Chapter 16

Book Chapter

Food Grains and Clothes Protection from Birds and Rain using Smart Roof

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Abstract

In regions susceptible to rainfall and where rooftops serve as storage spaces for food grains and clothes, protecting these items from environmental hazards and bird interference is imperative. This project presents an automated system designed to address these challenges by utilizing Arduino-based electronics, sensors, and actuators. The system integrates a raindrop sensor to detect precipitation and trigger protective measures, such as deploying covers over the stored items. Additionally, an ultrasonic sensor provides real-time monitoring for nearby objects, ensuring the system's safety and preventing potential loss of food grains. Through the amalgamation of modern technologies, this project demonstrates the adaptability and versatility of IoT (Internet of Things) applications while providing a workable solution to a typical issue. By making use of open-source hardware and software platforms such as Arduino, it encourages experimentation and innovation in DIY electronics and automation. This abstract encapsulates the project's objective, methodology, and significance, empha-

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sizing its contribution to enhancing the protection of stored goods against environmental threat.

Keywords: Audrino, Actuators Precipitation, Sensors, Automation.

1 Introduction

One of the pillars of the Indian economy is agriculture. India is mostly an agrarian nation. It is crucial to the advancement of our country.(Raja et al., 2022).High-quality substitutes for fishmeal and fish oil that don't compromise the viability, efficiency, or quality of the farmed goods are in greater demand. (Shrivastav et al., 2022).

Because of the traditional nature of farming, produces and consumes agricultural products in vast amounts. However, the documentation indicates that one The employment of antiquated and conventional methods for planting, harvesting, storing, shipping, and selling results in the loss of one-fourth of the world's crop production. Therefore, it is now necessary to reduce the percentage of crop loss and enhance crop output in terms of both quality and quantity throughout the harvesting and post-harvesting operations. (Raheem et al., 2019). However, Rapid innovation, digital capabilities, and IT skill integration has emerged as a key national practice for the general advancement of economies and communities. (Mittal, 2020). Thus, in many regions, particularly in agricultural and residential settings, protecting stored food grains and clothes from birds and rain on rooftops is a crucial concern. This project aims to address this issue by employing modern technologies like Arduino microcontrollers, sensors, and actuators to create an automated protective system.

One potential solution for prospective future problems facing the global food system is urban agriculture. It may be able to lessen the strain that the agriculture industry will eventually face.(Daneshyar, 2024). IPM technology may give relief.(Chakrabarti & Mittal, 2023). By integrating a raindrop module, ultrasonic sensor, servo motor, buzzer, and Arduino, this system can detect rainfall and the presence of objects, activate protective measures. The raindrop sensor detects rain, prompting the system to cover the stored items. Meanwhile, the ultrasonic sensor monitors for nearby objects like pigeon, crow etc and protects the foods grain from them. Fruit crops are harmed by frugivorous bird species such as parakeets, bulbuls, mynas, crows, koel, and barbets, among others. The pest that harms fruit crops the most is the rose-ringed parakeet. The ability of the birds to harm the agricultural plants is influenced by various factors, including the availability of food, field sizes, proximity to roosting locations, crop or orchard traits, fruit characteristics, and meteorological conditions.(Yodha et al., 2024).

In regions prone to heavy rainfall some of the houses have the closed roof systems to protect their clothes and the items on the roof from the rainfall. If not, there should be

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some person present over there to look over the items and clothes. This leads to more man power and when the rain stops the clothes can't be exposed to sun as they were already built in a closed way. This acts as one of the traditional techniques followed by our elders. Our new technique overcomes these problems by adopting it. Through this project, we not only provide a practical solution to a common problem but also demonstrate the application of Internet of Things technologies in everyday scenarios. Moreover, by utilizing open-source hardware and software platforms like Arduino, this project encourages exploration and innovation in Do-It-Yourself electronics and automation.

2 Literature Review

Rain sensors are switches that are triggered by precipitation. They are primarily used in two applications: automatic windscreen wipers and irrigation systems. When these sensors detect rainfall, the appropriate action is triggered. An Arduino UNO board is all that is needed to operate the system and communicate with the rain sensor. A module for rain control can regulate the movement of the sensor.(S, TM, & GT, 2021). When drying clothing outside during the rainy season, especially when they are not at home, a lot of people experience anxiety. People avoid drying their garments outside because of anxiety that the rain will ruin their clothes. As a result, when the weather is bad, a number of people dry their clothes on the terrace to keep them dry.

