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SMART CROPPROTECTION SYSTEM

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Abstract -Farmers who cultivate land near forest regions often struggle with frequent crop damage caused by wild animals. These unexpected intrusions not only reduce yield but also affect their income and livelihood. Common protection methods, such as guarding fields manually or installing fixed fences, are not always reliable because they demand constant attention and fail to respond immediately when animals enter the field. To solve this problem, this work proposes an intelligent crop protection approach that uses both artificial intelligence and embedded systems. In this system, an ESP32-based camera continuously captures images of the field. These images are processed using a machine learning model created with Edge Impulse, which can distinguish between humans and animals. This selective identification is important because it prevents unnecessary system activation when people are present. Once an animal is recognized, the system triggers a response mechanism. A stepper motor is used to control the connection of an electric fence, which is activated only for a short duration. The fence produces a mild, non-harmful shock that safely drives the animal away. Since the fence operates only when required, the system avoids continuous power usage and improves overall safety. This solution reduces the need for human supervision, reacts instantly to threats, and uses energy efficiently. It can also be expanded to suit different farm sizes, making it practical and affordable. In conclusion, the system highlights how modern technologies like IoT and machine learning can be applied to protect crops in a smarter and more dependable way, especially in wildlife-prone areas.
Keywords-Smart Agriculture, Crop Protection, Wild Animal Detection, ESP32 Camera Module, Edge Impulse, Machine Learning, IoT-Based Monitoring, Animal-Human Classification, Automated Deterrent System, Electric Fence Control, Stepper Motor Mechanism, Real-Time Surveillance

I. INTRODUCTION

Agriculture is very important to the economies and lives of many countries, especially in areas that are still developing. Farmers have a lot of problems, but one of the biggest is that wild animals and people who aren't supposed to be there can damage their crops. Common ways to protect crops, like manual monitoring, physical fencing, and scare devices, are often not very effective, take a lot of work, and don't always work. These methods need people to be involved all the time, and they might not give timely responses, which could cause big crop losses.As embedded systems and AI continue to improve quickly, there are more and more chances to make smart, automated solutions for farming. The combination of computer vision and machine learning techniques makes it possible to monitor things in real time and make smart decisions. Convolutional Neural Networks (CNNs)-based image classification models have done an amazing job of finding and telling apart different objects in a scene.This paper introduces an intelligent crop protection system that employs an ESP32-CAM module integrated with a machine learning model created using Edge Impulse. The system continuously takes pictures of the farm field and processes them with a Mobile Net-based CNN architecture that uses transfer learning.

The model learns to sort pictures into groups like "animals" and "people," which makes it possible to find things in real time. An automated control system is set up to run an electric fence system based on the results of the classification. A stepper motor is used to do this. The system turns on the fence when it sees an animal to keep crops from being damaged. On the other hand, the system

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turns off the fence to keep people safe when it sees a person or there is no threat. This smart way of making decisions cuts down on the need for people to get involved while making things more efficient and reliable.The suggested system is cheap, uses less energy, and can be used in real-world farming settings. The system shows a practical way to modernize crop protection methods by using both edge AI and embedded hardware. This work helps precision agriculture move forward by offering a scalable and automated way to protect crops while keeping people safe.

II.LITERATURE SURVEY

Protection against such crop pests can be considered one of the problems that arise in agriculture, as it is necessary to protect the crops from damage by animals and individuals not authorized to enter the agricultural field. The methods of monitoring and protecting crops from damages may include visual inspection of the farmland or even placing some fencing around it, but such measures cannot ensure the protection of crops round-the-clock. Another method may include usage of infrared and motion sensor devices, but they have difficulties recognizing objects and providing accurate notifications since they cannot differentiate between various objects. However, the recent progress in computer algorithms enabled them to recognize various objects by using images. Such recognition of crops by computers is provided thanks to the usage of artificial neural networks that can analyze the image and determine the objects on it due to the fact that they have the ability to distinguish the edges, contours and patterns. Such type of neural network analysis of images and videos is known as Convolutional Neural Network. MobileNet is a choice for things, like cameras and small devices because it does not need a lot of power to work. The ESP32-CAM is an example of a device that can process pictures right away. Some systems can even sound an alarm. Turn on a fence by itself but they often do not do a good job of figuring out what is really going on and keeping people safe. The Mobile-Net system we are talking about uses a kind of computer model to detect animals and humans and then it controls the fence. This way Mobile-Net helps to keep crops safe. People are not hurt by the fence. Mobile-Net does a job of protecting crops and keeping people safe at the same time.

