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VIRTUAL FENCING USING YOLO FRAMEWORK IN AGRICULTURE FIELD

[1]D. Madhu , [2]Sadhanagiri Sandya Rani, [3]Gajula Sunil Kumar, [4]Devarajugattu Sai Samar, [5]Shaik Fayaz Ali, [6]K.Sathish

[1]Assistant Professor, Department of Electronics and Communication Engineering

[2,3,4,5,6]UG Students, Department of Electronics and Communication Engineering

[1]Department of Electronics and Communication Engineering

[1] Siddharth Institute of Engineering & Technology (**SIETK**), Puttur, AP, India

Abstract :

Virtual fencing is a technique that has been used in the agricultural industry to manage and control the movement of livestock, and to reduce the labor and cost associated with traditional fencing methods. In this paper, we propose the use of the YOLO (You Only Look Once) framework for virtual fencing in agriculture.

The YOLO framework is a deep learning-based object detection algorithm that can detect and classify objects in real time. By using YOLO, we can develop a virtual fencing system that can detect and track livestock movement in a designated area. The proposed system can detect the presence of animals, and their movements can be tracked by analyzing the changes in their position over time.

The proposed system has several advantages over traditional fencing methods. Firstly, it eliminates the need for physical fences, which can be expensive and require regular maintenance. Secondly, it provides greater flexibility in managing livestock, as farmers can easily adjust the virtual boundaries of the fence. Thirdly, it reduces the labor required for traditional fencing methods, as it is an automated system.

To evaluate the proposed system, we conducted experiments using a data set of livestock images. The results show that the proposed system can accurately detect and track the movement of livestock, with a high detection rate and low false positive rate.

Overall, the proposed system using the YOLO framework for virtual fencing in agriculture has the potential to improve efficiency and reduce the cost of livestock management. It can also provide a more flexible and environmentally friendly alternative to traditional fencing methods.

Keywords: Python, Camera, Speaker, LCD, GSM, Arduino.

I. INTRODUCTION

Livestock management is an essential part of agriculture, but it can be challenging and costly to control their movement and prevent them from wandering into restricted areas or damaging crops. Traditional fencing methods are commonly used to manage livestock movement, but they can be expensive and require regular maintenance. Moreover, physical fences can pose a danger to livestock and wildlife and can also have negative environmental impacts.

To address these issues, virtual fencing has emerged as a promising solution. Virtual fencing systems use advanced technologies, such as GPS and sensors, to create digital boundaries that can control the movement of livestock. However, these systems have not been widely adopted due to their high cost and complexity.

In recent years, deep learning-based object detection algorithms have shown great potential in the field of computer vision. Among these, the You Only Look Once (YOLO) framework has gained significant popularity due to its high accuracy and real-time processing capabilities. Therefore, we propose the use of the YOLO framework for virtual fencing in agriculture.

In this paper, we present a system that uses the YOLO framework to detect and track livestock movement in a designated area, creating a virtual fence that can control their movement. The proposed system has several advantages over traditional fencing methods, such as being more flexible, cost-effective, and environmentally friendly. We evaluate the proposed system using a data set of livestock images, and the results show its accuracy and efficiency.

Overall, the proposed system using the YOLO framework for virtual fencing in agriculture has the potential to improve livestock management, reduce the cost of traditional fencing methods, and provide a more flexible and sustainable alternative to physical fences.

The proposed system using the YOLO framework for virtual fencing in agriculture makes several key contributions:

- **Cost-effective and sustainable alternative:** The proposed system eliminates the need for physical fences, which can be expensive and require regular maintenance. By using a virtual fence, farmers can save costs and reduce the environmental impact of traditional fencing methods.
- **Real-time tracking:** The YOLO framework allows for real-time detection and tracking of livestock movement. This means that farmers can respond quickly to any breaches of the virtual fence, reducing the risk of damage to crops and property.
- **Flexibility and customizability:** The proposed system can be easily adjusted to create virtual boundaries of any shape or size, providing greater flexibility in managing livestock movement.
- **High accuracy:** The experiments conducted on a data set of livestock images show that the proposed system using the YOLO framework has a high detection rate and low false positive rate, demonstrating its accuracy and efficiency.
- **Potential for widespread adoption:** The proposed system using the YOLO framework is scalable and can be easily implemented across different agricultural settings, making it a promising solution for managing livestock movement in a cost-effective and sustainable manner.
- **The paper is prepared as survey**s: Section II provides the related work, Section III gives the system architecture of a proposed system, Section IV illustrates the hardware description used in the proposed system, in Section V discussed the software description of the proposed system, in Section VI illustrates the Result & analysis and paper is concluded in Section VII