Atsiq, Andryan Gunawan, and Amin Alqudri Dwi Nugraha's (2022) suggests an automatic clothesline retractor as a solution to this problem. This gadget makes use of an Arduino UNO microprocessor, an LDR sensor, and a rain sensor. With the use of these sensors, the system determines the weather. If the LDR sensor detects no light, it anticipates rain, which prompts the device to retract the clothesline into a covered location. In contrast, the clothesline is moved to a sun-exposed region by the gadget when it detects sunlight. In order to guarantee that the clothesline is retracted during rains, the rain sensor further detects raindrops. People drying clothing during the rainy season can feel less anxious thanks to this automatic clothesline retractor. The creation of an automatic sliding door system with an infrared sensor is another aspect given by Oluwatomi and Obakin O's (2014).

This system opens and closes doors at public building entrances using a drive unit, a control unit, and a sensor. Gaining an understanding of automatic door systems and their underlying principles is the main goal. Making a basic circuit model to illustrate how the system works is the secondary goal.

Additionally, the goal of this thesis is to create a smart umbrella with a distinctive design that minimizes human labor and appeals to the market. With the unpredictable nature of wind and sudden downpours in today's culture, this umbrella is essential. Another project is proposed by Gudela et al.'s (2020) to produce an umbrella that can be

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used for both residential and commercial purposes and is extremely responsive to sunshine and rain. Working in the open during the summer can be challenging because of the intense heat caused by the sun. With the aid of sensors for wind, water, and temperature, this umbrella covers the whole hall in both sunny and rainy conditions. The umbrella's opening and shutting are managed by a motor, which responds quickly to the shaft—a vital component in power transfer. The shaft receives the necessary rpm from the motor. The temperature sensor alerts the Arduino control unit when the outside temperature rises above 35°C. The Arduino control unit subsequently turns on the motor to open the umbrella. The rain sensor covers the area where crops are spread, ensuring that the automatic roof operates as intended to protect the crops.

A novel idea for retractable roof constructions is presented in the study by Rammohan et al.'s (2018).The creation of a smart roofing system that can recognize rainfall and react appropriately is one possible remedy.(Swaraj et al., 2023). An adaptable architectural element, the retractable roof is intended to offer climate control and adaptable shelter for a variety of buildings, including arenas, stadiums, and outdoor areas. (P et al., 2024). It consists of a foldable lattice of beams joined by cylindrical connections, to which covering panels or membranes are attached. These structures can have different forms and fold towards their boundary. (Kassabian, You, & Pellegrino, 1999).Key design difficulties are addressed, such as how to retain the structures' mobility while connecting them to fixed foundation points and how to form the covering panels to prevent interference during retraction. Additionally covered is a long-span retractable roof structure based on scissor mechanisms and the beam string structure (BSS). The structure has a single degree of freedom when folding or unfolding since the BSS units are arranged parallel to one another and joined by a linear scissor mechanism. The retractable roof structure's geometry is explained, and then an integrated model of the unfolded configuration's structural analysis is shown. (Cai, Feng, & Jiang, 2014).

Further, E -taps can be introduced for irrigation purposes. The E-Tap is a water-saving innovation that uses a non-contact method to turn off the faucet. The goal of the E-Tap is to conserve water wherever it is put. Every office can utilize the E-Tap, and it can also be used at home. The tap will cut off in accordance with the water level in the bucket, so reducing water waste. (Tulasi Krishna Gannavaram et al., 2021).

3 Existing System

Current systems for protecting food grains and clothes from birds and rain on rooftops typically involve manual interventions or simple mechanical solutions. Following are some examples:

1. Manual Covers: One common approach is to manually cover the stored items with

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tarps or plastic sheets when rain is expected. While effective, this method requires constant monitoring and manual labour, making it impractical for large-scale or remote storage facilities.

2. Bird Netting: Another method involves installing bird netting or mesh screens over the rooftop storage area to deter birds. While this can be effective against bird interference, it may not provide adequate protection against rain and other environmental factors.

