Smart crop protection system from wild animals and birds using IoT

Name:K.Ruchitha

Department of ECE,Institute of Aeronautical Engineering

Roll.no:20951A04E0

Email:20951a04e0@iare.ac.in

Abstract:

The main aim of our project is to protect the crops from damage caused by animal as well as divert the animal without any harm. Crops in farms are many times ravaged by local animals like buffaloes, cows, goats, birds etc. This leads to huge losses for the farmers. It is not possible for farmers to barricade entire fields or stay on field 24 hours and guard it. So here we propose automatic crop protection system from animals. Animal detection system is designed to detect the presence of animal and offer a warning. In this project we used PIR and ultrasonic sensors to detect the movement of the animal and send signal to the controller. It diverts the animal by producing sound and signal further, this signal is transmitted to GSM and which gives an alert to farmers and forest department immediately.

Agriculture has always been India's most important economic sector. Wildlife tracking involves acquiring information about the behavior of animals in their natural habitat. This information is used both for scientific and conservation purposes. The primary form of information that needs to be obtained is the location of the animal at certain points in time and this is generally referred to as tracking or radio–tracking.

Keywords :GSM(Global system for mobile) module, Arduino UNO, Buzzer, Power Supply, Camera

INTRODUCTION:

In today's world, agriculture plays a crucial role in sustaining the growing population. However, farmers face numerous challenges, including crop damage caused by wild animals and birds. These animals often invade fields, destroying crops and resulting in significant financial losses for farmers. To mitigate this issue, a smart crop protection system utilizing the Internet of Things (IoT) technology has emerged as an innovative solution.

The smart crop protection system integrates various IoT components such as sensors, actuators, and connectivity devices to create an intelligent and automated solution for monitoring and deterring wild animals and birds. By leveraging real-time data collection, analysis, and response mechanisms, this system enables farmers to proactively protect their crops, minimize losses, and optimize agricultural productivity.

Functionality:

The smart crop protection system employs a range of IoT technologies and functionalities to create a comprehensive and efficient solution. Let's explore some of its key components and how they work together:

1.Sensor Network: Deployed strategically across the agricultural field, sensors detect the presence of animals or birds through various means such as motion, heat, sound, or visual recognition. These sensors capture real-time data and transmit it to the central control unit for analysis.

2.Central Control Unit: This unit serves as the brain of the system. It receives data from the sensor network, processes it using advanced algorithms and machine learning techniques, and identifies potential threats. The control unit makes decisions based on the analysis and triggers appropriate actions to protect the crops.

3.Actuators and Deterrents: Upon identifying a threat, the central control unit activates the appropriate actuators and deterrents. These could include devices like automated scarecrows, water sprayers, sound emitters, or even robotic mechanisms to scare away or repel animals and birds. The system can deploy these deterrents selectively based on the type of threat and the severity of the situation.

4.Connectivity and Communication: The IoT-enabled system relies on a robust network infrastructure to connect all components together. Wireless connectivity, such as Wi-Fi or cellular networks, enables seamless communication between sensors, the central control unit, and other devices. This connectivity allows real-time data transmission, system updates, and remote monitoring and control.

Benefits:

The integration of IoT into crop protection systems offers several significant advantages:

1.Improved Efficiency: The system's real-time monitoring capabilities enable early detection of animal or bird intrusions, allowing for immediate preventive actions. This proactive approach minimizes crop damage and optimizes resource utilization.

2.Cost Reduction: By automatically activating deterrent mechanisms only when necessary, the system reduces the need for manual intervention and constant surveillance. This leads to cost savings for farmers and a more efficient use of resources.

3.Data-Driven Insights: The system collects and analyzes vast amounts of data, providing valuable insights into animal behavior patterns, crop vulnerability, and environmental conditions. Farmers can leverage this data to refine their agricultural practices and make informed decisions.

4.Environmental Sustainability: By effectively deterring animals and birds without resorting to harmful or lethal methods, the system promotes a more sustainable approach to crop protection. It minimizes the use of pesticides, which can have adverse effects on the environment and human health.

