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Harvested Crop Protection System

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ABSTRACT: The Harvested Crop Protection System is an innovative, cost-effective solution designed to safeguard crops from excessive rainfall during the rainy season by integrating real- time rain detection, automated roofing, and instant farmer notifications. Built on the Arduino platform, the system utilizes a rain drop sensor to detect rainfall, triggering an automated motorized retractable roof that shields the crops from potential damage. Simultaneously, a GSM module sends an SMS alert to the farmer, ensuring they remain informed about changing weather conditions even if they are away from the field. Unlike traditional crop protection methods that rely on manual intervention or expensive, platform-specific technologies, this system offers an affordable and user-friendly alternative, reducing labor dependency while enhancing efficiency. Once the rainfall stops, the roof automatically retracts, restoring natural environmental conditions for optimal crop growth. By eliminating the risks associated with excessive water exposure, such as root rot and fungal infections, this system helps farmers minimize crop loss and protect their agricultural investments with minimal effort. Its ease of use, automation, and affordability make it a scalable solution suitable for both small-scale and large- scale farming operations, ensuring sustainable and resilient agricultural practices.

KEYWORDS: Arduino UNO, GSM, Rain Sensor and Pest detection.

I. INTRODUCTION

Agriculture is a cornerstone of global food production, with farmers continually striving to maximize yield while mitigating losses caused by environmental factors. One of the most significant challenges in crop protection is excessive rainfall, which can lead to soil erosion, root rot, fungal infections, and overall yield reduction. These issues are particularly severe for small and medium-scale farmers, who often lack access to cost-effective and efficient protective measures. Without adequate safeguards, unpredictable rainfall can cause significant financial losses and disrupt food supply chains.

Traditional crop protection methods, such as manually covering fields with plastic sheets or constructing permanent greenhouse structures, have several drawbacks. Manual coverings are labor-intensive and require constant supervision, while greenhouse solutions are expensive, making them impractical for many farmers. Additionally, existing methods lack automated response mechanisms, requiring farmers to remain vigilant about changing weather conditions. This limitation can lead to delayed intervention, resulting in irreversible crop damage.

To address these challenges, the Harvested Crop Protection System offers an automated and cost-effective solution to safeguard crops from excessive rainfall. Built on an Arduino-based platform, the system integrates a rain drop sensor, a motorized retractable roof, and a GSM module for real-time farmer alerts. When rainfall is detected, the system automatically deploys a protective roof, shielding crops from damage while simultaneously notifying the farmer via SMS alerts. Once the rain ceases, the system retracts the roof, allowing crops to receive natural light and air circulation.

The key advantage of this system lies in its automation and real-time monitoring capabilities. Unlike traditional methods, it eliminates the need for manual intervention, allowing farmers to focus on other essential agricultural tasks. Additionally, by incorporating wireless communication, farmers can monitor crop protection remotely, reducing the need for on-site supervision. This feature is especially beneficial for those managing multiple fields or living far from their farms. Embedded systems play a crucial role in modernizing agriculture, enhancing efficiency, and reducing dependency on labor-intensive practices. These systems integrate microcontrollers, sensors, actuators, and communication modules, enabling autonomous operation and precise decision-making. In addition to crop protection, embedded technologies have been widely applied in automated irrigation, climate control, pest detection, and post-harvest management. Their ability to process real-time environmental data ensures optimal resource utilization and minimal waste.

The Harvested Crop Protection System is an example of how embedded technology can be leveraged to improve agricultural resilience against unpredictable weather conditions. By providing a low-cost, scalable, and easy-to-use

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solution, it addresses the pressing need for affordable smart farming technologies. The system's ability to operate autonomously ensures minimal crop losses, ultimately enhancing farm productivity and profitability.

With continuous advancements in Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML), the role of embedded systems in agriculture is expanding rapidly. Future developments could integrate cloud-based data analytics and predictive weather models to further enhance decision-making and automation in farming. The Harvested Crop Protection System represents a step toward sustainable, technology-driven agriculture, enabling farmers to adapt to climate challenges while ensuring stable and efficient food production.