3. Roof Overhangs: Building structures with extended roof overhangs or eaves can help provide natural protection against rain, reducing the need for additional coverings. However, this solution may not be feasible for existing structures or in areas with limited space.

4. Manual Inspection: Inspecting the food grains manually for every half an hour or every hour, checking that if there are any birds or group of birds consuming the food grains or not. If yes, they need to stay on the roof for some time to handle the birds. Which needs a human to take care of it every time.

While these existing systems offer varying degrees of effectiveness, they may lack the flexibility, affordability, or automation capabilities desired for certain applications. The proposed Arduino-based system aims to address these limitations by providing a customizable, cost-effective, and automated solution for protecting rooftop storage from birds and rain.

4 Proposed System

The proposed work aims to develop an automated system using Arduino-based electronics, sensors, and actuators to protect food grains and clothes from birds and rain on rooftops. This system will offer a cost-effective, customizable, and efficient solution to address the challenges faced by individuals and communities in safeguarding rooftop storage areas.

1. Protection of clothes from rain: The proposed system concentrates on protecting clothes and other items on the terrace from getting wet and damaged by rain by closing the roof during rain and again opens the roof when the rain is stopped.

2. Protection of food grains from birds and rain: Another important feature which is proposed in this system is protecting food grains. Ultrasonic sensor is utilized to detect the birds which comes to eat the crops on the rooftop which signal the microcontroller to activate the buzzer, that leads to scare the birds and protect the food grains.

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3. Embedded development: The same system incorporates both bird and rain protection. There are no projects that offer the features of rain and bird protection in comparison to the systems that are currently in place, whether it be an automated roof to shield crops from excessive rainfall or a crop protection system in an agricultural field.

4. Arduino Programming: Developing the software code for the Arduino microcontroller to read sensor data, implement control logic, and actuate the servo motor and buzzer as necessary. The code will be enhanced for dependability and efficiency.

5. Integration and Testing: Integrating the components into a cohesive system and conducting rigorous testing to validate its performance under various environmental conditions. This testing phase will involve simulated rain events and object proximity scenarios to evaluate the system's effectiveness and reliability.

6. Optimization and Refinement: Fine-tuning the system parameters and control algorithms based on testing results to optimize its functionality and address any issues or limitations identified during testing.

7. Cost effectiveness: As it consists of embedded system which can perform multiple functions rather than investing in two different systems users can easily invest in single embedded system which leads to reduction in the cost of the product.

5 Methodologies Used

- System Design and Planning: Requirement Analysis: Identify the specific needs for protecting items on rooftops from rain and birds.
- Component Selection: Choose appropriate sensors, actuators, and microcontrollers for the project:
- Integrated Development Environment (IDE): Arduino IDE: If you're using Arduino boards like Arduino Uno, Nano, or Mega, you'll need the Arduino IDE to write, compile, and upload code to the microcontroller. The Arduino IDE supports C/C++ programming languages.
- Programming Libraries and Frameworks: Arduino Libraries: Utilize built-in or third-party libraries available in the Arduino IDE to interface with sensors, actuators, Libraries such as Servo are commonly used. Additional Libraries: Depending on the specific sensors and actuators you're using; you may need to install additional libraries from the Arduino Library Manager or download them from external sources.
- Simulation and Modelling Tools: Arduino Simulation Software: Optionally, before deploying your Arduino code to hardware, you can test and simulate it using Arduino simulation software like Proteus or Tinker Cad Circuits.By utilizing these software tools

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and platforms, you can develop and deploy an IoT-based system for protecting rooftop storage areas effectively, enabling remote monitoring and control while ensuring data processing and analysis capabilities for optimizing system performance.

- Testing and Calibration: Initial Testing: Conduct tests to ensure each component responds correctly to the respective conditions (rain detection and bird presence).
- Calibration: Fine-tune the sensitivity of the sensors and the movement range of the servo motor for optimal performance.
- Programming the Arduino:Develop the code to read inputs from the raindrop and ultrasonic sensors.Implement logic to control the servo motor based on sensor inputs.Include code to activate the buzzer in response to detected conditions.
- Documentation and Dissemination: Document the entire process, including circuit diagrams, code, and assembly instructions.
- Open-Source Sharing: Share the project on open-source platforms to encourage DIY electronics enthusiasts to explore and innovate.