III. METHODOLOGY

A. System Overview

The Smart Crop Protection System is made to help protect farms from animals. It does this by using cameras to watch the fields and machines to scare away animals. The system uses a camera to watch the field all the time. It takes pictures. Uses a computer program to look at them. This program is good at figuring out if the thing, in the picture is a person or an animal. If the program says it is a person the system does nothing. Just keeps watching.. If it says it is an animal the system starts the scare away process. The system uses a kind of motor to turn on a fence that gives a little shock to animals. This shock is not strong. It only lasts for a short time. It is just enough to make animals not want to come into the field. The Smart Crop Protection System runs all the time so it can watch the field find animals and scare them away without people having to be all the time. The Smart Crop Protection System is always working to protect the farm.

B.Block Diagram

Here in the block diagram, we have both hardware control and software control. First, we have Edge Impulse, which is used to train the model and for deployment. Then we have the ESP32 camera module, which detects animals and triggers the stepper motor. Here, if an animal is detected, the motor turns clockwise and gets contact with the fence. If the animal is gone, the stepper motor then turns anti-clockwise. To check whether the fence is getting charged or not, we added a buzzer connected to the fence.

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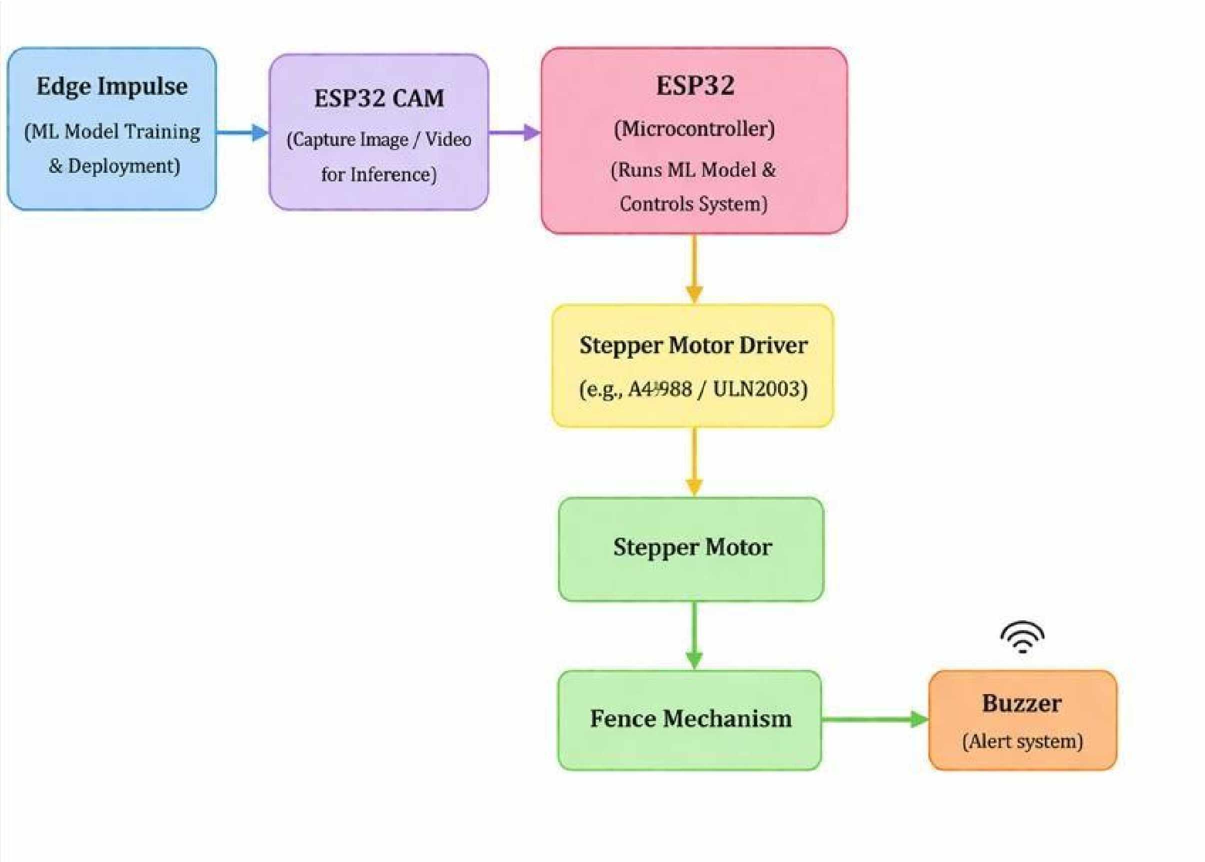

Fig.1. Block diagram illustrating the overall system architecture

C. Flow Chart

The flowchart describes the working process of smart crop protection system .The operation begins with ESP32 camera which captures the image of field continuously. When animal is detected it triggers the stepper motor and fence get activated along with buzzer. If no animal is detected it continues the process by capturing Image again.