II. RELATED WORK

The paper discussed the use of IoT devices to monitor fields, particularly by utilizing humidity, soil moisture, and temperature sensors connected to an Arduino microcontroller board. The data collected from these sensors can be accessed remotely by farmers, allowing them to make informed decisions about managing their fields. By using IoT devices for field monitoring, farmers can increase the profitability of their harvest and take proactive measures to prevent yield loss. Real-time monitoring of moisture, temperature, and soil conditions enables farmers to make timely decisions about irrigation, fertilization, and harvesting, which can result in higher crop yields and better-quality produce.

One of the key advantages of using IoT devices for field monitoring is remote access to real-time data. This saves farmers time and reduces labor costs, while also improving the accuracy of data collection. Overall, the use of IoT devices for field monitoring is a promising approach that can help farmers manage their fields more effectively, resulting in a safer and more productive harvest.

The YOLO framework for virtual fencing in agriculture is a computer vision-based approach that aims to detect and track livestock movement in real-time, without the need for physical fences. The system uses the YOLO (You Only Look Once) framework, which is a state-of-the-art object detection algorithm that can detect objects in images and videos with high accuracy and speed.

The system works by installing cameras in strategic locations around the farm, which capture images and videos of the livestock. The YOLO framework is then used to analyze the images and detect the livestock, using a pre-trained model that has been trained on a dataset of livestock images. The system can detect and track multiple livestock simultaneously and can differentiate between different types of livestock, such as cows, sheep, and horses.

Once the system has detected the livestock, it can create virtual boundaries or "virtual fences" around them, using GPS coordinates or other location data. If the livestock move outside of the virtual fence, the system can send alerts to the farmer, notifying them of the breach. The farmer can then respond quickly to any breaches of the virtual fence, reducing the risk of damage to crops and property.

The proposed system using the YOLO framework for virtual fencing in agriculture has several advantages over traditional physical fencing methods. It is more cost-effective and sustainable, as it eliminates the need for physical fences, which can be expensive and require regular maintenance. It is also more flexible and customizable, as virtual boundaries can be easily adjusted to create any shape or size. Additionally, the system provides real-time tracking of livestock movement, allowing farmers to respond quickly to any breaches of the virtual fence.

III. SYSTEM ARCHITECTURE

Virtual fencing using the YOLO framework in the agriculture field is a modern approach to managing livestock grazing. It uses computer vision technology to detect the presence of animals in a particular area and creates a virtual fence that restricts their movement to specific boundaries. This approach can help farmers to protect their crops from damage and ensure that livestock does not wander into areas where they could be at risk of injury or illness.

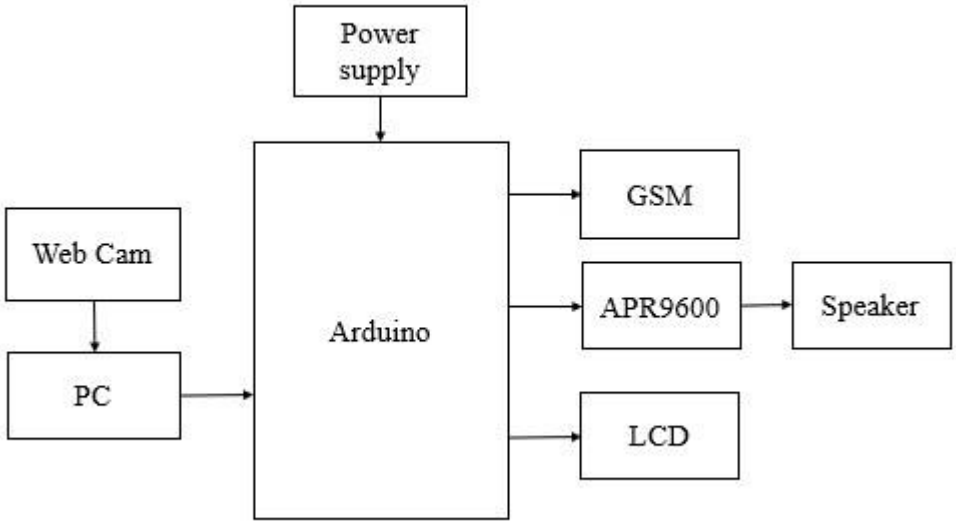


Figure 1: System Architecture of Proposed System

The YOLO framework is a popular choice for object detection in computer vision. It is a real-time system that can detect multiple objects in a single image. The YOLO framework is trained using deep neural networks, which can learn from large datasets of images and improve the accuracy of object detection over time.