LITERATURE SURVEY:

The author[1] described the advanced automotive active safety systems, in general, and autonomous vehicles, in particular, rely heavily on visual data to classify and localize objects, such as pedestrians, traffic signs and lights, and nearby cars, to help the corresponding vehicles manoeuvre safely in their environments. However, the performance of object detection methods could degrade rather significantly in challenging weather scenarios, including rainy conditions. Despite major advancements in the development of draining approaches, the impact of rain on object detection has largely been understudied, especially in the context of autonomous driving.

The authors[2] described Object Detection algorithms find application in various fields such as defence, security, and healthcare. In this paper various Object Detection Algorithms such as face detection, skin detection, colour detection, shape detection, target detection is simulated and implemented using MATLAB 2017b to detect various types of objects for video surveillance applications with improved accuracy. Further, various challenges and applications of Object Detection methods are elaborated.

The authors [3]: A lightweight and stable feature extraction module is used to reduce the computational load and stably extract more low-level feature, an enhanced feature processing module significantly improves the feature extraction ability of the model, and an accurate detection module integrates low-level and advanced features to improve the multiscale detection accuracy in complex environments, particularly for small objects.

The authors [4] explored Developing a unique application of monoplotting enables visualization of the results of deep-learning object detection and traditional object tracking processes applied to a perspective view of a parking lot on aerial imagery in realtime. Connecting the real world and perspective spaces, we can create a resilient object tracking environment using both coordinate spaces to adapt tracking methods when objects encounter occlusions.

The authors [5] described State-of-the-art techniques either use back-tracing for owner identification or there is no provision of reporting ownership of the abandoned objects. We propose a convolution neural network-based framework for abandoned object localization and owner identification in video surveillance systems that performs exceptionally well on publicly available datasets and our newly developed dataset.

The authors [6] described Utilizing a monocular image for 3-D object detection is served as an auxiliary module for autonomous vehicles and is a growing concern recently. Currently, the expensive lidar and stereo cameras have a predominant performance on accurate 3-D object detection, whereas monocular-based

methods are considerably lower in performance. The 2-D and 3-D proposals are extracted through a proposal generation network that is enhanced and utilized for estimating accurate 3-D detection and localization.

The authors [7] suggested an object measurement technique for real-time video by utilizing OpenCV libraries and includes the canny edge detection, dilation, and erosion algorithms. The suggested technique comprises of four stages: (1) identifying an object to be measured by using canny edge detection algorithm, (2) using morphological operators includes dilation and erosion algorithm to close gaps between edges, (3) find and sort contours, (4) measuring the dimensions of objects.

The authors [8] proposed four different methods for object-centric anomaly detection in surveillance videos based on autoregressive probability estimation. By means of the methods we propose, normal (typical) events in a scene are learned in a probabilistic framework by estimating the features of consecutive frames taken from the surveillance camera.

The authors [9] proposed A dataset suitable for TensorFlow's Object Detection API has been prepared for traffic signs by using photographs in different traffic and weather conditions. This dataset was trained by selecting the appropriate deep learning model and results were obtained on the test data.

The authors [10] developed a cross domain edge detection based label decoupling salient object detection network (CDENet) is proposed to improve the accuracy of saliency detection and make more adequate use of the edge information in an image. In order to make better use of edge information, a cross-domain edge detection module (CDED) is proposed, which fuses the features of RGB domain and HSV domain. CSSM uses the implicit association between body prediction and edge prediction to strengthen the information interaction between different branches of the neural network. CDED and CSSM can accurately fuse features of different branches and improve the salient object detection accuracy.

The authors [11] Primary object segmentation is essential for understanding videos generated by unmanned aerial vehicles, and this paper proposes a hierarchical deep cosegmentation approach that outperforms 17 state-of-the-art methods in segmenting primary objects in aerial videos.

The authors [12] Deep neural networks and deep learning have been successful in many signal and image processing applications, but this article focuses on the problem of detecting objects of interest from microscopic materials-science images. It introduces different approaches to incorporate object shape, symmetry, and 3D consistency into deep learning to enable network training with fewer data annotations.

The authors [13] This paper attempts to analyze scene information by augmenting salient object information with background information using Minimum Directional Contrast (MDC). The gradient of MDC is calculated and added to the energy functional of GVF so that the contour formation utilizes both edge and saliency information. Three public datasets have been used to evaluate the results.

