Proceedings of the 8th International Conference on Communication and Electronics Systems (ICCES 2023)
IEEE Xplore Part Number: CFP23AWO-ART; ISBN: 979-8-3503-9663-8

Prototype for Smart Crop Protection Against Wild Animals

Sushmitha Bhatta
Department of ECE
GRIET
Telengana,Hyderabad,India
sushmithabhatta123@gmail.com

Shiva Goud Bathini
Department of ECE
GRIET
Telengana,Hyderabad,India
shivagoudbathini2609@gmail.com

Hemanth Reddy Devarapalli
Department of ECE
GRIET
Telengana,Hyderabad,India
hemanth123reddy143@gmail.com

Mounica Machunoori
Department of ECE
GRIET
Telengana,Hyderabad,India
mounica432@gmail.com

Krishna Reddy G
Department of ECE
GNITS
Telengana,Hyderabad,India
chkrishnareddy_eee@cbit.ac.in

Ajitha D
Department of Software Systems
Vellore Institute of Technology
Vellore, Tamilnadu, India
ajitha.d@vit.ac.in

2023 8th International Conference on Communication and Electronics Systems (ICCES) | 979-8-3503-9663-8/23/$31.00 ©2023 IEEE | DOI: 10.1109/ICCES57224.2023.10192812

***Abstract*— Crop protection system against wild animals are essential for maintaining agricultural productivity and reducing human-wildlife conflicts. There has been a growing focus on creating novel and eco-friendly methods for safeguarding crops from wildlife damage over the past decade. The primary goal of crop protection system against wild animals is to reduce the economic and social losses caused by wildlife and to promote coexistence between humans and animals. In this study, a system is proposed to protect crops from fire and wild animals by hard computing and Open CV software. Arduino device equipped with motion and smoke sensors is used to estimate the motion of any entity (specifically animals) and Open CV software is used to identify the type of entity that entered to the farm. The microcontroller is programmed to trigger a warning alarm to scare away animals approaching the field and notify the farmer via SMS and call-in case of any danger. This monitoring system ensures complete protection of crops, preventing potential losses due to animal attacks or fire incidents. The development of effective and sustainable crop protection systems against wild animals is crucial for promoting agricultural productivity, reducing human-wildlife conflicts, and fostering coexistence between humans and animals.The proposed prototype proves to achieve the same considering various factors including the type of wildlife, the local environment, the available resources, and the ethical implications of different methods. The system also proves to be cost efficient and safe in terms of the acoustics used to scare the animals and prevent them from entering the farm.**

Keywords*— *Crop Protection, Human-Wildlife Conflicts, Agricultural Productivity, Open CV, Acoustic Deterrents

I. INTRODUCTION

The agricultural sector is a crucial pillar of numerous global economies, serving a pivotal function in feeding the expanding population. However, farmers face several challenges in their daily operations, such as unpredictable weather conditions, pests, diseases, and wild animal attacks. Among these challenges, wild animal attacks can cause significant losses to crops and can sometimes result in the loss of entire harvests. Farmers spend a considerable amount of time and resources protecting their crops from these animals by installing physical barriers or hiring guards. These methods are expensive, time-consuming, and may not always be effective.

With recent advances in technology, it is now possible to develop efficient and cost-effective solutions to protect crops from wild animal attacks. One such solution is the use of Arduino microcontrollers. Arduino is an open-source electronic platform that allows for the creation of a wide range of devices, including those for agriculture. The platform is easy to use, versatile, and highly customizable, making it an ideal choice for farmers looking to protect their crops [1][2].

The proposed methodology explains the working of crop protection system against Wild animals using Arduino. The system is designed to detect and respond to two primary threats to crops, namely, wild animals and fires. A motion sensor-based system is employed to identify the presence of animals in the vicinity of the field, while a smoke sensor is utilized to detect the occurrence of fire. This proposed system is cost-effective, easy to install and operate, and highly efficient. It provides an innovative and reliable solution for farmers to protect their crops against wild animal attacks and fire incidents reducing the loss of crops and improving their yields. Overall, the project is expected to have a significant impact on agriculture by providing a practical and sustainable solution for farmers worldwide.