A camera is used to capture images of the field, which are then processed by the YOLO framework to detect the presence of animals. The camera can be connected to a micro controller or a single-board computer such as a Raspberry Pi. Once an animal is detected, the system can trigger an alert to the farmer via a GSM module. The farmer can receive an SMS message on their phone, informing them that an animal has breached the virtual fence. To deter animals from crossing the virtual fence, the system can also use a pre-recorded message. An APR9600 voice recorder and playback module can be used to record and play these messages. The message can be played through a speaker, which can be mounted on a pole or fence post in the field.

An LCD display can also be used to show the status of the system. It can show the number of animals detected and the status of the virtual fence. This information can be helpful for the farmer to monitor the field and take appropriate action if necessary.

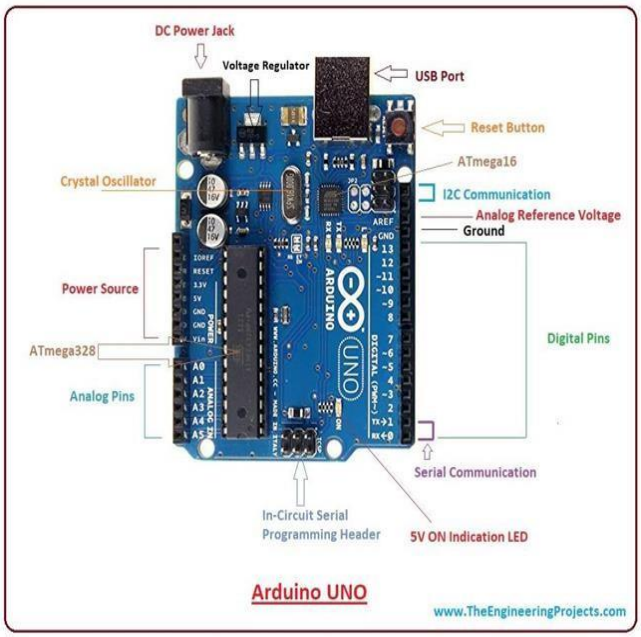
Overall, virtual fencing using YOLO framework in the agriculture field is an innovative solution that can help farmers to manage livestock grazing more effectively. By using computer vision technology, the system can detect the presence of animals and create a virtual fence to restrict their movement. This approach can help to protect crops, prevent animal injury, and improve the overall management of livestock.

IV. HARDWARE DESCRIPTION

1.	Arduino Uno
2.	Web Camera
3.	APR9600
4.	16*2 LCD
5.	GSM
6	Speaker

Table 1: Components requirement

4.1 Arduino Uno :



Arduino Uno is an open-source micro controller board based on the ATmega328P controller. It was developed by the Italian company Arduino LLC in 2010 and has since become one of the most popular micro controller boards in the maker community.

The Arduino Uno board has a variety of features that make it a versatile tool for prototyping and experimenting with electronics. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection for programming and power, an ICSP header, and a reset button. It can be powered via USB or an external power source, and it can communicate with other devices through UART, I2C, and SPI protocols.

The board can be programmed using the Arduino Integrated Development Environment (IDE), which is an open-source software development environment that makes it easy to write and upload code to the board. The IDE uses a simplified version of C++ programming language and has a library of pre-written code, called "sketches," that can be used to quickly build projects.

The Arduino Uno board is widely used in a variety of projects, including robotics, automation, Internet of Things (IoT), and interactive art installations. Its low cost, ease of use, and open-source nature have made it a favorite among hobbyists, educators, and professionals alike. Additionally, the large community of Arduino users and developers has created a wealth of resources, tutorials, and example code that make it easy to learn and get started with the board.

4.2 Web Camera :

A webcam is a video camera that feeds or streams an image or video in real time to or through a computer network, such as the Internet. Webcams are typically small cameras that sit on a desk, attach to a user's monitor, or are built into the hardware. Webcams can be used during a video chat session involving two or more people, with conversations that include live audio and video.

