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Design And Implementation of An Intelligent Intrusion Detection System

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Abstract
India has abundant natural resources. Numerous accounts of animal assaults have been reported from all around the world. The main issue addressed by forest officials and farmers is human-animal conflict in forest areas and agricultural fields. The suggested approach tries to prevent such occurrences by keeping an eye on the boundaries of agricultural areas and forests and alerting users to intrusions. The proposed design employs an ultrasonic sensor to find any nearby birds or animals. The object will be photographed by the camera after being picked up by the ultrasonic sensor. A pretrained YOLOV3 model is then used to classify the camera's acquired image. YOLOV3 is used for object detection in real-time. When YOLOV3 detects the object, a notification is delivered to the user's mobile device via the BLYNK app. If the identified object is considered dangerous, the buzzer at the monitored area begins to beep simultaneously.

Keywords:*Image Processing, Convolutional Neural Network, Real-time Object, YOLOv3, Bounding Box, Intersection Over Union, COCO Dataset, Ultrasonic Senor, NodeMCU, Buzzer.*

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I. INTRODUCTION

Human-animal conflict is a major issue for farmers and forest officials. Attacks by animals and birds on farms will significantly reduce the crop. People lose their property, crops, livestock, and even lives are in jeopardy. It is impractical for a farmer or a forest officer to constantly monitor a specific area to look for intrusions. Their lives are in jeopardy even if they are doing this. There is a possibility that the animal will assault them. It is important to remember that animals are also living things. The proposed approach therefore addresses this issue by continuously monitoring the area and notifying farmers or forest officers of intrusions without endangering the invader.

II. EXISTING SYSTEM

To prevent animals from invading agriculture, electric fences are employed. When an animal contact one of these fences, the animal will receive an electric shock to the body. Animals and birds are frightened away from the field using acoustic systems. Different strategies are employed in various locations to deter animal encroachment. Farmers in certain regions burn things to create smoke to deter animals. As a strategy to keep wild animals out of fields, this has an adverse effect on air quality. Farmers wouldn't have to be concerned about these issues if they adopted this smart intrusion detection system.

III. OBJECTIVE

The project's primary goal is to keep wild animals away from the edges of agricultural fields and forests while yet protecting them by driving them away rather than killing them. Additionally, the project aims at protecting people from animal attacks.

IV. SCOPE

The proposed system aims to create a protective system that forbids animals from entering the boundaries of agricultural fields or forests. Additionally, it shields crops from harm. Using sensors, it is designed to examine animal interference, alert the user, and protect the crop from wild animals. A timely warning is sent to the farmer via the BLYNK App. A buzzer sound is produced when the sensor is turned on, which drives animals away from the field's entrance. The system's low power usage is its main advantage.

V. PROPOSED SYSTEM

Introducing a system that can detect any kind of hazardous intrusions in agricultural land.Informing the farmer, without harming the intruder.First, it will detect the intrusion around the zone using the ultrasonic sensor. If any object is detected, a message is sent to the camera by Node MCU. Then the camera will capture the image of the intruder and classify them YOLOV3. Finally, it sends a notification to farm owners and forest officials using the BLYNK app. At the same time, if the detected object is found hazardous, the buzzer will start to beep.