The emerging intelligent transportation systems puts higher demands on the collection and analysis of the traffic data. LiDAR can provide high-precision point clouds of traffic objects, making it a promising choice for the surveillance device

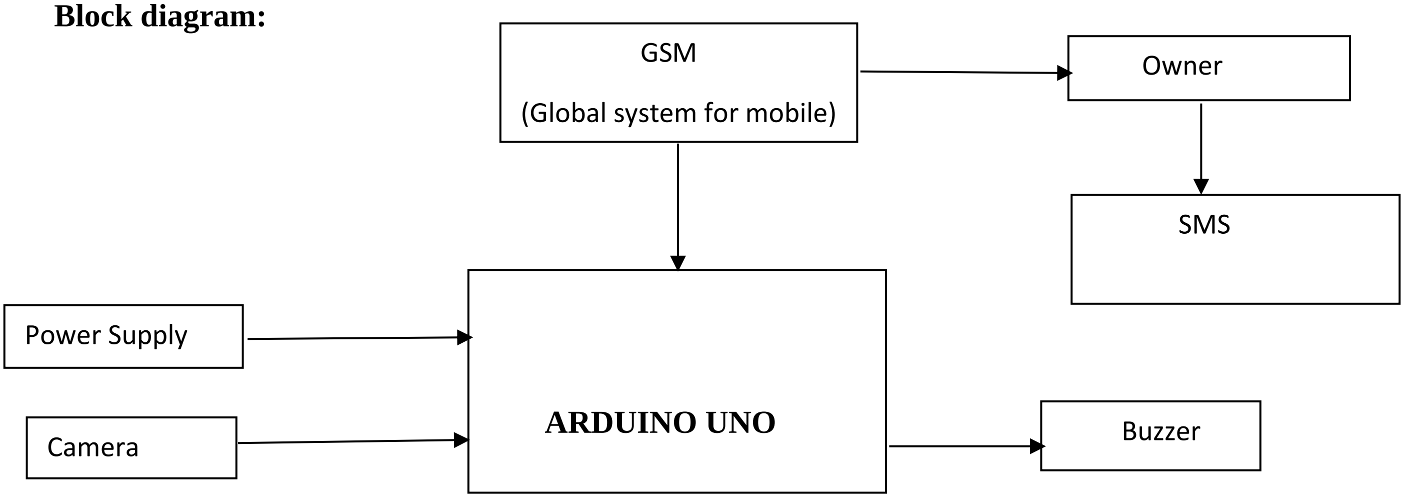
The authors [14] proposed a novel background normalization procedure based on a textural pattern to detect motion exposed by an object and identify it within a blob. It outperforms other object tracking methodologies like Group Target Tracking (GTT), ViPER-GT, grab cut, snakes in terms of accuracy and average time. It also outperforms Gamifying Video Object (GVO) in terms of precision, recall and F1 measure.

The authors [15] had proposed Monocular 3-D object detection is a low-cost and challenging task for autonomous vehicles and robotics. This performance gap is minimized by reforming the monocular-based method as a single internal network and exploiting the correlation between 2-D and 3-D detection spaces. Experimental results on the KITTI dataset show that the proposed method improved the accuracy of 3-D objects by 25% and 32%.

The author [16] had proposed UAVs are emerging as a powerful tool for industrial and smart city applications, and this work proposes a deep learning approach for detection of objects in aerial scenes captured by UAVs. It categorizes the current methods, delineates the specific challenges involved, and proposes an optimized architecture to achieve superior performance.

The author [17] had proposed object detectors are essential for modern computer vision applications, but they can make different predictions due to small image distortions. They proposed a method to measure object detection consistency over time, and shows that applying image distortion corrections such as WEBP Image Compression and Unsharp Masking can improve consistency by as much as 5.1%.

Block diagram:



METHODOLOGY:

1.EXISTING SYSTEM:

The existing system consists of animal detection sensors to scare the animals in order to prevent the damage of crop from animals. In our project we are detecting the presence of animals using ultrasonic sensors and save the dried crop from the predators. Our device can even sense the objects in several scenarios. It includes alarm for object detection in banks, theft recognition in several places. Every year, crop damaged by wild animals is dramatically increasing. Since more and more wild animals are causing damage to their cultivation; humans could not tolerate it. With that background, the objective of this study is to detect wild animals before entering into the crop fields and implementing appropriate scare-away mechanisms in real-time. Based on the prediction sudden flashes of light, ultrasound, and bee sound will be produced to scare away the animals. This system significantly reduces human-animal conflict in crop fields by automatically implementing scare-away mechanisms based on the prediction.