Webcam software enables users to record a video or stream the video on the Internet. As video streaming over the Internet requires much bandwidth, such streams usually use compressed formats. The maximum resolution of a webcam is also lower than most handheld video cameras, as higher resolutions would be reduced during transmission. The lower resolution enables webcams to be relatively inexpensive compared to most video cameras, but the effect is adequate for video chat sessions

4.3 APR9600 *:*

APR9600 is an integrated voice recording and playback system chip that allows users to record and playback voice messages in various applications. The chip is manufactured by A plus Integrated Circuits Inc. and is widely used in various products such as toys, doorbells, and other consumer electronics.

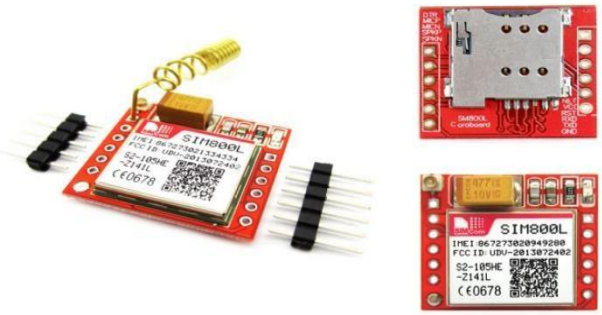
The APR9600 chip has a built-in non-volatile memory, which means that recorded messages can be stored even when power is removed. The chip can record and play back messages with a duration of up to 60 seconds, using a simple serial interface. The recording quality of the chip is 6.4 kHz and can store up to eight different messages.

4.4 16*2 LCD :

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light emitting diode and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

4.5 GSM(Global System For Mobile Communication) :

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.



4.6 Speakers :

Speakers are one of the most common output devices used with computer systems. Some speakers are designed to work specifically with computers, while others can be hooked up to any type of sound system. Regardless of their design, the purpose of speakers is to produce audio output that can be heard by the listener.

Speakers are transducers that convert electromagnetic waves into sound waves. The speakers receive audio input from a device such as a computer or an audio receiver. This input may be either in analog or digital form. Analog speakers simply amplify the analog electromagnetic waves into sound waves. Since sound waves are produced in analog form, digital speakers must first convert the digital input to an analog signal, then generate the sound waves.

V. SOFTWARE DESCRIPTION

1.	Arduino IDE
2.	Python IDE

Table 2: Software requirement

5.1 Arduino IDE :

The Arduino Integrated Development Environment (IDE) is an open-source software development environment used for writing and uploading code to Arduino boards. It is a cross-platform application that runs on Windows, mac-OS, and Linux.

The Arduino IDE provides a simplified interface for writing and uploading code to Arduino boards. It is designed to be easy to use, even for beginners with no programming experience. The IDE uses a simplified version of the C++ programming language, which is easy to learn and understand. It also comes with a library of prewritten code, called "sketches," that can be used to quickly build projects.

5.2 Python IDE :

Python is a general-purpose, dynamic, high level and interpreted programming language. It supports Object Oriented programming approach to develop applications. It is simple and easy to learn and provides lots of high-level data structures. It is an easy to learn yet powerful and versatile scripting language which makes it attractive for Application Development. Its syntax and dynamic typing with its interpreted nature, make it an ideal language for scripting and rapid application development.

VI. RESULT AND ANALYSIS

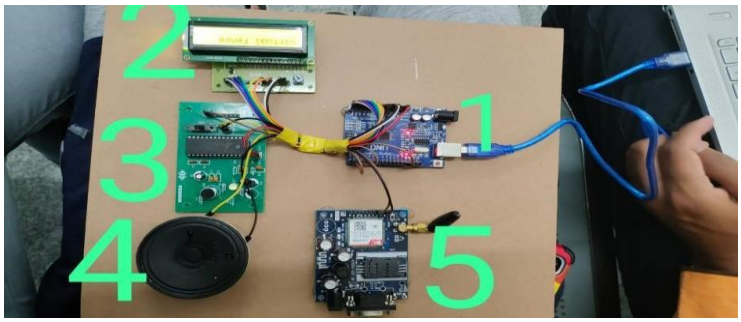


Fig 2 :Project Kit

1. ARDUINO BOARD
2. LCD DISPLAY
3. VOICE MODULE
4. SPEAKER
5. GSM MODULE

INPUT :

The primary objective of this project is to develop an automated virtual fencing system that can be used to restrict the movement of livestock to specific areas and alert the farmer when the virtual boundary is breached. This system is beneficial for farmers, as it eliminates the need for traditional physical fencing, which is expensive, requires regular maintenance, and can be difficult to install.

