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Smart Crop Protection System from Animals using IoT

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***Abstract* - Agriculture is one of the most important sectors for food production, but crops are often damaged by wild animals such as elephants, monkeys, wild boars, and cattle. Traditional protection methods like fencing and manual monitoring are not always effective. This project proposes a Smart Crop Protection System using IoT and Wireless Technology to detect animals entering farmland and alert farmers in real time.**

The system uses sensors, cameras, and wireless communication modules to monitor the farm area continuously. When an animal is detected, the system sends alerts to the farmer through a mobile application or SMS notification. It can also activate sound alarms or lights to scare away animals. This automated system reduces crop loss, improves farm security, and saves farmers' time and effort.

I. INTRODUCTION

Agriculture plays a vital role in the economy and food production of many countries. Farmers depend on healthy crops for their livelihood and to supply food to the population. However, one of the major challenges faced by farmers is the damage caused by wild animals such as elephants, wild boars, monkeys, and cattle. These animals often enter agricultural fields and destroy crops, which leads to significant financial loss for farmers. Therefore, protecting crops from animals has become an important concern in modern agriculture.

Traditionally, farmers use methods such as fencing, scarecrows, and manual monitoring to protect their fields. In many rural areas, farmers stay in the fields at night to guard their crops from animals. These traditional techniques require a lot of time and human effort and are not always effective. Animals can still enter the fields by damaging fences or finding other ways to access the crops. As a result, farmers need a more reliable and automated solution to protect their farmland.

With the advancement of modern technology, the use of the Internet of Things (IoT) has become very popular in agricultural applications. IoT allows different devices such as sensors, cameras, and microcontrollers to communicate with each other through wireless networks. These smart devices can monitor environmental conditions, detect movement, and send real-time information to farmers. By using IoT technology, it is possible to

create an intelligent system that can automatically detect animals entering farmland.

The Smart Crop Protection System using IoT and wireless technology is designed to monitor agricultural fields continuously and prevent animal intrusion. The system uses sensors to detect movement and sends alerts to farmers through wireless communication such as GSM or WiFi. In addition, the system can activate alarms, lights, or sound devices to scare away animals. This smart solution helps farmers protect their crops effectively, reduce manual effort, and improve agricultural productivity.

II. METHODOLOGY AND APPROACH

The methodology of the Smart Crop Protection System from animals using IoT and wireless technology is based on continuous monitoring, real-time detection, and automatic response. The system follows a structured approach where sensors, processing units, and communication modules work together to protect crops from animal intrusion. The main goal of the methodology is to reduce manual effort and improve the efficiency of crop protection using smart technologies.

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Fig 1: Animal Detection

A. Data Monitouring and Trasmission

In this data sensing and monitoring the sensors such as PIR motion sensors and ultrasonic sensors are installed around the farm boundaries. These sensors continuously monitor the field for any movement or changes in distance. When an animal enters the farm area, the sensors detect motion and generate a signal. This sensing process is the foundation of the system as it enables early detection of animal intrusion.

In the processing unit once the sensors detect movement, the generated signal is sent to the microcontroller, such as an Arduino or Raspberry Pi. The microcontroller acts as the brain of the system and processes all incoming data. It analyzes whether the detected motion is valid and requires action. This step ensures that the system responds only when necessary.

B. Decision making and Verification

In The microcontroller processes the sensor data using pre-programmed logic. It determines whether the detected movement corresponds to an animal entering the field. Based on this evaluation, the system decides whether to activate the alert and deterrent mechanisms. This step improves accuracy and avoids false alarms.

In this the image capturing and verification does when motion is detected, the camera module is activated to capture images or video of the detected object. This helps in verifying the presence of animals and identifying the type of animal entering the farm. This visual data can also be stored for future analysis and monitoring

C. Wireless Communication

The system uses wireless communication technologies such as GSM, WiFi, or LoRa to send notifications to the farmer. When an animal is detected, an alert message is sent to the farmer's mobile phone through SMS or a mobile application. This enables the farmer to monitor the field remotely and take immediate action if required.