6 Architecture

6.1 Sensor Network:

Ultrasonic Sensors: In this project, the ultrasonic sensor is utilized to detect the presence of birds and other objects near the stored food grains on rooftops. It works by emitting ultrasonic waves and measuring the duration of time required for the echoes to return after hitting an object. When a bird or other object is detected within a certain range, the sensor sends a signal to the Arduino. The Arduino then activates protective measures, such as or triggering an alert, to safeguard the stored items. This helps prevent damage and contamination from birds and ensures the stored items remain safe.(see figure 1)

Figure 1. Ultrasonic Sensor

The raindrop module: in this project is employed to identify the presence of rain

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and initiate protective measures for stored food grains and clothes on rooftops. When raindrops fall on the sensor, it detects the moisture and sends a signal to the Arduino microcontroller. The Arduino processes this signal and activates the servo motor to move a cover into place, protecting the items from getting wet. This automatic response ensures that the items are shielded from rain as soon as it is detected, providing an efficient and reliable solution to weather-related concerns. (see figure 2).

Figure 2. Raindrop Module

6.2 Data Acquisition and Processing Unit:

The Arduino Uno: a widely-used microcontroller, forms the project's core. It receives inputs from sensors like the raindrop module and ultrasonic sensor. Based on these inputs, it commands the servo motor and other actuators for protective measures. Its programmable nature enables flexible automation in IoT applications. (see figure 3).

6.3 Actuators

The servo motor: in this project is makes use of automate the protective cover mechanism for stored food grains and clothes on rooftops. When the Arduino receives a signal from the raindrop sensor indicating rainfall, or from the ultrasonic sensor detecting the presence of birds, it sends a command to the servo motor. The servo motor then rotates to move a cover or shield into place, effectively protecting the items from rain or bird interference. This automation ensures timely and efficient protection, reducing the need for manual intervention and safeguarding the stored items under various conditions (see figure 4).

The buzzer: a simple audio output device, alerts users in response to specific events detected by sensors. In this project, it emits audible signals to indicate rainfall detection or the presence of objects. Its integration enhances the system's ability to communicate

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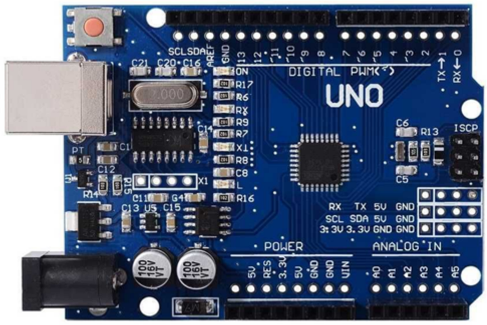

Figure 3. Arduino Uno

status updates to users.(see figure 5).

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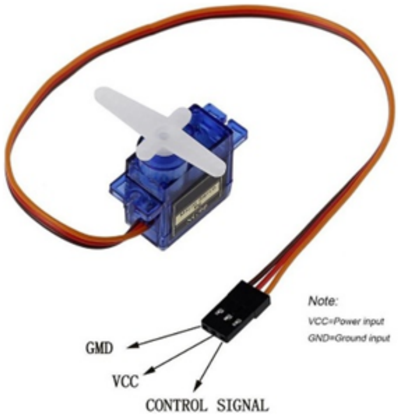

Figure 4. Servo Motor


Figure 5. Buzzer

6.4 Communication Module:

Jumper wires: serve as the communication medium in this project, facilitating the connection between various electronic components such as sensors, actuators, and the Arduino microcontroller. They enable the transmission of signals and power, ensuring seamless interaction between different parts of the system.(see figure 6).

6.5 Power Supply:

The 9V battery powers the complete system, allowing it to function continuously even when there are no external power sources available.(see figure 7).

Battery Clip: By facilitating the process of connecting the battery to the circuitry, this part guarantees a reliable and safe power source.