In Sri Lanka, agriculture is one of the major economic forces. percentage and generated Rupees 555,679 (Central Bank of Sri Lanka, 2018) Every year, thousands of human-animal human-animal conflicts occur when animals raid crop fields in search of food. and they are forced to come out of their range agriculture ministry of Sri Lanka, it has been confirmed that 40 percentage of the annual crop is destroyed by wild animals. by elephants, wild boars, monkeys, peacocks, between humans and animals has caused serious damage to crops and resulted in the loss of the economy and the lives of farmers and animals in Sri Lanka.

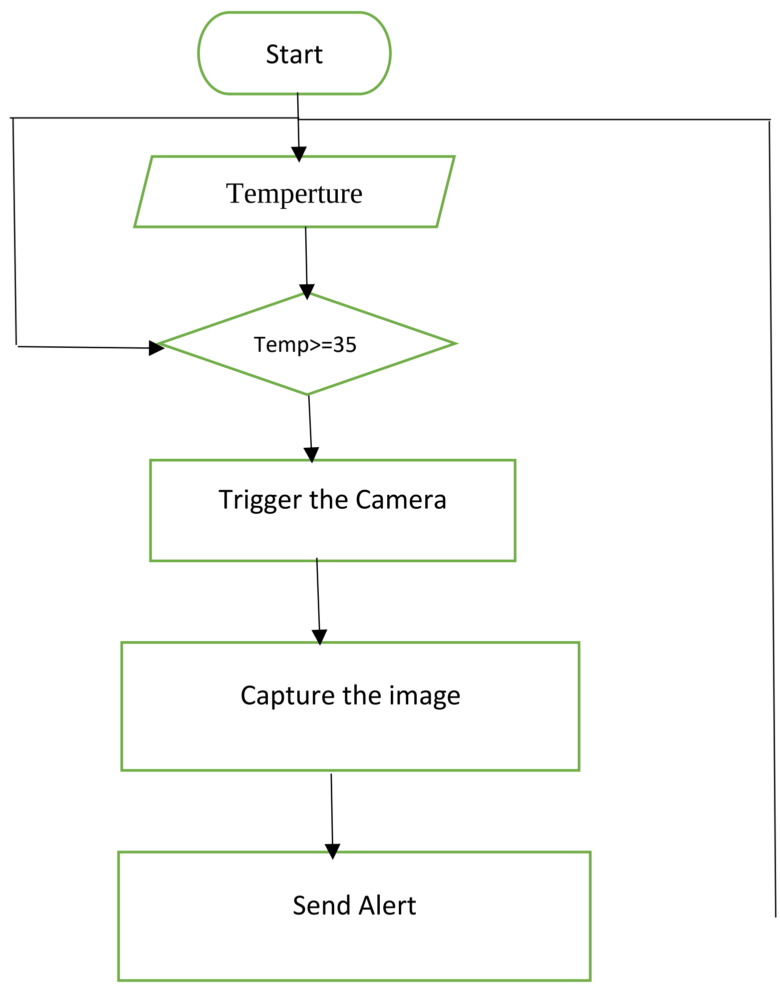


Fig 1: Flow chart of Existing model

2.PROPOSED SYSTEM

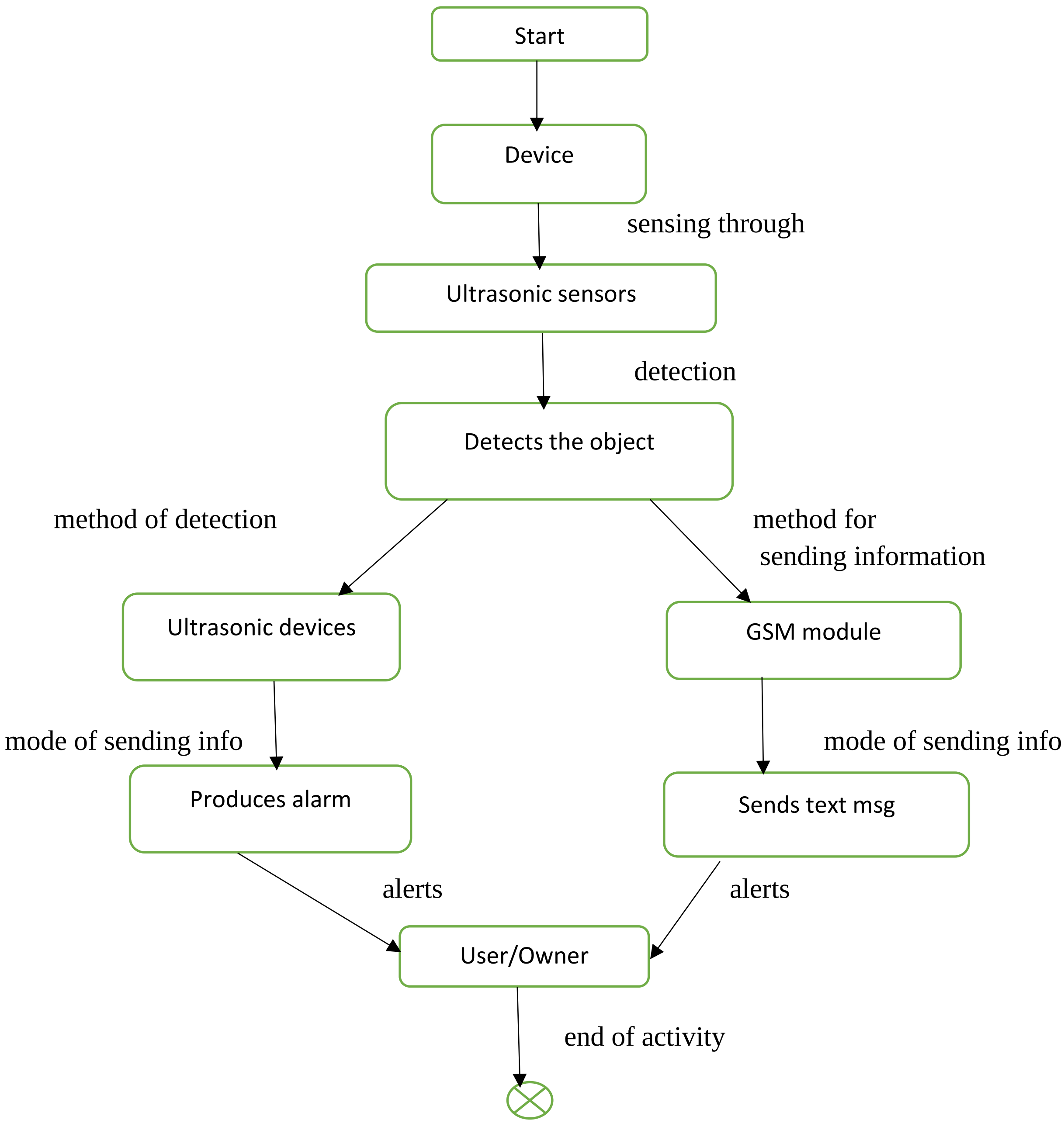


Fig 2 : Flow chart of proposed model

GSM module:

GSM or Global System for Mobile Communication is a Wireless Communication standard for mobile telephone systems. It was developed by the European Telecommunications Standards Institute (ETSI) as a replacement to the 1st Generation Analog Cellular Network.

Breadboard:

A breadboard, solderless breadboard, or protoboard is a construction base used to build semi-permanent .

Compared to more permanent circuit connection methods, modern breadboards have high parasitic capacitance, relatively high resistance, and less reliable connections, which are subject to jostle and physical degradation. Signaling is limited to about 10 MHz, and not everything works properly even well below that frequency.

Connecting wires:

A connecting wire is represented by a straight line. It is usually made of copper and is provided with insulation to make electrical connections between two points.Symbol.

Microchip:

A microchip is a small device implanted between the shoulder blades of an animal that is used for permanent identification. The microchip is about the size of a grain of rice and can be read by a microchip scanner. Each microchip contains a series of unique numbers similar to a vehicle VIN number.

Arduino uno:

The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV!

We need to connect these components as directed and connect GSM module to the users mobile.