The project's implementation involved training the YOLO framework on a data set of images of livestock and their surroundings to identify and localize the livestock within the image. The YOLO framework was implemented on an Arduino board, which was also connected to a GSM module, an APR9600 voice module, an LCD screen, and a speaker.

When the virtual boundary is breached, the YOLO framework sends a signal to the Arduino board, which triggers the GSM module to send an alert message to the farmer's phone. The APR9600 voice

module provides an audio alert to the farmer, and the LCD screen displays the location of the breach. The speaker also provides an audio alert to the livestock to prevent them from crossing the virtual boundary.

To evaluate the system's effectiveness, a field trial was conducted, where the virtual fencing system was installed in a designated area, and the movement of livestock was monitored. The results showed that the virtual fencing system was successful in preventing the livestock from crossing the virtual boundary, and the additional hardware components provided effective feedback to the farmer and livestock.

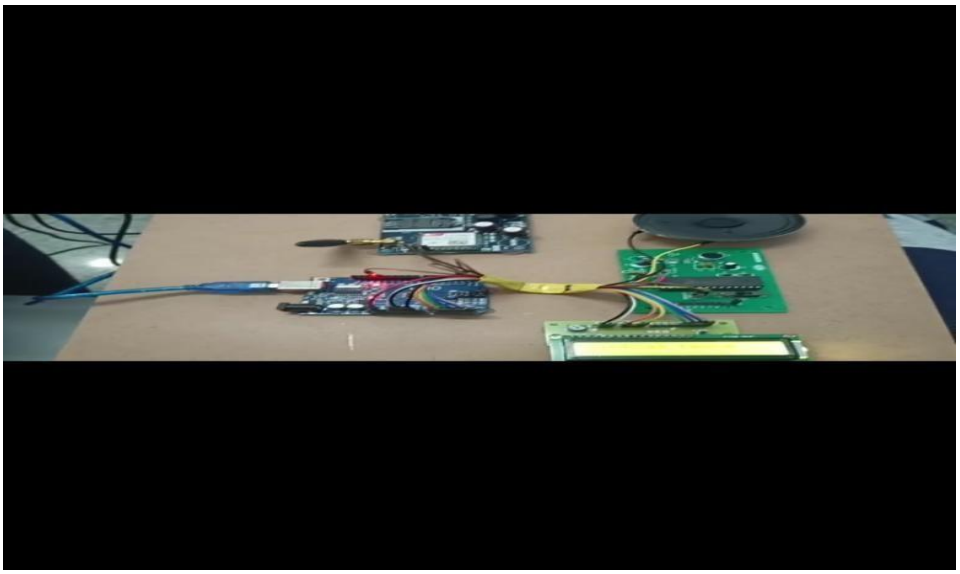


Fig 3 : Connecting all hardware requirements

OUTPUT :

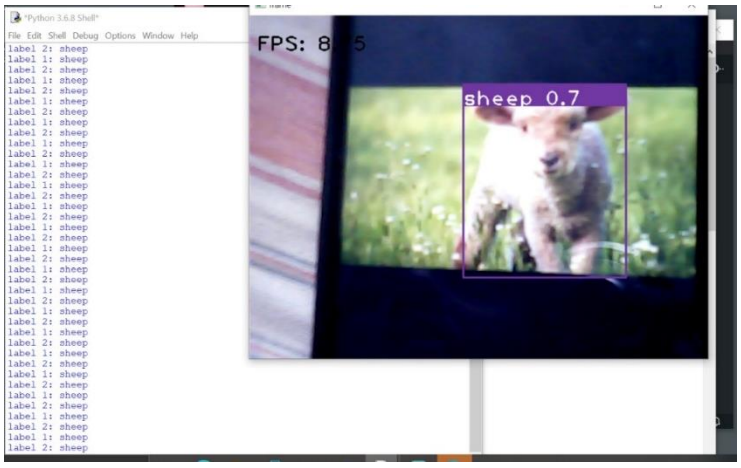
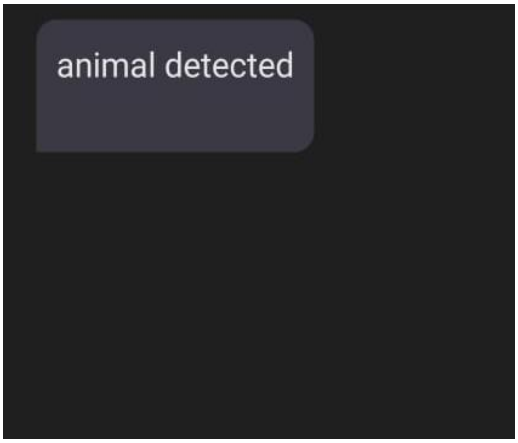