Sensors taking input from the devices is not only limited to animal intrusion detection but also in various domains like health care [3-5], accident prediction [6][7]

The study presents in-depth review of various IoT systems and relevant sensors for implementing the same. Section II describes various sensors used for various applications followed by the existing parameters, micro-controllers used in building an effecting IoT system. Section III details the methodology opted for implementing the proposed system followed by results indicating the intrusion detection in Section IV.

II. RELATED WORK

Over the last few decades there exists various crop protection methods ranging from traditional methods such as scarecrows, loud noise alarm conditions, egg spray units and fences to more advanced methods such as using sensors, drones, and artificial intelligence to detect and deter animals. For example, some farmers use sensors that detect the presence of animals and activate loudspeakers to emit sounds that scare them away. Other farmers use drones to monitor their crops and identify areas where animals are causing damage,allows them to take preventive measures quickly. [1]

Some crop protection systems also use non-lethal methods such as spraying natural repellents or using visual deterrents such as reflective tapes and lights. These repellents can be made from natural ingredients or synthetic chemicals, and they can be effective in deterring animals from feeding on crops.[2]

Physical barriers such as fences, nets, and electric wires can be used to prevent wild animals from accessing crops. These barriers can be designed to be animal specific, and they can be effective in keeping animals away from crops.[8][14]

Modifying the habitat surrounding crops can make it less attractive to wild animals. For example, planting unpalatable crops as a buffer zone can help deter animals from entering crop fields.[9]

Further, A cost-effective technology that utilizes Radio Frequency Identification is being used for multiple purposes, including detecting and counting animals in farmland and forests, as well as tracking their movements using GPS. Also generates buzzer and sent alert messages to the owners. [10][15]

The current paper develops “An intelligent security system for farm animal protection”, a technique that uses widely wired network devices to shield crops from animals. When an animal contacts a fence under this method, it is tracked. The sensor for identifying the animals is made out of fencing wire. Because the wire has a high resistance, an amplifier circuit is also used. The microcontroller's analog-to-digital converter (ADC) will receive and magnify every alteration detected in the fencing wire. Due to modification, a GSM module-based SMS is sent to the farmers which prevents the crop from animals which destroys field.[11-13].

III. CONCEIVED IOT CROP PROTECTION SYSTEM

The proposed system for crop monitoring uses sensors to gather data in agricultural fields, including a PIR sensor, smoke sensor, camera, and GSM. When an animal is detected by the PIR sensor, the signal is processed by a microcontroller and triggers the system, which activates a buzzer, sends an alert via SMS and intimate to the owner. Additionally, the camera can identify the type of animal and emit sounds with varying frequencies to deter the animal. The Microcontroller Block is responsible for receiving input signals from the PIR and smoke sensors and controlling the entire system. When movement or smoke is detected, the GSM module sends an SMS and makes a call to the farmer to alert them that animals may be attempting to enter the farm.

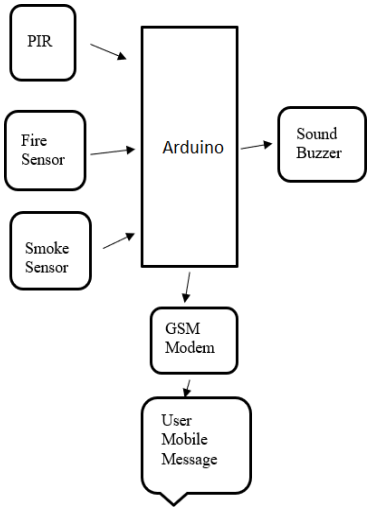

Fig. 1. Block Diagram of the propose Prototype

A. Methodology

An Internet of Things (IoT) powered system is created to generate frequency signals that are bothersome to animals yet imperceptible to humans. The frequency selection is based on a specific method that takes into account the animals' hearing frequency and the level of irritation caused by increasing frequency. Animal detection is done through images captured by cameras, and buzzers are used to emit irritating sounds. The prototype is built as depicted in Fig 2 and includes a PIR sensor for animal detection, as well as smoke and fire sensors, all of which are connected and controlled by an Arduino microcontroller. The specified irritating frequency is emitted through a speaker.