The GSM Module with Arduino. There are different kinds of GSM modules available on the market. We are using the most popular module based on Simcom SIM900 and Arduino Uno for this tutorial. Interfacing a GSM module to Arduino is pretty simple. You only need to make 3 connections between the gsm module and Arduino.

A GSM Module is basically a GSM Modem (like SIM 900) connected to a PCB with different types of output taken from the board – say TTL Output (for Arduino, 8051 and other microcontrollers) and RS232 Output to interface directly with a PC (personal computer). The board will also have pins or provisions to attach the mic and speaker, to take out +5V or other values of power and ground connections. These types of provisions vary with different modules.

Lots of varieties of GSM modems and GSM Modules are available in the market to choose from. For our project of connecting a gsm modem or module to Arduino and hence sending and receiving SMS using Arduino – it's always good to choose an Arduino compatible GSM Module – that is a GSM module with TTL Output provisions.

IMPLEMENTATION:

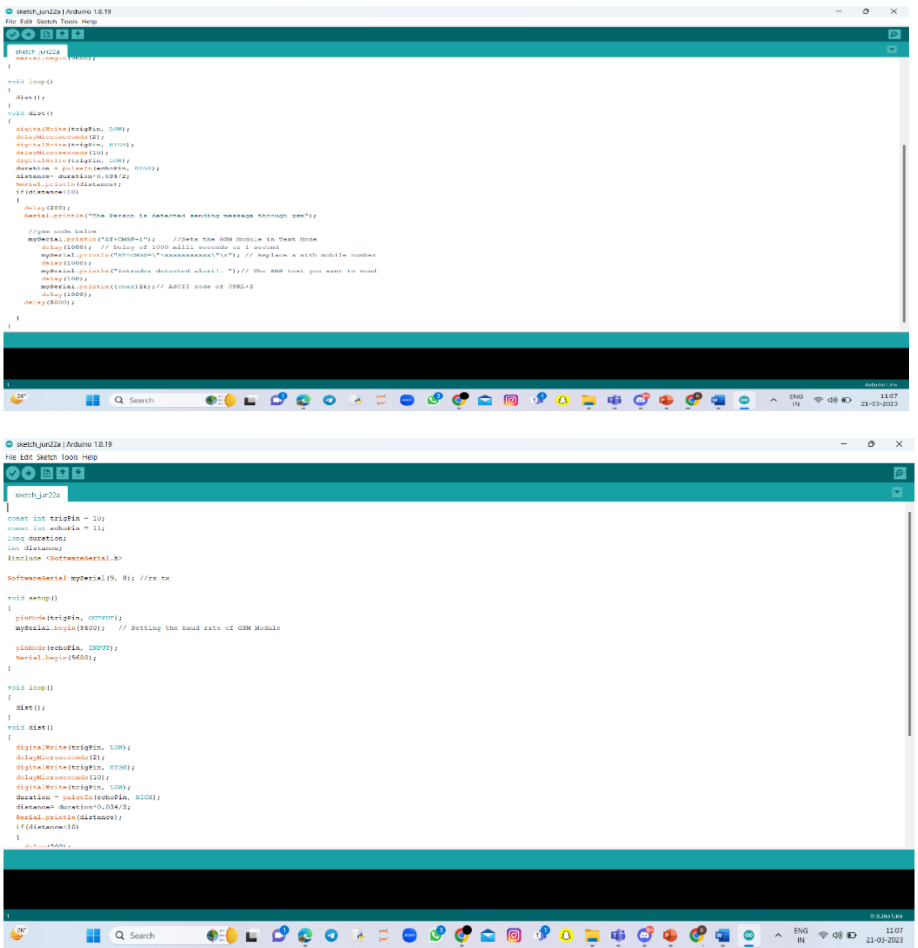


Fig 3: Implementing codes

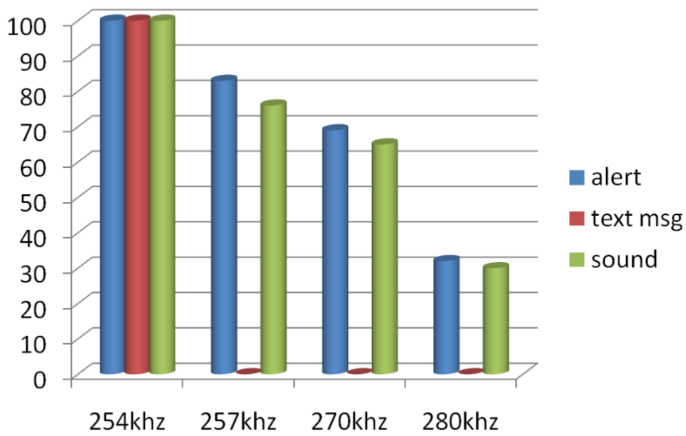


Fig 4:ALERT RATES

Our project aims to detect objects coming near by the device set up i.e. ultrasonic sensor helps in detecting objects with least decibels that are closer to the targeted area. The GSM module is present in the device made in order to give the information to user in form of alarm or a text message in order to alert the user or the owner.

Implementing micro camera:

We are unable to satisfy such typical case of installing a micro camera.

Overcoming some challenges like weather condition, external pressures like vehicles .If any vehicle passes from the object we made then the object may get damaged.

Battery efficiency:

Battery efficiency, simply put, is the amount of energy you can get out of a battery relative to the amount of energy that's put into it.