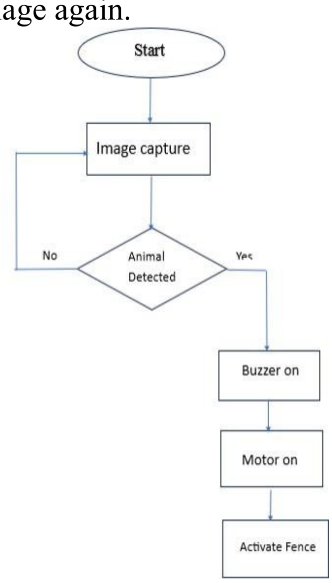

Fig.2. Flowchart of the Proposed System

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D. Circuit Diagram

The circuit diagram shows how the Smart Crop Protection System is built witThis driver connects the low-power control signals from the microcontroller to the stepper motor so that it can work properly. The ULN2003 driver connects to the stepper motor's output pins (OUT1– OUT4) and powers it through an external 5V supply, which keeps the motor running smoothly. The fence mechanism gets its power from an outside 12V power supply. The stepper motor is connected to a switching system that controls the connection between the fence and the power supply. When the motor is turned on, it turns to close the switch, which lets electricity flow from the power source to the fence. This gives the fence energy and keeps animals away.h hardware. It includes an ESP32-CAM module, a ULN2003 stepper motor driver, a stepper motor, and an external power supply. The ESP32-CAM is the main processing unit. It takes pictures and runs the machine learning model for object detection.

The ULN2003's input pins (IN1–IN4) are connected to the GPIO pins of the ESP32-CAM. All parts have a common ground that keeps the reference voltage stable and makes sure everything works properly. The design makes sure that the fence only turns on when it needs to, which makes it safer and uses less power.

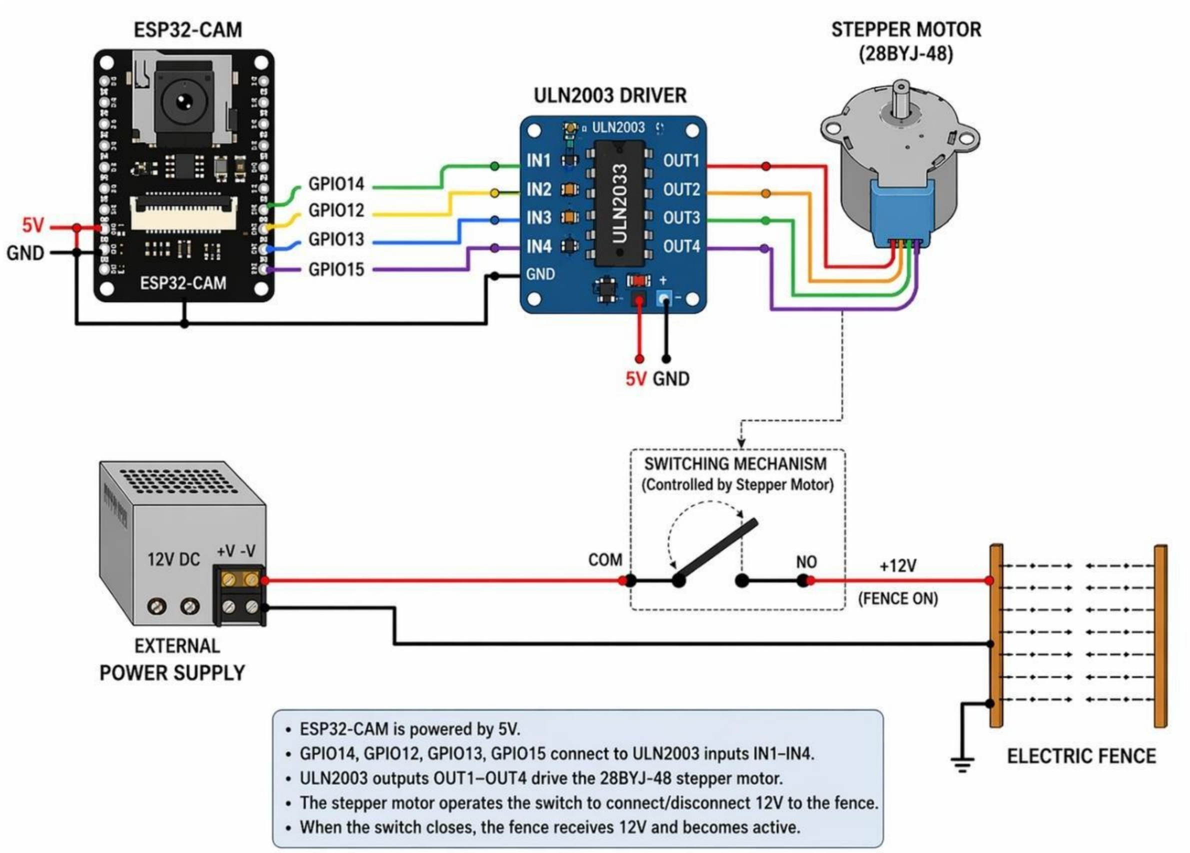

Fig.3. Circuit Diagram of the Proposed System

IV. RESULTS AND ANALYSIS

The Smart Crop Protection System that was suggested was successfully put into use and tested in a controlled setting to see how well it worked. The ESP32-CAM, which had a machine learning model made with Edge Impulse built in, could find and sort objects as either people or animals in real time. The system worked well and correctly identified most of the time.

