes the farm's rooftop to protect the crops, while the collected rainwater is stored for future usage. Upon system initialization, a message is displayed on the LCD screen.

If rain is detected, the panels close to shield the crops; otherwise, they remain open as explained in Figure 4.3. Corresponding messages about the panels' status are shown on the LCD and sent to the farmer via the Telegram App as given in Figure 4.2. A humidity sensor measures and displays air moisture and temperature on the LCD screen. A moisture sensor monitors soil moisture levels; if the soil is dry, the system automatically activates the water pump to irrigate the field.

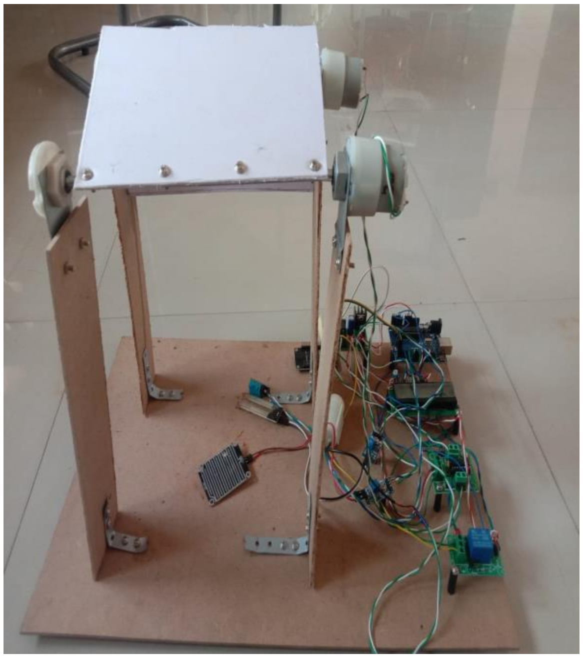

Fig. 4.1 Project Model

Fig. 4.2 Message received in Bot

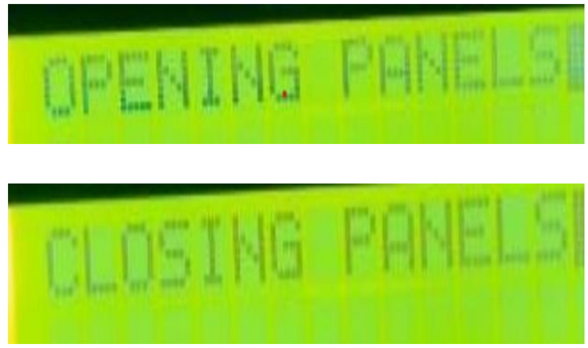

Fig 4.3 LCD showing Output for opening and closing panels

Fig. 4.4 LCD Displaying Output

CONCLUSION

In conclusion, our automated crop protection system effectively shields crops from heavy rainfall, ensuring optimal growth and yield during the rainy season. By integrating rain sensors, moisture sensors, and a NodeMCU-controlled Arduino microcontroller, the system automatically deploys protective measures, such as closing rooftop panels to prevent crop damage. This collected rainwater is efficiently reused for irrigation, promoting sustainable water management. Real-time data display and remote notifications via Telegram enable farmers to monitor and control their fields from anywhere, making informed decisions based on current environmental conditions. This user-friendly and cost-effective solution significantly enhances crop resilience and agricultural productivity, safeguarding farmers' livelihoods against adverse weather conditions. IoT technologies so real-time sensor data and alert messages send to the concerned person. Until the concern person comes and resets the device the alarm doesn't turn off.

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