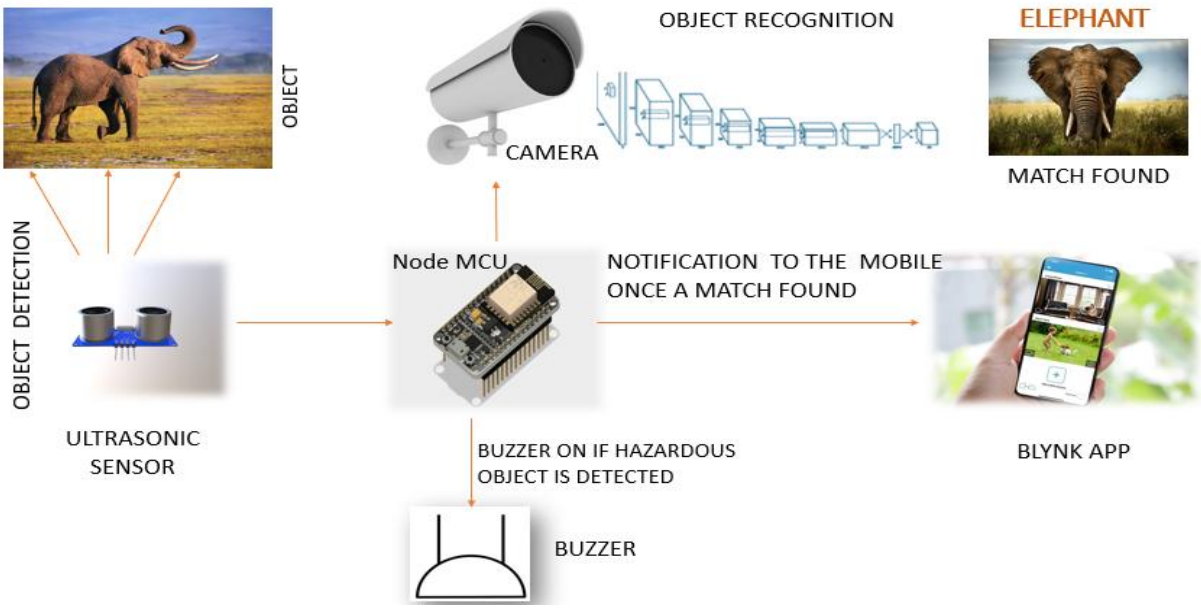

Figure 1: Overall process of proposed system

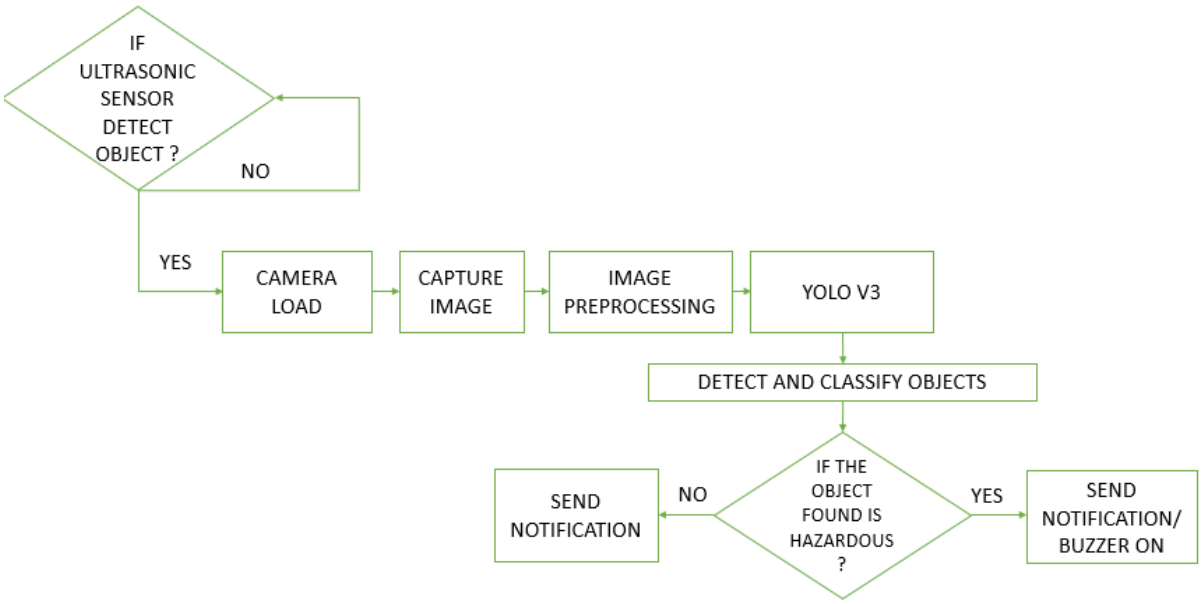

Figure 2: Data Flow Diagram

VI. SYSTEM ARCHITECTURE

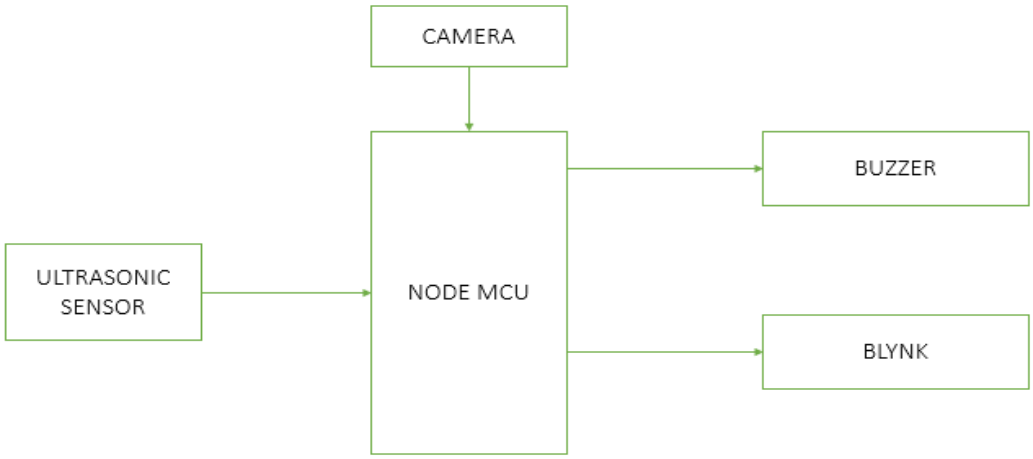

Figure 3: Block Diagram

Figure 2 shows the block diagram of the proposed detection system. Precisely, the proposed system uses ultrasonic sensor and camera to detect the intrusion and send notification to the user through BLYNK app if the object is detected. At the same time buzzer starts beeping to scare away the animal from the field.

VII.METHODOLOGY

For the task of object detection in this project, I used a pretrained Yolov3 model trained on the COCO dataset. Convolutional neural networks (CNN) are used by the YOLO method to recognize items instantly. Convolutional neural networks are incredibly effective deep learning techniques for image processing. The best algorithms available right now for automating image processing. The primary applications of CNN are in image analysis tasks like segmentation, object detection, and picture recognition.

CNN

CNN is an artificial neural network used for object and image recognition and classification is the CNN. Thus, Deep Learning uses a CNN to identify items in a picture. Convolutional Neural Networks (CNNs) can learn intricate objects and patterns because they have an input layer, an output layer, multiple hidden layers, and millions of parameters. Prior to applying an activation function, it subsamples the input using convolution and pooling techniques. All the hidden layers are partially connected in the beginning, and the output layer is the final fully connected layer. The size of the input image is mirrored in the