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Smart Crop Protection System

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Abstract- Crop protection is the practice of protecting crop yields from different agents, including pests, weeds, plant diseases, and other organisms. India relies on a variety of crops for food production. When these crops are damaged due to animal attacks, farmers face a significant financial loss, which will affect the gross GDP of our country as well. The farmers can't barricade entire fields for 24 hrs. Many ideas and devices existed to protect crops from animals. One of them is the electric fencing system which is mainly used nowadays. The main problem with using an electric fencing system i.e. non-secure for animals and farmers by the electric shock. So, we got an idea of a smart crop protection system, which can eliminate those problems. As per our idea, it can prevent the entry of animals into agricultural fields, and this idea can be applicable for any farm buildings & houses as well.

Keywords: Electric fencing system, smart crop protection system, Barricade, & agricultural fields.

I. INTRODUCTION

Crop damage caused by stray & wild animals is a persistent challenge in agricultural regions, leading to significant economic losses for farmers. It is estimated that 30-40% of crops are destroyed annually due to attacks by wild animals in India (1). Conventional protection methods, such as manual guarding and physical fencing, are labour-intensive, costly, unsafe and impractical for continuous operation. Moreover, the requirement of uninterrupted monitoring makes these approaches inefficient, particularly for small and medium-scale farmers.

Hence, there is a growing need for an automated, low-cost, and energy-independent crop protection system that can operate reliably without human intervention. The scheme "Assistance for Crop Losses Due to Wild Animal Attacks" is a sub-component of the umbrella scheme "Compensation for Loss of Life and Property Caused by Wild Animals in and around Forest Areas", which is implemented by the Department of Forest, Government of Uttarakhand (2). These schemes are proposed by the state governments of India for the loss of crops due to animal attack.

This may loss for the farmer and the government economic system as well. So, to prevent this, I propose this idea. Agriculture provides food for people and raw materials for industries, but animal intrusion and fires in farmlands cause heavy crop losses(3). In this contest, the present work proposes an automatic solar-powered animal intrusion, detection and alert system designed to safeguard agricultural fields without the use of grid electricity. The system operates on renewable solar energy, where a solar panel charges a battery through an inverter cum charging unit during the daytime. Once the battery reaches full charge, the charging process automatically terminates, ensuring safe and efficient energy management.

The stored energy is utilised for uninterrupted operation during nighttime, making the system suitable for round-the-clock field protection. Automation and IoT are new technologies used to improve security in farms worldwide. These devices help farmers and farm owners protect their fields and benefit easily (4). In (5), the author says that an Arduino-based system using ultrasonic and PIR sensors to detect animals and protect farm fields, helping farmers reduce crop losses, improve yields, and avoid financial losses. But as compared to them, the idea which I proposed is less costly, simpler in construction and more efficient.

Objectives

- To protect the crop from the entry of animals and avoid damage to the field crops.
- To improve crop production yields.
- To support the farmers, which is important in the farming sector.
- To increase resource use efficiency, enhancing farmers' economic viability.

II. MATERIALS & METHODOLOGY

- Problem Identification/Concept
- Literature Survey
- Problem Definition
- Design and Fabrication
- Testing and optimisation

A methodology primarily consists of a few steps that we have developed to create the prototype of the component. The first thing to do is identify the problem by understanding the current situation. The main problem is the damage to the crops by the fencing system, which is non-secure for the farmers and animals and which is expensive to the farmers. So, to eliminate some of these problems and to find an alternative use to avoid these problems next step is to search and collect information on whether any substitutes are available to solve these problems. Based on an extensive literature survey of modern methods and equipment used and tested in various solar energy-based farm applications.

This motivated us to carry out the research on a sensor and solar energy-based crop protector, which is an automatic system. Once the problem is defined, the Computed aided design modelling is done. After procuring the components of the equipment, the fabrication and assembly of the same is completed. The last and important phase of the work is testing and optimising the model, which is done experimentally. The sensor and solar energy-based crop protector research is experimental research. In (6), A. V. Prabu proposes an intelligent IoT-based smart agriculture system using advanced sensors, hyperspectral cameras, and deep learning to monitor crops, detect plant diseases and animal intrusion, and improve crop productivity and profits for small villages and cities. So, these A. V. Prabu proposed an idea with a complex material, construction and more cost.

MATERIALS

Solar panel, Battery, Inverter cum charging unit, LED lights, Resistors, Light Dependent Sensors, Laser light, Buzzer, Mirrors.

1) **Solar panel:** The solar panel is the primary energy source of this system. It converts solar radiation into electrical energy during daytime. This generated power is used to charge the battery through inverter cum charging unit. Since this system does not depend on grid electricity, it is suitable for remote agricultural fields and ensures sustainable operation.
2) **Inverter cum charging unit:** The inverter-cum-charging unit regulates the power flow between the solar panel and the battery. It performs two main functions:

- Controls the charging process of the battery during daytime
- Inverter converts DC (direct current), which comes from a solar panel, into AC (Alternating Current)

3) Battery: The battery stores the electrical energy generated by the solar panel. The stored energy is used to operate the laser, LDR sensor, and buzzer, especially during nighttime or low sunlight conditions. This ensures Continuous and uninterrupted operation of the crop protection system.