The amount of energy you get out is always going to be less than what's put in - however, there are specific factors that will affect that difference.

RESULTS:

We will be able to overcome crop loss for the farmer from external sources.

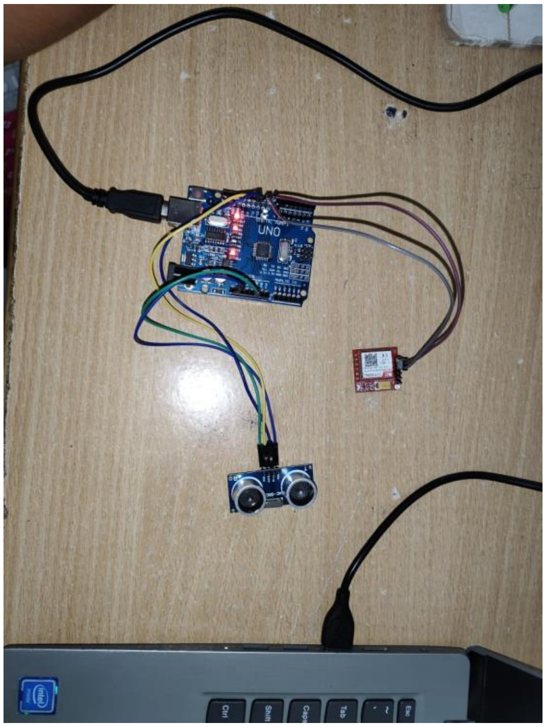


Fig 5 : System setup

CONCLUSION:

There have been several reports of human-animal confrontations in the past, which have seriously harmed yielded crop and negatively impacted the economy and lead a great loss financially for the farmers. It is important to protect yielded crops from animals and to keep yield of crop safe.. For the purpose of detecting animals in crop yield regions and preventing human-animal conflicts, a real-time deep learning-based system has been proposed. Animals were automatically identified using object detection methods in machine learning and scared off by the sound produced with high pitch. The system has been put in place to accomplish three goals: spotting animals, keeping animals out of the yielded crop, producing high frequency alarm and alerting the user.

The device detects the presence of the objects coming nearby in the specified area mentioned in chip code. It alerts the user through a text message and produces sound as alarm near specified region using ultrasonic sound after sensing the object through ultrasonic sensor.The categorization model's output included a useful fright tactic, like a bee buzzing sound, ultrasound, or a quick burst of light. The farmer will also receive information about the animals via the mobile application at the same time. According to our research, the detecting system had an average accuracy of 72%.

REFERENCES

[1]M. Hnewa and H. Radha, "Object Detection Under Rainy Conditions for Autonomous Vehicles: A Review of State-of-the-Art and Emerging Techniques," in IEEE Signal Processing Magazine, vol. 38, no. 1, pp. 53-67, Jan. 2021.

[2]A. Raghunandan, Mohana, P. Raghav and H. V. R. Aradhya, "Object Detection Algorithms for Video Surveillance Applications," 2018 International Conference on Communication and Signal Processing (ICCSP), Chennai, India, 2018, pp. 0563-0568.