output shape. The method of convolution involves combining two functions to create the result of the other function. A convolution neural network may extract information from an image with the aid of several hidden layers. CNN's four key layers are as follows:

1. Convolution layer
2. ReLU layer
3. Pooling layer
4. Fully connected layer

YOLO

Convolutional neural networks (CNN) are used by the YOLO method to recognize objects instantly. The approach just needs one forward propagation through a neural network to detect objects, as the name would imply. This indicates that a single algorithm run is used to perform prediction throughout the full image. Multiple class probabilities and bounding boxes are simultaneously predicted using the CNN. There are numerous variations of the YOLO algorithm. Tiny YOLO and YOLOv3 are a couple of the more popular ones. The YOLO algorithm employs the following three methods:

1. Residual blocks,
2. Bounding box regression,
3. Intersection Over Union (IOU)

The final detection findings are created by combining the three techniques. The image is first separated into grid cells. Bounding boxes are predicted in each grid cell, along with confidence scores. To determine the class of each object, the cells forecast the class probability. A single convolutional neural network is used to make all the

predictions concurrently. It is ensured via intersection over union that the predicted bounding boxes match the actual boxes of the items. This phenomenon gets rid of bounding boxes that aren't necessary or don't match the properties of the objects (like height and width). Unique bounding boxes that precisely fit the objects will be the result of the final detection.