II. LITERATURE SURVEY

Several studies have explored automated crop protection using sensor-based systems to mitigate excessive rainfall damage. Traditional methods like manual coverings and greenhouses are often costly and impractical for small-scale farmers. Research on rain-responsive canopies and IoT- based climate control systems has shown effectiveness, but high costs limit adoption. Low-cost embedded microcontroller systems have demonstrated success in automated irrigation, pest control, and real-time monitoring. Additionally, GSM-based alerts have been used to notify

farmers of weather changes, improving decision-making. The Harvested Crop Protection System integrates rain sensors, a retractable roof, and GSM alerts to provide an affordable, automated solution for safeguarding crops against heavy rainfall. This system ensures real-time response to changing weather conditions with minimal human intervention, making it highly efficient for small and medium-scale farms. By leveraging embedded technologies, it enhances crop protection, reduces labor costs, and improves agricultural sustainability. Future enhancements could include IoT-based cloud integration for advanced data analytics and predictive weather modeling.

III. METHODOLOGY AND PROPOSED SYSTEM

3.1 System Overview

The Harvested Crop Protection System is an automated solution designed to shield crops from excessive rainfall, ensuring optimal growth conditions with minimal human intervention. It integrates key components for efficient operation:

- **Arduino Microcontroller** – Central unit managing system operations.
- **Rain Sensor** – Detects rainfall and activates the protective mechanism.
- **DHT11 Sensor** – Monitors temperature and humidity.
- **PIR Sensor** – Detects motion or pests.
- **GSM Module** – Sends SMS alerts to farmers.
- **16x2 I2C LCD Display** – Provides real-time system data.
- **Motor Driver & Relay Modules** – Operate the retractable roof and additional devices.
- **Buzzer** – Alerts for rain or pest activity.
- **Room Heater & Pest Repeller** – Maintains optimal crop conditions.
- **Solar Panel & Battery System** – Ensures renewable power supply.

Upon detecting rainfall, the system automatically deploys a protective cover and notifies the farmer via SMS. Once the rain stops, the cover retracts, restoring natural conditions while continuously monitoring environmental factors. This automated, energy-efficient system enhances crop protection, farm productivity, and sustainability, making it a valuable tool for modern agriculture.

3.2 Methodology

The Harvested Crop Protection System follows a structured approach to safeguard crops from rain, pests, and unfavorable conditions while ensuring ease of use for farmers.

Step 1: Sensor Integration and Data Acquisition

The system integrates multiple sensors for accurate environmental monitoring:

- Rain Sensor detects rainfall and sends data to the Arduino for decision-making.
- DHT11 Sensor monitors temperature and humidity to maintain optimal storage conditions.

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- PIR Sensor identifies motion, detecting potential pest intrusions.
- LCD Display shows real-time environmental data for easy monitoring.

The Arduino processes sensor data in real-time and triggers appropriate responses based on predefined thresholds.

Step 2: Rain Detection and Roof Control
The system monitors rain sensor data continuously and controls the motorized retractable roof:

- If rain is detected (sensor value < 450), the roof automatically closes.
- When rain stops, the roof retracts, restoring natural conditions.
- The GSM module sends SMS alerts and calls to notify the farmer.

This automation eliminates manual intervention while ensuring crops remain protected.

Step 3: Pest Detection and Repelling
Pests can cause significant crop damage, so the system integrates motion-based pest detection:

- The PIR sensor detects movement, activating the pest repeller via a relay.
- A buzzer sounds for 10 seconds, alerting nearby personnel.
- The GSM module notifies the farmer of pest activity via SMS. This ensures real-time pest deterrence and quick farmer response.

Step 4: Temperature and Humidity Regulation
To prevent spoilage, the system maintains optimal storage conditions:

- If temperature falls below 18°C or humidity drops below 40%, the heater is activated.
- Once optimal levels are restored, the heater automatically turns off.
- Farmers receive SMS alerts if conditions become unfavorable.

Step 5: Communication and Notifications
The GSM module ensures real-time remote monitoring by:

- Sending SMS and calls during rain detection, pest detection, or extreme temperature/humidity changes.
- Displaying live data on the LCD screen for instant system status updates.

