Design of Animal Intrusion Detection and Rescue System

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***Abstract*-As deforestation continues to increase day by day, many forest animals lose their habitat due to the scarcity of food and water and move in search of new habitats where they can live without any intervention from humans. As these wild creatures go in search of new habitats, they knowingly or unknowingly come in contact with humans which results in either threat to the species or the devastation they cause to human life.**
Altogether, to avoid this circumstance, there is an intelligent CNN system built that not only restricts the animals from going out of the forest but also informs the forest officials to take the necessary action so that these wild species are completely restricted from going beyond the forest boundaries.
Image processing is a vast concept which is dominated in medical technology and computer vision.

Keywords: CNN

Introduction

This project is based on an effective concept of image processing i.e., object detection. For detecting animals, YOLO (You Only Look Once) algorithm is used which in turn uses a convolutional neural network to classify the object and draw the bounding box on them. The main agenda of the project is to detect wild animals using the algorithm from a trained model and specific countermeasures to shoo the animals. The system uses a specific technique to scatter the animals based on their wildness, in turn reporting to the forest officials via mailing. The algorithm mentioned above is used to extract the required features from an image and analyze them. The image is captured on the camera and the signals are received by the processor for the further processing of the image.

CONVOLUTIONAL NEURAL NETWORK

This involves four main steps:
1) Convolution
2) Pooling
3) Fully Connected
4) SoftMax

CNN, or convolutional neural network, is a form of neural network model created for working with two-dimensional picture data, while it may also be utilized with one-dimensional and three-dimensional data.

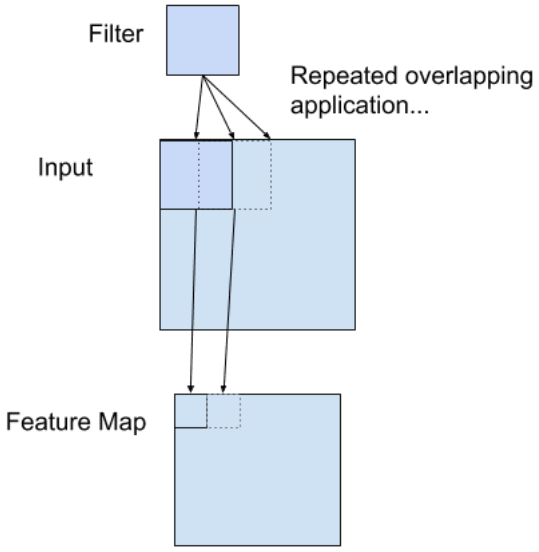


Fig 1: Convolution layer

1) Convolution layer
The convolution means the multiplication of the set of the weights with the given input which results in a single value. This is also called a Dot product.

Because the multiplication results in a single value, it is also called Scalar Multiplication.

When an input image is given to detect a specific feature in that image, masks are used these are called Filters or Kernels. The filter overlaps into the part of the input image (starting from left to right). Each pixel of the input image and the pixel of the filter that has been overlapped gets multiplied and all the pixels that are resulted from the multiplication are added such that we get a partial output. The final value of the pixel is given by the maximum of the set of values from the resulting mask.

2) Pooling layer

This is the technique where the n dimension masks are slid over the input image and the values are compared between the input image and the overlapped filter values. Thus, these values are called the Tensors.

3) Fully Connected layer

In this technique, we use the n Tensors which were the result of the pooling and are convoluted many times with each of the neurons with those of the neurons in other tensors.

4) SoftMax layer

This is the last layer of the CNN which describes the prediction of the multinomial probability function.

Proposed Method

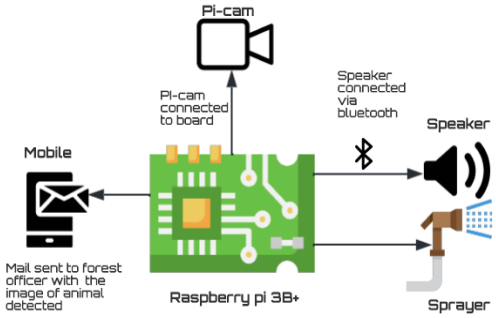


Fig 2: Block diagram of the project

The project uses the raspberry pi 3b+ model board which has 1Gib RAM and 32 GB of external storage. The board contains 40 pins (28 GPIO, 8 GND, 4 VCC). The pi camera is installed onto the board for image capturing. The resolution of the camera is 5 MP. Animals are detected through the camera, we know that video is a series of images. At each frame, the image is sent for processing. With the help of Yolo real-time object detection which uses a Convolutional Neural Network(CNN) to detect and recognize the wild animal and makes them agitated using specific tasks and also takes the picture of the animals which is invading the place and sends them to the responsible officials.