[3]Y. Tao, Z. Zongyang, Z. Jun, C. Xinghua and Z. Fuqiang, "Low-altitude small-sized object detection using lightweight feature-enhanced convolutional neural network," in Journal of Systems Engineering and Electronics, vol. 32, no. 4, pp. 841-853, Aug. 2021.

[4] B. J. Koskowich, M. Rahnemoonfai and M. Starek, "Virtualot — A Framework Enabling Real-Time Coordinate Transformation & Occlusion Sensitive Tracking Using UAS Products, Deep Learning Object Detection & Traditional Object Tracking Techniques," IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium, Valencia, Spain, 2018, pp. 6416-6419.

[5] F. Amin, A. Mondal and J. Mathew, "A Large Dataset With a New Framework for Abandoned Object Detection in Complex Scenarios," in *IEEE MultiMedia*, vol. 28, no. 3, pp. 75-87, 1 July-Sept. 2021.

[6] Q. M. ul Haq, M. A. Haq, S. -J. Ruan, P. -J. Liang and D. -Q. Gao, "3D Object Detection Based on Proposal Generation Network Utilizing Monocular Images," in *IEEE Consumer Electronics Magazine*, vol. 11, no. 5, pp. 47-53, 1 Sept. 2022.

[7] N. A. OTHMAN, M. U. SALUR, M. KARAKOSE and I. AYDIN, "An Embedded Real-Time Object Detection and Measurement of its Size," *2018 International Conference on Artificial Intelligence and Data Processing (IDAP)*, Malatya, Turkey, 2018, pp. 1-4.

[8] A. E. Bilecen and H. Özkan, "Object-Centric Video Anomaly Detection with Covariance Features," *2022 30th Signal Processing and Communications Applications Conference (SIU)*, Safranbolu, Turkey, 2022, pp. 1-4.

[9] I. Kilic and G. Aydin, "Traffic Sign Detection And Recognition Using TensorFlow' s Object Detection API With A New Benchmark Dataset," *2020 International Conference on Electrical Engineering (ICEE)*, Istanbul, Turkey, 2020, pp. 1-5.

[10] S. Zheng, J. Guo, H. Yue and X. Liu, "Cross Domain Edge Detection Based Label Decoupling Salient Object Detection," *2021 IEEE 21st International Conference on Communication Technology (ICCT)*, Tianjin, China, 2021, pp. 1143-1147.

[11] J. Li, P. Yuan, D. Gu and Y. Tian, "Hierarchical Deep Cosegmentation of Primary Objects in Aerial Videos," in *IEEE MultiMedia*, vol. 26, no. 3, pp. 9-18, 1 July-Sept. 2019.

[12] L. Fu, H. Yu, X. Li, C. P. Przybyla and S. Wang, "Deep Learning for Object Detection in Materials-Science Images: A tutorial," in *IEEE Signal Processing Magazine*, vol. 39, no. 1, pp. 78-88, Jan. 2022.

[13] G. Srivastava and R. Srivastava, "Modification of Gradient Vector Flow Using Directional Contrast for Salient Object Detection," in *IEEE MultiMedia*, vol. 26, no. 4, pp. 7-16, 1 Oct.-Dec. 2019.

[14] D. Mohanapriya and K. Mahesh, "Multi object tracking using gradient-based learning model in video-surveillance," in *China Communications*, vol. 18, no. 10, pp. 169-180, Oct. 2021.

[15] Q. M. ul Haq, M. A. Haq, S. -J. Ruan, P. -J. Liang and D. -Q. Gao, "3D Object Detection Based on Proposal Generation Network Utilizing Monocular Images," in *IEEE Consumer Electronics Magazine*, vol. 11, no. 5, pp. 47-53, 1 Sept. 2022.

A. Jain *et al*. [16] A. Jain *et al*., "AI-Enabled Object Detection in UAVs: Challenges, Design Choices, and Research Directions," in *IEEE Network*, vol. 35, no. 4, pp. 129-135, July/August 2021.

[17] C. Tung *et al*., "Why Accuracy is Not Enough: The Need for Consistency in Object Detection," in *IEEE MultiMedia*, vol. 29, no. 3, pp. 8-16, 1 July-Sept. 2022.