By combining sensor-based monitoring, automation, and remote alerts, this system ensures comprehensive crop protection with minimal effort.

3.3 Block Diagram of Harvested crop protection system
The Harvested Crop Protection System is an automated solution designed to shield crops from adverse weather using interconnected components. An Arduino Microcontroller processes data from sensors and controls system operations. The Rain Sensor triggers a Motorized Roof Mechanism, managed by a Motor Driver Controller, to protect crops from excessive moisture. A DHT11 Sensor monitors temperature and humidity, while a PIR Sensor detects pests, activating a Pest Repeller as needed.

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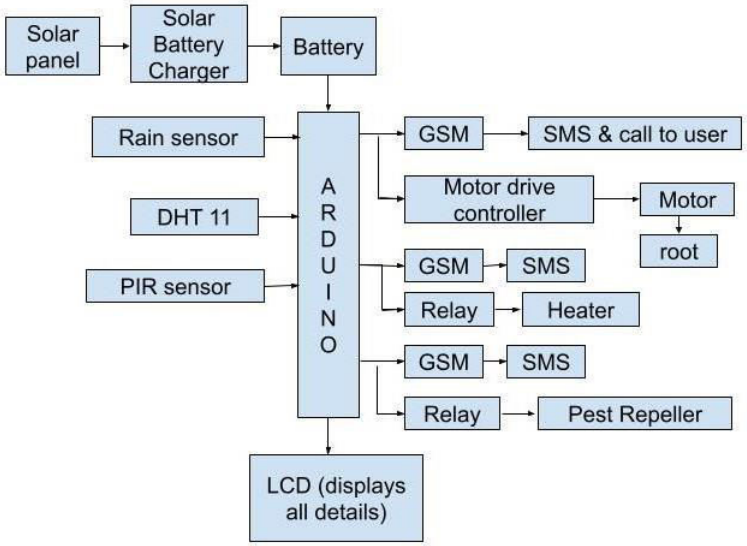

Fig 1: Block Diagram of Harvested Crop Protection System

A GSM Module ensures real-time alerts via SMS, while a 16x2 I2C LCD Display provides system updates. The setup is powered by a Solar Panel, storing energy in a Battery via a Solar Charger, with a DC to AC Converter ensuring uninterrupted operation. This system enhances agricultural reliability and efficiency.

IV. RESULTS AND DISCUSSION

The image below displays the fully assembled Harvested Crop Protection System, integrating the Arduino microcontroller, rain sensor, motorized roof, PIR sensor, DHT11 sensor, GSM module, LCD display, and solar power system. The setup demonstrates automated crop protection, where the roof closes during rain, the pest repeller activates on motion detection, and temperature/humidity sensors regulate climate conditions. Real-time SMS alerts and live data monitoring ensure efficient operation with minimal manual intervention, making it a cost-effective and reliable agricultural solution.

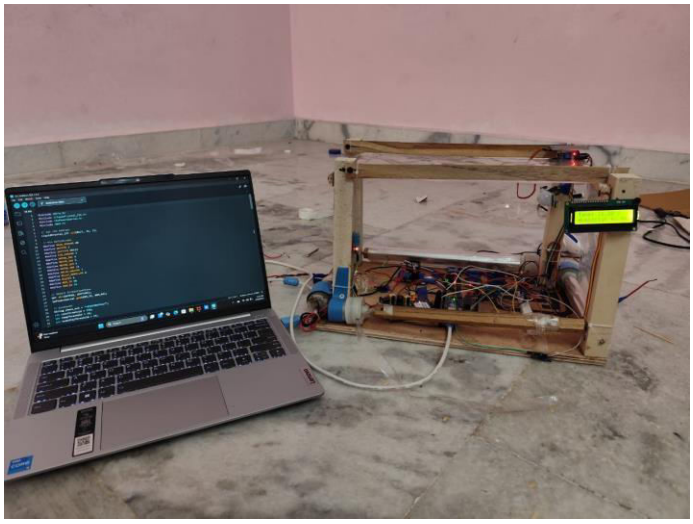

Fig 2: Implemented Setup of Harvested Crop Protection System

The LCD screen serves as a real-time status indicator for the automated roof system. It displays messages such as "Roof Opening" or "Roof Closing", based on sensor inputs and system logic. This feature ensures that the user can

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visually monitor the system's response to environmental conditions, enhancing usability and troubleshooting. The display updates dynamically, reflecting the current state of the protective mechanism.