When a monkey is detected cold water is sprayed on them and loud scaring noise is played to scare them away. For wild cats, bears are detected, their picture is captured, and sends to officials also played a loud cracker sound to shoo. Perhaps the elephant panics at bees and hence bee's sound is played when it's detected.

The model should be trained with an ample amount of dataset to detect the animals. Training the model includes several processes. However, there is a pre-trained model which is the COCO dataset but it does not contain all the wild animals. The process for training the model includes:

1. Gathering the data: Collecting suitable classes of images for classification in a huge amount with a minimum of 200 images of each class. More the images greater will be the efficiency but longer the runtime.
2. Annotating/Labeling: Labeling in object detection is drawing the bounding box on the object to be detected and labeling the object with a suitable class for classification.
3. Importing darknet and creating the required files: Darknet is an open-source neural network which makes computational calculations with the help of CPU and GPU. The configuration file is created which will have the convolutional layers, batch size and other information for computations. The names file contains the names of the classes for detection. The dataset is fed to the darknet to train the model which then after the process it creates a weights file which contains trained features for recognition.

YOLO Algorithm

YOLO (You Only Look Once) is a single-stage image processing with a deep learning algorithm which uses a convolution neural network (CNN) to detect, and recognize the object and also helps in drawing bounding boxes on the objects.

Initially, the image is divided into multiple grids i.e. splitting images by S * S dimension.

The image is fed to an algorithm, then the framework image into grids. Object detection works by going through three steps that are

-Classification.
-Localization.
-Detection.

Classification- It determines the object of a particular class is present.

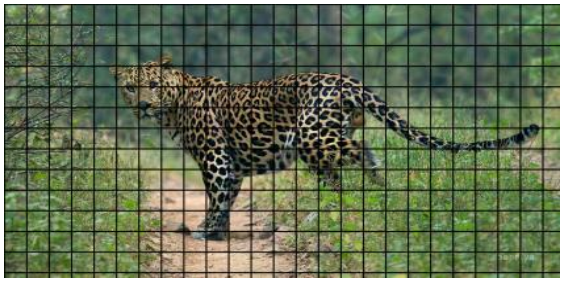


Fig 3: Image is converted to multiple grids

Localization- It helps in locating the specified object present in the image.

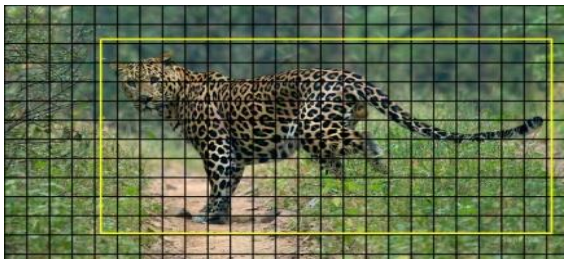


Fig 4: Locate animal by drawing bounding box

Detection- It is the final stage where all the objects in the image are localized and the bounding box is being drawn over and labelled them.

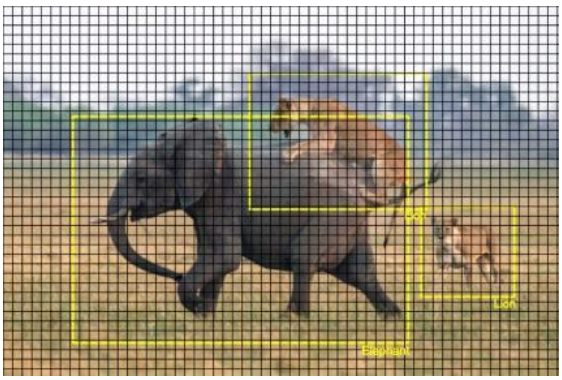


Fig 5: Drawing bounding boxes on multiple animals and labeling

The bounding boxes are drawn on them can be described by descriptors that are

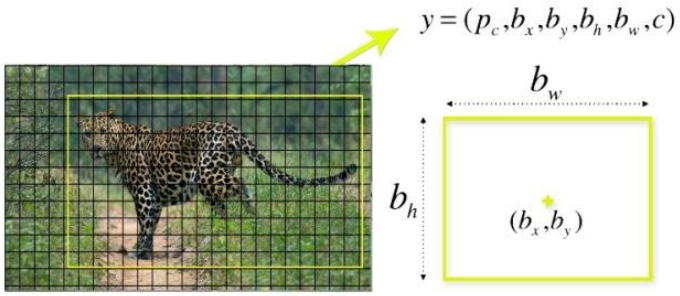


Fig 6: Bounding box probability calculation

After the image is captured it is divided into grids then at each grid the data following data are collected.