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Figure 6. Jumper Wires

Figure 7. 9V Battery

6.5.1 Integration and Control Logic:

Integration and control logic refer to the systematic organization and coordination of different components within the project. This involves designing algorithms and programming logic to ensure that the sensors, actuators, and microcontroller work together effectively. Integration involves connecting the hardware elements and writing code to control their behavior based on input from sensors and user-defined conditions. Control logic dictates how the system responds to different stimuli, such as activating the servo motor to cover stored items when rain is detected or triggering the buzzer to alert users.

7 Flow Chart

The workflow has been represented in the following diagram:(see figure 8)

1. Start: Initialize sensors and actuators: The system initializes all the components it will use, such as the raindrop sensor, ultrasonic sensor, servo motor, and buzzer. This stage guarantees that every part is prepared for use.

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2. Check Ultrasonic sensor: If nearby object detected (e.g., bird): The system checks if the ultrasonic sensor detects a nearby object, such as a bird. Activate buzzer to scare away the object: If an object is detected, the system activates the buzzer to scare away the object and prevent it from damaging or accessing the stored items.
3. Check Raindrop sensor: If rain detected: The system checks if the raindrop sensor detects rain. If rain is detected, it proceeds to the next steps. Activate servo motor to cover stored items: The system activates the servo motor to cover the stored items, protecting them from rain. Wait for rain to stop: The system waits until the rain stops before proceeding to check for other conditions.
4. Repeat steps 3 and 4 periodically: The system continuously repeats the process of checking the raindrop sensor and ultrasonic sensor to monitor environmental conditions and take appropriate actions as needed.
5. End: This is the end of the process.

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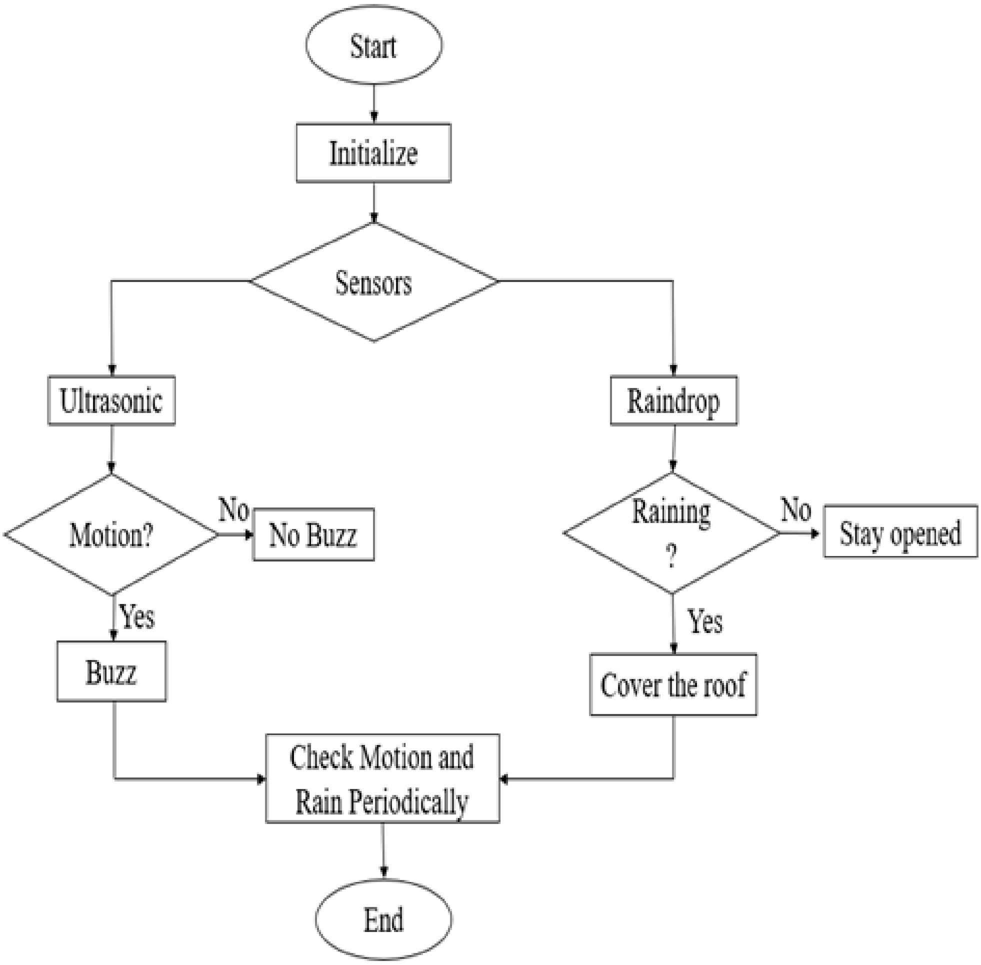