D. Activation and Monitouring

In the activation of deterrent mechanisms, once the system confirms animal intrusion, it activates devices such as buzzers, alarms, lights, or flame modules. These deterrent mechanisms create noise or visual disturbance to scare animals away from the field. This automatic response helps in preventing crop damage even when the farmer is not physically present.

The system operates continuously, monitoring the field day and night. If animals enter again, the same process is repeated. The system also provides feedback through alerts and notifications, allowing the farmer to stay informed about field conditions at all times

E. Integration and Power management

All components, including sensors, microcontroller, communication modules, and deterrent devices, are integrated into a single system. The design allows for future expansion, such as adding more sensors, advanced AI-based animal detection, or cloud-based monitoring systems. This makes the system flexible and suitable for modern smart agriculture applications.

The system is designed to operate using efficient power sources such as batteries or solar panels. Solar energy is especially useful in remote agricultural areas where electricity supply may be limited. This ensures uninterrupted operation of the system.

III. EXISTING SYSTEM

In traditional agriculture, crop protection from animals mainly depends on manual methods. Farmers often guard their fields by staying overnight and watching for animals that may enter the farmland. This method requires continuous human presence, which is physically exhausting and not practical for large-scale farming. It also becomes difficult to monitor crops throughout the entire day and night.

Another commonly used method is the installation of physical barriers such as fences made of wood, wire, or metal. In some cases, electric fencing is used to prevent large animals

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from entering the fields. While these barriers can provide some level of protection, they are not always reliable. Animals can break the fences, dig under them, or find weak points to enter the farmland.

Farmers also use traditional techniques like scarecrows to frighten birds and small animals. These scarecrows are designed to resemble humans and are placed in fields to prevent animals from approaching crops. However, over time, animals become familiar with these objects and realize that they do not pose any real threat, making them ineffective.

Noise-making methods are also used in some farms to scare away animals. Farmers hang metal objects, bells, or cans that produce sound when the wind blows. In some cases, farmers manually create loud noises to drive animals away. These methods are simple but unreliable because they depend on environmental conditions and do not guarantee consistent protection.

In addition, some farmers use chemical repellents or natural substances to keep animals away from crops. These substances are sprayed around the farmland to create an unpleasant smell or taste for animals. However, these methods require frequent application and may not be effective against all types of animals.

Lighting systems are sometimes used to protect crops, especially during night time. Bright lights are installed around the field to deter animals from entering. While this method can be effective to some extent, it consumes a significant amount of electricity and may not always prevent determined animals from entering the farmland.

Another limitation of existing systems is the lack of real-time monitoring and alert mechanisms. Farmers are not immediately informed when animals enter their fields, which leads to delayed response. By the time the farmer becomes aware of the intrusion, crops may already be damaged.

Overall, the existing systems for crop protection are mostly manual, less efficient, and require continuous human effort. They do not provide automated detection or quick response to animal intrusion. Due to these limitations, there is a need for a smart and automated system that can monitor farmland continuously and protect crops more effectively.

Fig 2: Notification to farmer

IV. PROPOSED SYSTEM

The proposed Smart Crop Protection System is designed to provide an automated and intelligent solution for protecting crops from animal intrusion using IoT and wireless communication. The system integrates sensors, microcontrollers, and communication modules to continuously monitor the farmland. It eliminates the need for constant human supervision and ensures that the crops are protected at all times.

In this system, motion detection sensors such as PIR sensors and ultrasonic sensors are placed around the boundary of the agricultural field. These sensors continuously observe the surroundings and detect any movement caused by animals entering the farm. When motion is detected, the sensors send signals to the microcontroller, which acts as the central processing unit of the system.