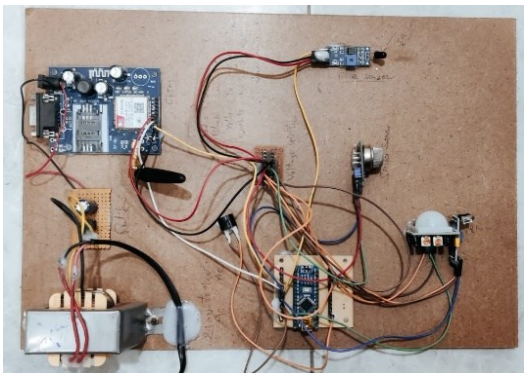

Fig 2: Prototype of Intrusion Detection System

- Identify the requirements: The primary step is to identify the requirements for the system. This involves understanding the business process, the data that needs to be collected, and project requirements.

- Select the sensors and devices: The next step is to select the appropriate sensors and devices to collect the required data. This may involve selecting sensors that can measure the motion of an object, smoke and fire.

- Design the Circuit: Lay out the project's circuit, which should include the sensors, Arduino, and other components. Use a secure power source.

- Develop the infrastructure: Once the sensors and devices have been selected, the next step is to develop the infrastructure part. This involves developing the software, hardware, and networking components that will allow the sensors and devices to communicate with each other.

- Configure the Arduino: When the sensors detect the presence of animals, smoke, or fire, program the Arduino to activate the speakers or GSM module and receive inputs from the sensors and it sends a message to the phone by connecting the GSM module.

- Implement the System algorithm: The system algorithm entails utilizing a Passive Infrared (PIR) sensor to detect animals and a camera to capture their images. These images are then transmitted to the system for processing, which involves identifying the animals through image recognition. The information about the detected animal is, which generates frequencies using a sound buzzer.

- System evaluation: To make sure the system works, test it on a small scale. By moving infront of a PIR sensor. For instance, can check to see if it recognise the subsequently transmitted to an Arduino microcontroller movements and activates the speakers or GSM module.

- Test the system: Once the system has been developed, it should be thoroughly tested to ensure that it is functioning as intended. This includes testing the sensors, devices, and the hardware part.

- Deploy the system: Once the system has been tested and validated, it can be deployed in the field. The system should be monitored to ensure that it is working as intended and to make any necessary adjustments.

- Maintain the system: In order to ensure that the system remains operational, it is crucial to carry out regular maintenance activities. These activities comprise monitoring the system for malfunctions, replacing sensors and devices as required, and updating the software and algorithms whenever necessary.

The fire sensor, smoke sensor and the PIR sensor are the inputs to the microcontroller. When it detects animal motion or fire or smoke it automatically sends SMS to the farmer through the GSM modem. The software part detects the images of the animals in a crop and provides the live video. The animals are identified by the capturing images and sendsthe alert messages to the farmers.