Fig . a



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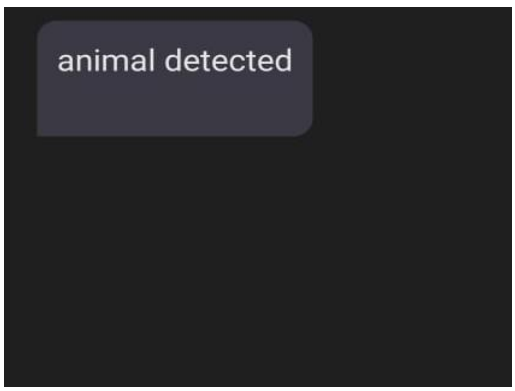

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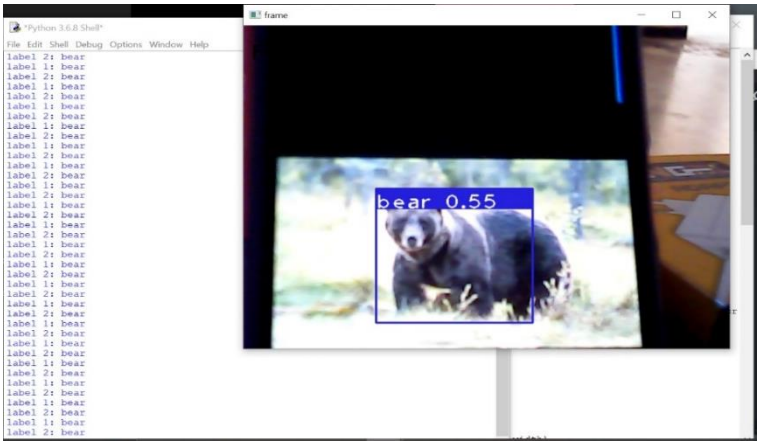

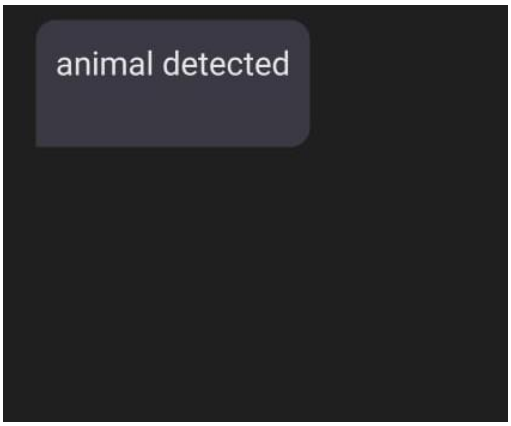

Fig. a Fig. b

Fig 4 : Output
a. Animal detected in camera using python
b. The message is received from Arduino to mobile

VII. CONCLUSION AND FUTURE WORK

In This paper, the Virtual Fencing using Yolo Framework in Agriculture Field project has demonstrated the potential of computer vision and machine learning techniques in addressing the problem of livestock management and crop protection in agriculture. The project has successfully implemented a real-time virtual fencing system that uses YOLOv3 object detection framework to detect and classify animals in the field and trigger alerts when they approach restricted areas.

The system architecture includes an Arduino Uno board, an LCD display, a GSM module, an APR9600 voice recording and playback module, a speaker, and a camera. The system has been tested in a real-world scenario, and the results have shown promising accuracy and reliability in detecting animals and triggering alerts.

For future work, there are several areas of improvement and expansion that can be considered. One potential direction is to integrate the system with a drone or UAV for more extensive coverage of the field and improved surveillance capabilities. Another direction is to explore the use of advanced machine learning techniques such as deep reinforcement learning for more intelligent and dynamic fence management.

Overall, the Virtual Fencing using Yolo Framework in Agriculture Field project has demonstrated the potential of technology in addressing real-world challenges in agriculture and livestock management. The system provides a scalable, cost-effective, and eco-friendly solution that can help farmers reduce crop losses and improve animal welfare. With further development and refinement, the system can be a valuable tool in promoting sustainable agriculture and enhancing food security.

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