The microcontroller, such as Arduino Uno or Raspberry Pi, processes the incoming signals from the sensors. It is programmed to analyze whether the detected movement is significant and corresponds to animal intrusion. Based on this analysis, the system decides whether to activate further actions like alerts or deterrents.

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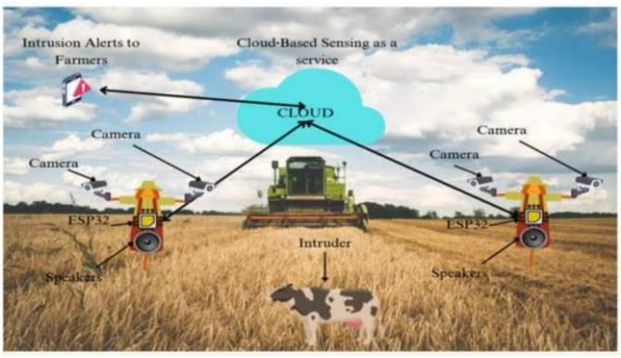

Fig 3: Proposed crop protection system from animals

The system uses wireless communication technologies such as GSM, WiFi, or LoRa to send real-time alerts to the farmer. When an animal is detected, a notification is sent to the farmer's mobile phone through SMS or a mobile application. This allows the farmer to monitor the farm remotely and take necessary action immediately.

To prevent animals from damaging crops, the system includes deterrent modules such as sound alarms and light systems. When triggered, these modules generate loud noise or bright light to scare away animals. These deterrents are especially useful during nighttime when animal intrusion is more common.

The system is powered using a reliable power supply, which may include batteries or solar panels. Solar-powered systems are highly beneficial for agricultural fields as they provide continuous operation even in remote areas without electricity. This ensures that the system works efficiently throughout the day and night.

Overall, the proposed system provides a smart, efficient, and cost-effective solution for crop protection. By combining IoT technology, real-time monitoring, wireless communication, and automated deterrent mechanisms, the system significantly reduces crop damage, minimizes manual effort, and supports the development of modern smart agriculture practices.

V. RESULTS OBTAINED

The Smart Crop Protection System from animals using IoT and wireless technology was successfully implemented and tested in a simulated agricultural environment. The system was able to detect animal movement using sensors such as PIR and ultrasonic sensors with good accuracy. Whenever an animal entered the monitored area, the system quickly responded by identifying the movement and initiating further actions. This shows that the system is reliable for real-time detection of animal intrusion in farmland.

The alert mechanism worked effectively by sending notifications to the farmer through wireless communication modules such as GSM or WiFi. The farmer received instant alerts in the form of SMS or mobile notifications, which helped in taking quick action. This real-time communication reduces the delay in response and helps in preventing crop damage. The system proved to be efficient in keeping the farmer informed at all times.

The deterrent modules such as sound alarms and light/flame systems were also tested and showed positive results. When activated, these modules successfully scared away animals from the farmland. The combination of sound and light created a disturbance that forced animals to leave the area quickly. This automatic response reduces the need for human intervention and protects crops even during night time.

Overall, the system demonstrated effective performance in detecting animals, alerting farmers, and preventing crop damage. It reduces manual effort, saves time, and improves agricultural productivity. The results indicate that the proposed system is a practical and cost-effective solution for modern smart farming and can be further enhanced with advanced technologies like AI-based animal recognition in future developments.