VIII. HARDWARE REQUIREMENTS

1. Processor
    - Laptop - i3 or higher processor
2. Memory
    - Laptop - 4 GB RAM or higher
3. USB cable
4. System: PC/Laptop
5. Ultrasonic Sensor
6. Camera
7. NodeMCU
8. Buzzer

IX. SOFTWARE REQUIREMENTS

1. Operating system
    - Windows 11
    - Windows 10
    - Windows 7
    - Windows Server 2019
    - Windows Server 2016
    - Linux Distros (Ubuntu, openSUSE, et cetera)
    - Macintosh
2. Programming Language
    - Python
    - Embedded c
3. Dataset
    - COCO Dataset
4. Computing Environment
    - Spyder IDE
    - Arduino IDE

X. RESULTS AND ANALYSIS

After the model was built and integrated. The implementation results and the respective performance analysis is displayed using screenshots in the following sections.

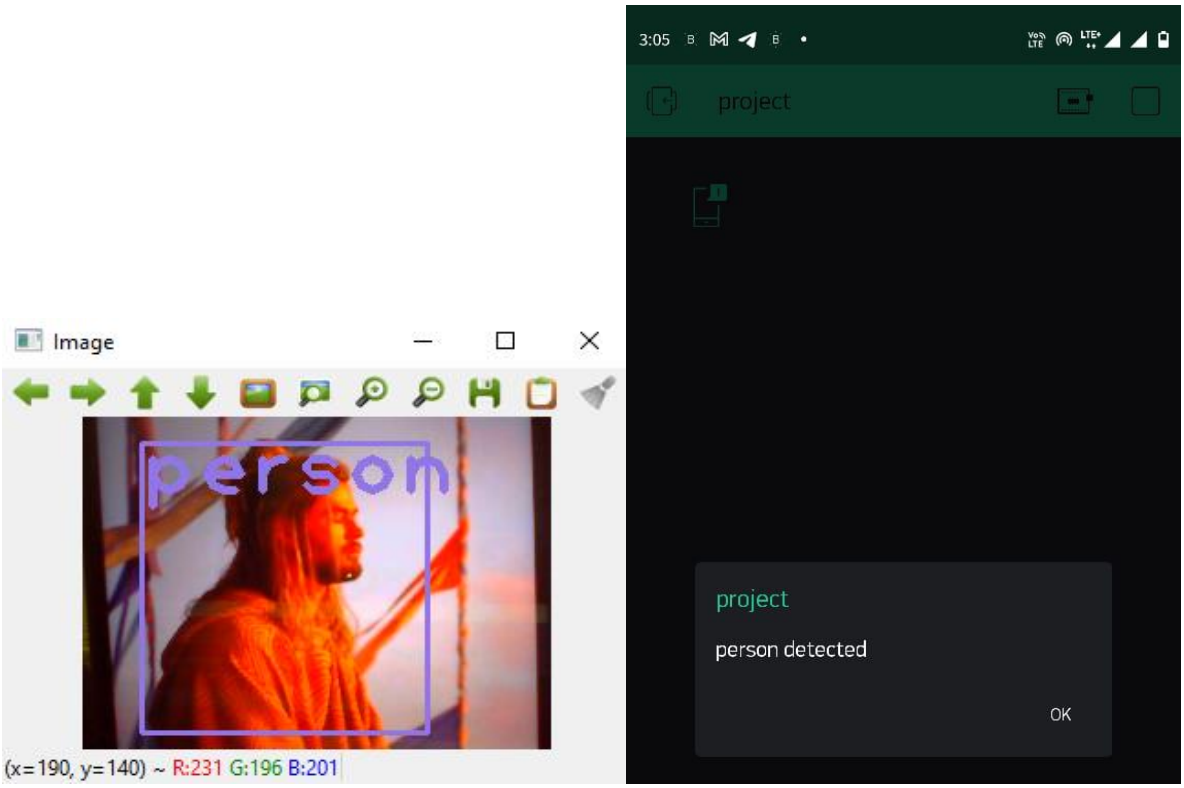

Figure 5: Screenshot of Person Detection and notification received on detecting person

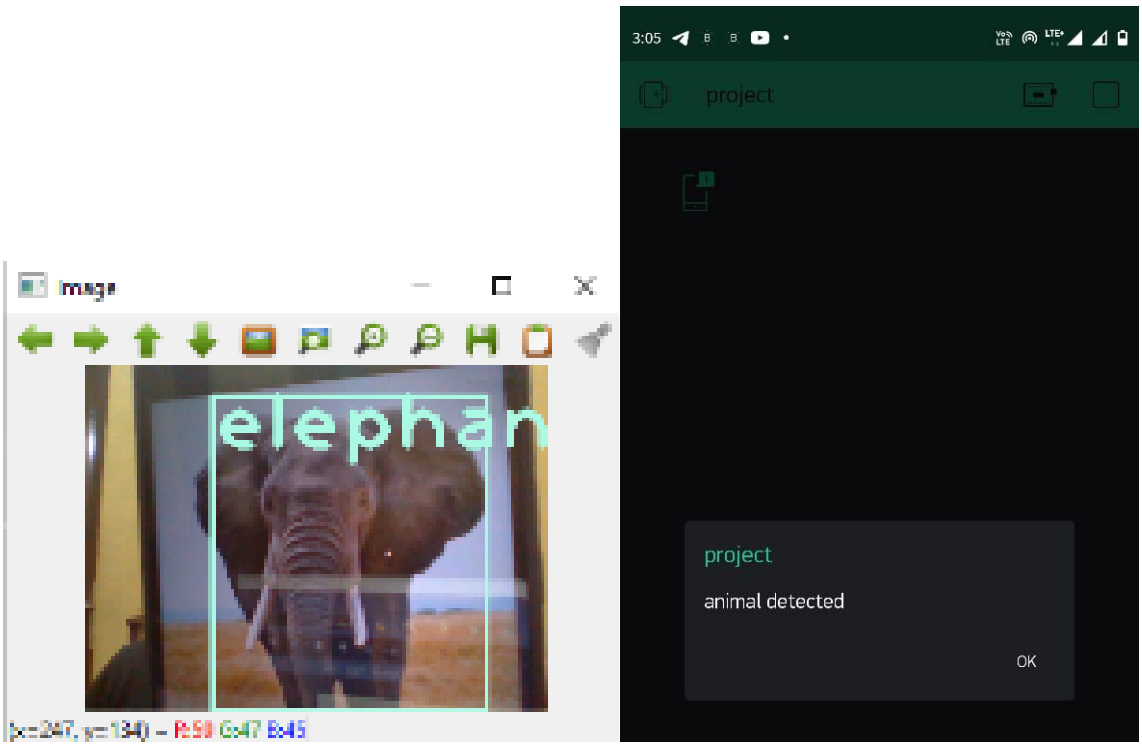

Figure 6: Screenshot of Animal Detection and notification received on detecting animal.