Figure 8. Workflow of Smart Roof

8 Result

The result has been demonstrated in the following figure:(see figure 9)

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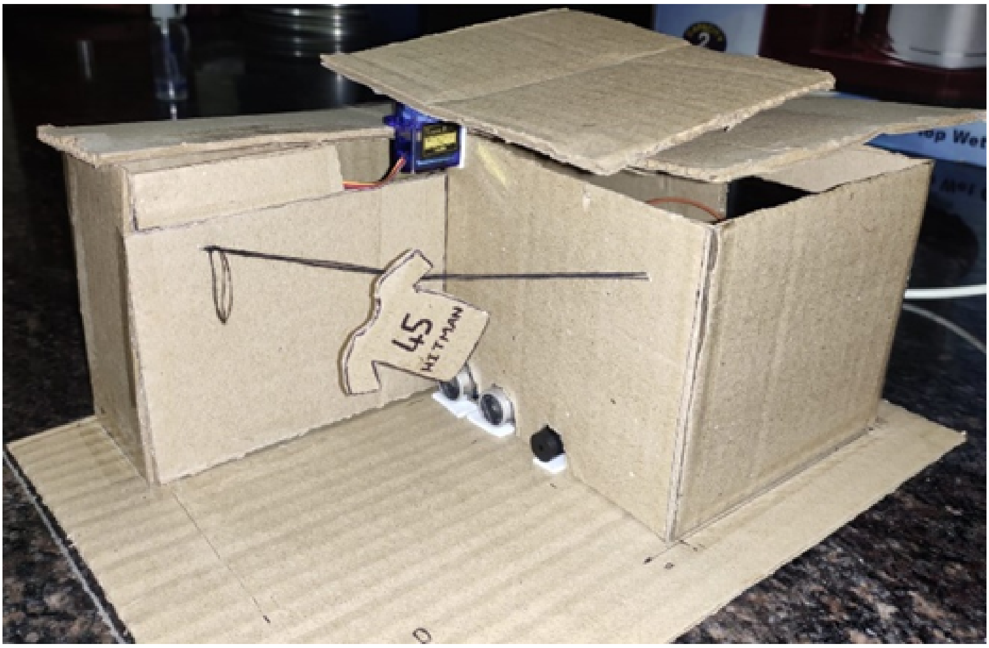

Figure 9. Working of Smart Roof

9 Conclusion

In conclusion, the development and implementation of the IoT-based Smart Rooftop Protection System represent a significant advancement in addressing the challenges associated with safeguarding food grains and clothes from birds and rain on rooftops. Through the integration of sensors, actuators, and communication technologies, this system offers an automated and efficient solution that enhances protection while minimizing manual intervention. The successful achievement of the project objectives demonstrates the feasibility and effectiveness of leveraging IoT technologies for rooftop storage protection. By accurately detecting rainfall and monitoring bird activity in real-time, the system can proactively deploy protective measures, such as deploying covers over stored items, to mitigate the risk of damage. The comprehensive testing and validation conducted under various environmental conditions have confirmed the reliability, accuracy, and effectiveness of the rooftop protection system.

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Users can confidently rely on the system to provide timely alerts, remote monitoring, and control capabilities, thereby enhancing convenience and peace of mind. Furthermore, the documentation and training materials provided ensure that end-users can easily deploy, operate, and maintain the system. The scalability and potential for future enhancements underscore the system's adaptability to evolving needs and technological advancements, positioning it as a versatile solution for rooftop protection in various settings. In summary, the IoT-based Smart Rooftop Protection System represents a valuable contribution to improving the resilience and efficiency of rooftop storage areas, ultimately enhancing food security and resource management in both agricultural and residential contexts.

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