4) Laser Source (Light): The laser acts as a sensing transmitter. It emits a continuous laser beam along the boundary of the field. The beam is guided using mirrors placed at the corners of the field so that a single laser source can cover multiple sides of the agricultural area.

5) Mirrors (Mirror1, Mirror2, Mirror3): The mirrors are strategically placed at the corners of the field boundary. Their function is to:

- Reflects the laser beams around the perimeter of the field.
- This arrangement reduces the need for multiple lasers and minimises system cost while ensuring full boundary coverage

6) LDR sensor (Light Dependent Resistor): The LDR sensor acts as the receiver of the laser beam. Its resistance changes based on the light intensity:

- When the laser beam falls on the LDR, its resistance remains low, and the buzzer stays OFF.
- When the beam is interrupted, the LDR's resistance changes, triggering the control circuit.

Thus, the LDR plays a key role in detecting animal movement across the field boundary

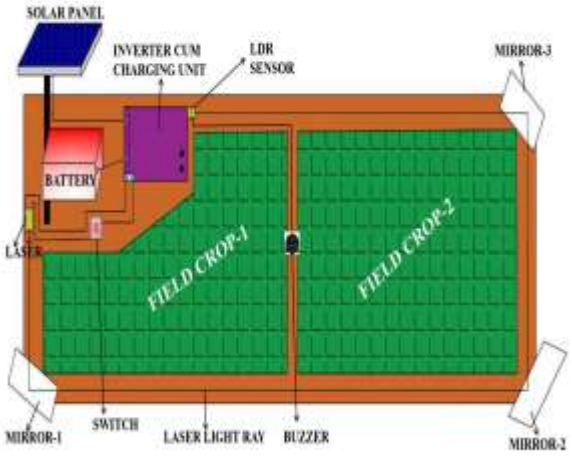
8) Switch: The switch is used to manually activate or deactivate the system. Once switched on, the laser

beam, sensing circuit and buzzer become operational. This provides flexibility for maintenance or manual control when required.

9) Buzzer (Human-Voice-Sound Generator): The buzzer is placed at the centre of the field to ensure uniform sound distribution. Unlike a conventional buzzer, it produces human-like warning sounds, which are more effective in scaring animals. When the laser beam is interrupted, the buzzer is immediately activated, creating a perceived threat and forcing animals to retreat.

Construction & Working Of The System

Working of this model is automatic, and there is no use of electricity, solar panel is used for generating electricity. The solar panel is connected to the inverter cum charging unit for indication purposes. During the day, with the help of a solar panel, a battery connected to a circuit gets charged and use in night. When the battery is full, the automatic charging of the battery stops. Whenever the switch is turned on, the working process begins, i.e. the laser light is "ON" and passes the light ray to the LDR sensor through the 3 mirrors placed at the 3 corners, which covers all sides of the field as one beam. Here, when laser light falls on the LDR sensor, there is no passage of electricity to the buzzer (buzzer is processed with human voices), and when the light falls on the LDR stopped, then the buzzer is activated and sounds like a human voice (buzzer is placed in the middle of the field).



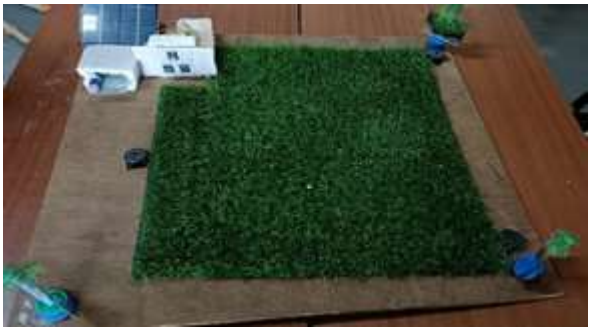


Figure-01: Block diagram & prototype model of the smart crop protection system

When the animals enter from any side of the fields or any direction, the laser beam gets destroyed by the animal, which prevents the fall of the laser beam on the sensor and, thus, the buzzer is activated and produces sounds. Here, due to the buzzer sound, animals think there is a threat in that area and try to escape from the field. Hence, there is no essential requirement for continuous monitoring of the field. Automation reduces time, effort, and cost, and also it provides farmers to concentrate on the primary objectives of their business. Multiple tasks can be completed faster. Automating processes ensures high-quality results as each task is performed identically, without human error.

II. FUTURE SCOPE AND POSSIBLE DEVELOPMENT

Although the proposed sensor-based crop protection system effectively prevents animal intrusion, several enhancements can be incorporated in the future to improve performance and scalability.

- IoT-based remote monitoring and alert system.
- Multi-sensor integration for improved detection accuracy.
- AI-based animal identification to reduce false alarms.
- Scalable and weather-resistant design for large fields.

IV. CONCLUSION

The proposed sensor-based crop protection system provides an effective, economical, safe and eco-friendly solution to the growing problem of crop

damage caused by animal intrusion. By integrating laser-LDR sensing with a human-voice alert mechanism, the system successfully detects animal entry from any direction and responds instantly without the need for continuous human monitoring. The system operates entirely on renewable solar energy, making it independent of grid electricity. Automatic battery charging and controller power management enable uninterrupted day and night operation, enhancing reliability and usability. This system can also be used for buildings, farm houses, nursery greenhouses, storage areas, off-grid locations and open land protections, etc.

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