VI. BLOCK DIAGRAM

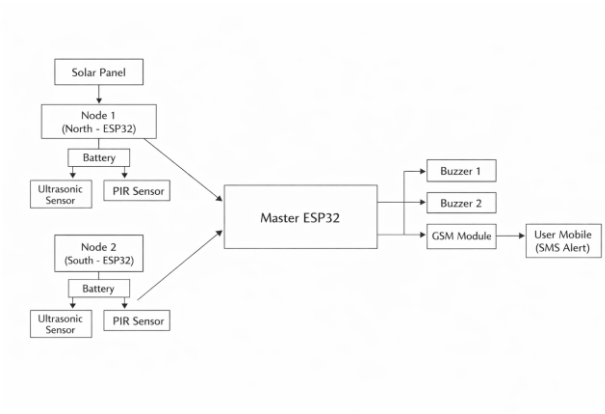

Fig 4: Block diagram of smart crop protection

The proposed Smart Crop Protection System using IoT consists of multiple sensing nodes and a central master controller to monitor and protect agricultural land. The system is divided into two main sensor nodes, namely the North Node and the South Node, each built using an ESP32 microcontroller. These nodes are equipped with ultrasonic sensors and PIR sensors to detect the presence and movement of animals in the field. The ultrasonic sensor measures the distance of objects, while the PIR sensor detects motion based on infrared radiation. Both nodes are powered using a solar panel and battery setup, ensuring continuous operation in real-time outdoor conditions.

The data collected from these sensor nodes is transmitted to a central Master ESP32, which acts as the main processing unit. Upon receiving intrusion signals from any node, the master controller activates alert mechanisms such as buzzers to scare away animals. Additionally, a GSM module connected to the master ESP32 sends an SMS notification to the farmer, providing real-time alerts about field intrusion. This system ensures efficient, automated, and eco-friendly crop protection by combining sensing, communication, and alert mechanisms in a structured manner.

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VII. FUTURE SCOPE

The Smart Crop Protection System from animals using IoT and wireless technology has a wide scope for future improvements and advancements. One of the major future enhancements is the integration of Artificial Intelligence (AI) and Machine Learning (ML) algorithms. By using AI-based image processing, the system can accurately identify different types of animals such as elephants, wild boars, or monkeys. This will help in providing specific responses based on the type of animal detected, making the system more intelligent and efficient.

Another important future scope is the use of advanced communication technologies such as LoRa (Long Range Communication) and 5G networks. These technologies can improve the range and speed of data transmission, especially in remote agricultural areas where network connectivity is limited. With better connectivity, farmers can receive faster alerts and monitor their fields in real time without any delay.

The system can also be enhanced by integrating renewable energy sources such as solar power. Using solar panels can make the system more energy-efficient and suitable for rural areas where electricity supply is not reliable. In addition, energy storage systems like batteries can ensure continuous operation of the system during night time or cloudy weather conditions.

Future developments can also include the addition of more advanced deterrent techniques such as automated water sprinklers, ultrasonic sound devices, or drone-based monitoring systems. Drones can patrol large farm areas and provide real-time video surveillance, helping farmers cover more area efficiently. These technologies can further reduce human effort and increase crop protection efficiency.

Finally, the system can be connected to cloud platforms and mobile applications for better data analysis and remote monitoring. Farmers can store historical data, analyze animal movement patterns, and make better decisions for crop protection. With continuous technological advancements, the Smart Crop Protection System can evolve into a fully automated smart farming solution that improves agricultural productivity and ensures sustainable farming practices.

VIII. CONCLUSION

The Smart Crop Protection System from animals using IoT and wireless technology provides an innovative and reliable solution to protect agricultural fields from animal intrusion. By integrating sensors, microcontrollers, and wireless communication, the system can continuously monitor farmland and detect the presence of animals in real time. This helps in minimizing crop damage and ensures better safety for agricultural production.

The system also reduces the burden on farmers by eliminating the need for constant manual monitoring. With features such as sound alarms, light or flame deterrents, and instant mobile notifications, farmers can respond quickly to any threat even from a remote location. This not only saves time and effort but also improves the efficiency of crop protection methods compared to traditional techniques.

Overall, this smart system supports the development of modern agriculture by combining automation and IoT technology. It is cost-effective, easy to implement, and suitable for both small and large-scale farms. In the future, with further advancements, this system can be enhanced with artificial intelligence and advanced sensors to provide even more accurate detection and improved protection, contributing to sustainable and smart farming practices.

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