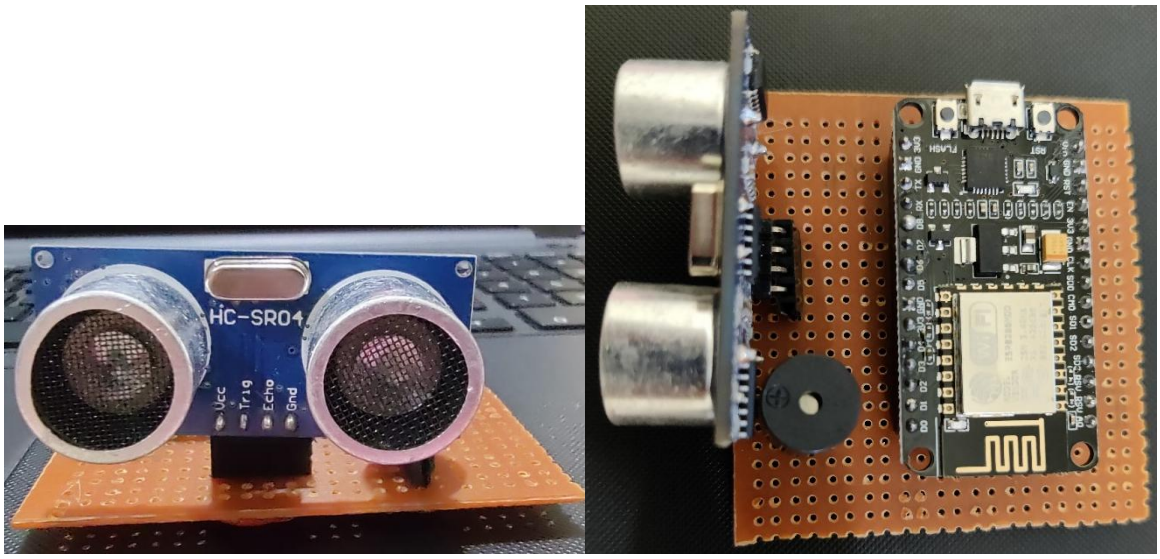

Figure 7: Hardware (Ultrasonic sensor, Buzzer, NodeMCU)

XI. PERFORMANCE EVALUATION

Table 1: Performance Evaluation Table

NAME	ACTION	EXPECTED OUTCOME	OBSERVED OUTCOME	STATUS
STREAM	Stream video/Image	Video captured by the web camera of the laptop in real time.	Video captured by the web camera of the laptop in real time.	SUCCESS
DETECTION	Detect animal/bird in real time.	If an animal or bird found encircle it with a rectangular box and display the name in the real time stream.	If an animal or bird found encircle it with a rectangular box and display the name in the real time stream.	SUCCESS
BUZZER	Buzzer ON	Beep the buzzer connected to NodeMCU for 2 seconds.	Beep the buzzer connected to NodeMCU for 2 seconds.	SUCCESS
NOTIFICATION	Receive Notification	Receive notification to the mobile through BLYNK app.	Receive notification to the mobile through BLYNK app.	SUCCESS
ULTRASONIC SENSOR	Detect Object	Detect the object and send information to camera through NodeMCU.	Detect the object and send information to camera through NodeMCU.	SUCCESS

Table 2: Accuracy Evaluation Table

ACTION	EXPECTED TIME	OBSERVED TIME	STATUS
Animal/Bird Detection (YOLOV3)	1 Sec	1 Sec	SUCCESS
Notification Receive (BLYNK App)	1 Sec	1 Sec	SUCCESS
Buzzer On	2 Sec	1-2 Sec	SUCCESS
Object Detection (Ultrasonic Sensor)	2 Sec	2 Sec	SUCCESS

XII. CONCLUSION AND FUTURE ENHANCEMENT

In this research, I put up an IoT concept to keep animals and birds out of agricultural areas and forest edges. Consequently, protecting lives and preventing crop loss results in increased income for farmers. Farmers' traditional practices, such as electric or physical fencing, would be harmful to the animals. This project strives to safeguard animal lives as well. We can easily add new features to the suggested system as an improvement. We can identify all types of fire accidents in the area by placing a smoke and temperature sensor. By modifying the dataset, this system can be expanded to detect human theft behaviors.

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