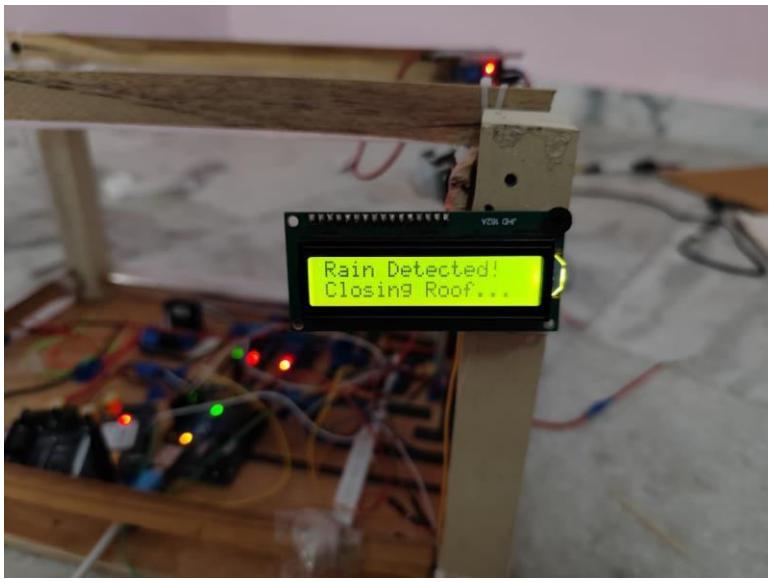

Fig 3: LCD Status Display of Roof Mechanism

The system incorporates a GSM module to send automated alerts to the user's mobile device in case of rainfall or any critical condition affecting the harvested crop. Notifications are delivered via SMS or call, ensuring timely awareness. This feature allows remote monitoring and intervention, enabling farmers to take necessary precautions even when they are away from the field. The alert system enhances the reliability and practicality of the crop protection mechanism.

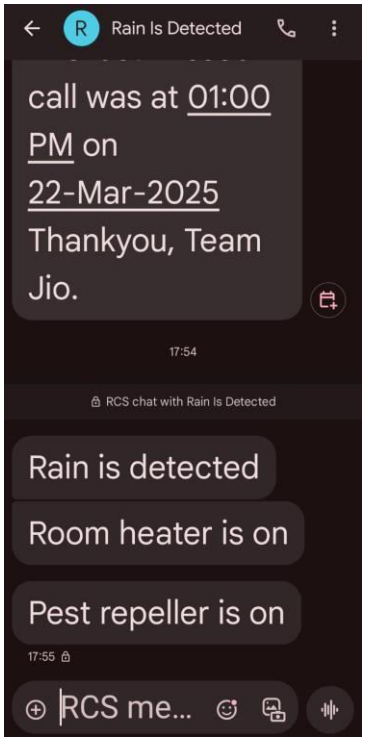

Fig 4: Alert Notification Received on Mobile Device

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V. CONCLUSION

The Harvested Crop Protection System offers a fully automated and cost-effective approach to protecting crops from excessive rainfall, pests, and adverse environmental conditions. By integrating sensors, a motorized retractable roof, and GSM-based alerts, the system ensures real- time monitoring and rapid response with minimal manual intervention. The rain sensor triggers the roof mechanism, while the PIR sensor and pest repeller prevent crop damage from pests.

Additionally, the DHT11 sensor regulates temperature and humidity, activating a heater when necessary to maintain optimal crop storage conditions. With SMS alerts and live data monitoring, farmers can remotely track environmental changes and take necessary action.

Powered by renewable solar energy, the system remains operational even in remote areas, promoting sustainable and smart farming. By reducing crop losses, lowering labor costs, and improving farm efficiency, this system provides a reliable, scalable, and practical solution for modern agriculture.

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