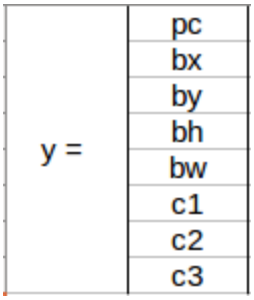
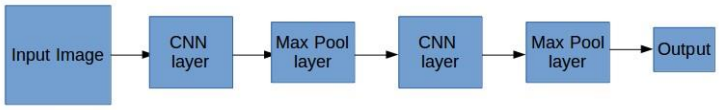


Fig 7: Dimensional vector for each grid cell

pc- Determines whether the object is present in the image or not. If the object from a class is present in an image then pc will be 1 else it will be 0. Therefore, collecting other data is not necessary as they are not applicable.
(bx, by, bh, bw)- tells the information about the bounding box if the object is present.
c1, c2, and c3-are the classes of objects. For example, c1 be a leopard, c2 be an elephant, and c3 be a lion. For the above image c1 will be 1 and c2, and c3 will be 0 as there is no elephant and lion.
With the input image and its corresponding vector, the model will be trained.



These includes both forward and backward propagation. During testing phase the image is fed in forwarding propagation to predict output y.

Method of Implementation

The raspberry pi circuit is the microcontroller which is switches between the GPIO pins and also processes the given input data from the camera (In the case of our project)
The camera which is definitely a pi cam is interfaced with the raspberry pi circuit to the given interface port.

By activating the Raspbian OS and rebooting it, we can make the camera ready to capture the images.
When the images are captured the specific task is done through actuators to shoo the animals away.
The required Actuators are attached to the R-pi board, which are shown in the block diagram

1. Speaker - This is an actuator that plays a required sound when the particular animal is detected.
2. Sprayer pump - This actuator is activated only when the monkeys are detected.

After the image is detected and recognized, the image of the animal that has been detected is mailed to responsible officials through automation.

CONCLUSION

There are many issues to consider here where in many scenarios humans get in contact with animals. Due to massive deforestation, climate change, migration and development growth, the animals are intruding on villages, towns, and cities. This results in jeopardy for both humans and animals, keeping this problem in mind the proposed paper helps animal intrusion detection and its rescue operation. The project can be even enhanced by incorporating night vision cameras such that it is efficient in dark conditions.

RESULT

An automated system that continuously analyses the environment and upon detection of the specified wild animal, the required action is performed to try and keep the animals out of human habituated zones. This is an efficient way to make sure that people are informed when the wild animals cross the forest barrier. The below pictures depict, the animals have been detected, recognized and also reported via mail.

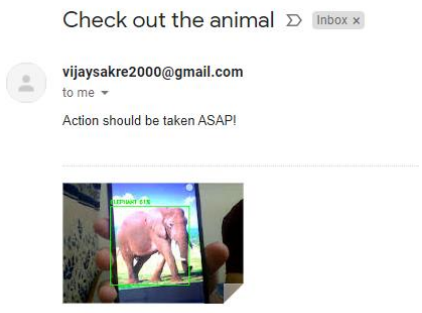


Fig 8: Image of animal received through mail

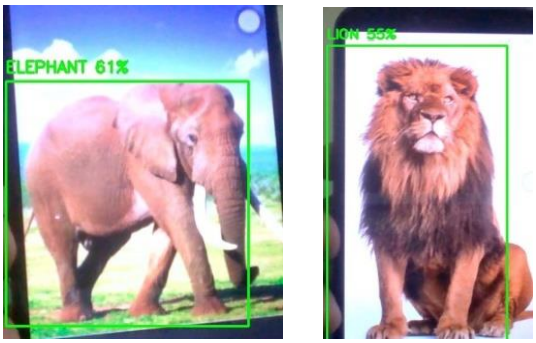


Fig 9: Animals detected through YOLO

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