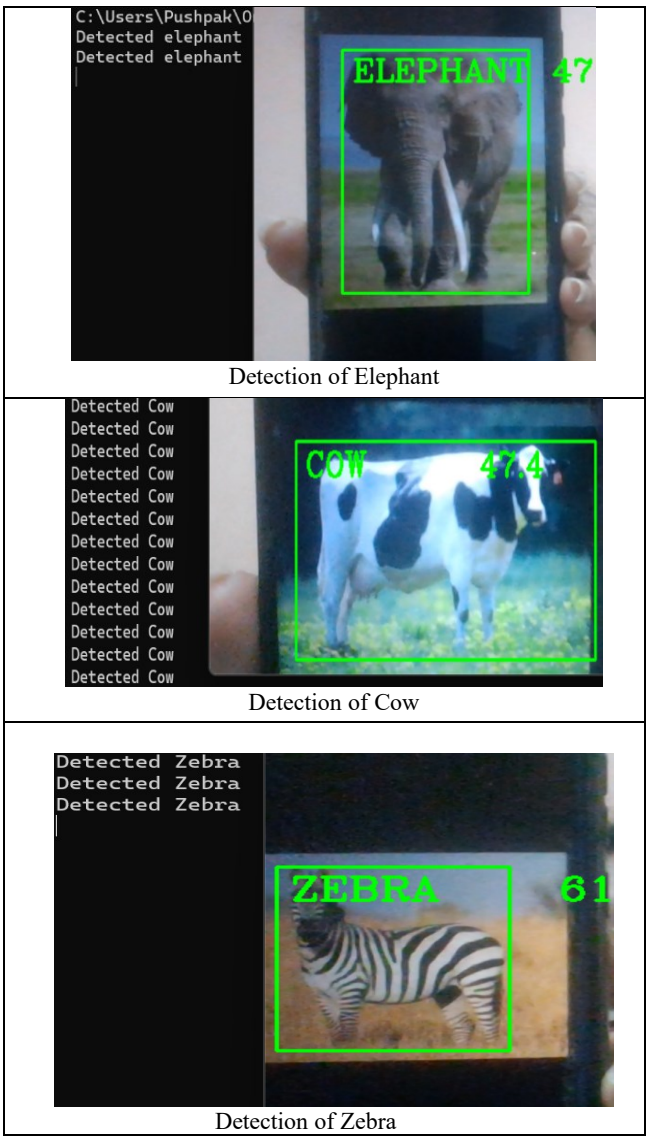

Fig. 3. Intrusion prediction of Different animals (Domestic and Wild)

IV. RESULTS AND DISCUSSION

On the instance of detecting any animal movement in the vicinity of the motion sensor, the PIR sensor relays the initial input signal for additional processing. Subsequently, the processed signal is sent to the microcontroller, which activates the system, triggers the buzzer, and sends an SMS.

Table 3. Comparision of Different Prototypes built for Intrusion Detection for Crop Protection

Reference	Main Core Component	Camera	Automatic Generation of irritating frequency depending on animal detected	Intimation to owner	Alert System
[1]	Raspberry Pi	YES	YES	NO	NO
[2]	PIC microcontroller	NO	NO	YES	YES
[9]	Arduino Uno	YES	NO	YES	YES
[10]	Arduino Mega 2560	NO	NO	NO	YES
[11]	Arduino Uno	NO	NO	NO	YES
Proposed System	Arduino Nano	YES	YES	YES	YES

The system also has a measure to simultaneously notifying the owner through a phone call for faster communication of intrusion.

The software part includes OpenCV python libraries which detects the images of animals and accuracy. Then it produces different irritating frequencies for different type of animals. Camera used here detects the type of animal and automatically produces the sounds having different frequencies to irritate the animal.

Fig-3 illustrates the detection of different animals which are captured by the camera. Three different animals were captured by the camera for detection including Elephant and Zebra which fall under the wild animals category and Cow which is a domesticated animal. The OpenCV libraries identify the animals and can be witnessed seen on the screen as in the figure. The further process of intimation to owner and buzzer for preventing the animals from entering the farm as implemented as discussed in Section-3.

A comparative analysis of various prototypes developed on the concept of IoT based animal intrusion detection for crop protection are studies and tabulated in Table-1. The table indicates the microcontroller used for building the prototype, existence of camera for ease of detecting the animal, message generation and subsequently intimating the owner and simultaneously using the acoustic frequency which would scare the animals away from the farm. The proposed prototype addresses the issues which have not been focused on in the existing systems. The vital element of analysis in which the proposed prototype outruns the other systems is its cost efficiency. The developed system proves to be user friendly as the owner can access the message via the network. New infrastructure or techniques for message receiving is not required as the entire system exploits the concept of GSM which is inherently available on the Mobile phones.

V. CONCLUSION

One of the biggest issues farmers deal with is the devastation of crops by wild animals. So, the goal of this study is to find a way to keep animals out of grain fields. As a result, a system is created that is economical and uses little energy. Those living nearby won't be bothered by the technology because it employs frequencies to keep animals out of the crop field. A system like this will protect the farmer's fields and prevent them from suffering serious financial losses. In the present, crop damage by wild animals has grown to be a significant social issue. So, it needs quick attention and a workable solution. As a result, this project has significant social significance because it seeks to solve this issue. It is discovered that the suggested system, which is based on the Arduino system, is more portable, user-friendly, and less sophisticated, making it easier to utilize for performance. Also, it alerts the farmer by sending messages. In the future, this system can be created more effectively by utilizing wire-free, cost-effective solar-powered camera and sound buzzers. The project's next goals include employing GPS and RFID injectors to locate the animals.

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