During testing, the model was able to tell the difference between people and animals, which meant that the deterrent mechanism only went off when it was needed. As soon as the stepper motor detected an animal, it quickly activated the switching mechanism, which connected the fence to the outside power supply. The fence going off and the buzzer going off together helped keep the animal away right away. The system was better because it was more automated, needed less human monitoring, and used power more efficiently because the fence only worked when it was needed.

Fig.4. Hardware Prototype used for Experimental Evaluation

The table shows how the system works in different situations, such as when it detects an animal, when a person is present, or when there are no objects. It shows that the system works correctly by only turning on the deterrent when it's needed, which keeps everyone safe and makes the system work better.

Case No.	Scenario	System Detection	Action Taken	Result
Case 1	Animal Detected	Animal	Stepper motor activated, fence energized, buzzer ON	Animal was successfully deterred
Case 2	Human Detected	Human	No action taken, system continues monitoring	Safe operation ensured, no false triggering
Case 3	No Object (Empty Field)	No detection	No action taken	Energy saved, continuous monitoring
Case 4	Human and Animal Detected	Human prioritized	Deterrent system not activated	Safety maintained, avoided risk

Test Case 1: Finding Animals (Correct Detection)

When an animal came into view of the camera, the trained model correctly identified it. The ESP32 turned on the stepper motor, which made it possible for the fence to connect to the outside power source. The fence was powered on for a short time, and the buzzer went off. The response was quick and worked to scare the animal away. Test Case 2: Detecting humans (safe condition)

Test Case 2: Detecting humans (safe condition)

The system correctly identified the object when it saw a person and did not turn on the deterrent mechanism. The stepper motor didn't move, and the fence didn't get any power. The system kept an eye on things to make sure they were safe and to avoid false triggering.

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Test Case 3: No Object / Empty Field
The system stayed in continuous monitoring mode because there was no object. No action was taken, and the power use was low, showing that it worked well with little energy.

Test Case 4: More than one object (person and animal)
The system put safety first when both a person and an animal were in the frame. The system didn't turn on the fence if it detected a person and an animal at the same time, which shows how safe it is to use.

V.CONCLUSION

The Smart Crop Protection System described in this work is an automated and effective way to keep wild animals out of agricultural fields. The system can tell the difference between people and animals and respond appropriately because it uses machine learning and embedded hardware. Using an ESP32-CAM module for real-time monitoring and a control system based on a stepper motor makes it possible to turn on the deterrent system only when it's needed. The experimental results show that the system works well in a variety of situations, making it safer, requiring less manual intervention, and using less energy. There were some small problems when the lights were low, but overall, the performance shows that the proposed method is useful. This system can be improved and made bigger for use in real-world farming.

VI. FUTURESCOPE

The Smart Crop Protection System that has been suggested can be made even better to work better, be more accurate, and be more flexible in real-world situations. Future upgrades could include adding advanced sensors like infrared or thermal cameras to make it easier to find things at night or in low-light situations. The system can also be made bigger so that it can recognize more than one type of animal and use different methods to keep them away depending on the type of threat. Farmers can also get real-time alerts and keep an eye on field activity from afar by using wireless communication technologies like GSM or IoT-based cloud platforms. Using solar power can make the system use less energy and be better for use in remote farming areas. Improving the machine learning model even more can make it more accurate at finding things and cut down on false classifications. In general, these improvements can make the system stronger, more flexible, and better for use on a large scale in farming.

REFERENCES

[1] A. Kumar and R. Singh, "Smart Agriculture System Using IoT and Machine Learning," International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 6, pp. 123– 126, 2020.
[2] S. Patel et al., "Animal Detection and Repellent System Using Embedded Systems," International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), vol. 8, no. 5, pp. 456–460, 2019.
[3] B. Sharma and P. Verma, "IoT-Based Smart Farming System for Crop Protection," IEEE Conference on Smart Technologies, pp. 210–215, 2021.
[4] D. L. A. G. A. Slade, "Agricultural Automation and Animal Management Systems for Crop Protection," Journal of Smart Agriculture Systems, 2018.
[5] A. M. G. R. Pinto, "IoT-Based Animal Detection and Monitoring in Agricultural Applications," International Journal of IoT and Smart Systems, 2019.
[6] J. Brownlee, "Introduction to Machine Learning for Image Classification," Machine Learning Mastery, 2019.