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SMART AGRICULTURAL SECURITY SYSTEM

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Abstract:

Farmers generally suffer a lot of crop damage due to animal attacks, a constant threat to agricultural lands that concern farmers severely. To circumvent this damage, farmers have been using scarecrows. To settle on a plan of action for this issue, a simple application has been developed that detects the animal in the field and plays that particular animal's nemesis sound. The real-time motion of the animals in the fields is captured by interfacing the Pi camera with the raspberry pi. Then, by using image processing and machine learning the animal can be identified and the nemesis sound is generated using the speakers connected in the fields to scare away the animals. It is a more efficient way of protecting the field as the real-time motion is captured and the sound of the nemesis animal from the speaker is produced immediately.

Keywords: Crop Protection, Animal Detection, Raspberry Pi, Pi Camera

INTRODUCTION

Farmers generally suffer a lot of crop damage as seeds may be removed after sowing, seedlings may be pulled out, and grains in the milky stage or at the ripening stage may be fed upon by animals or birds, this being a constant worry for farmers in agriculture. To reduce this damage, farmers have been using scarecrows which are primarily made from a wooden stick frame and old clothes, which are then stuffed with straw. The head is made from burlap and often painted to look like a simple face making it a decoy in the shape of a human. The loose clothing flaps in the breeze, giving the illusion of a real, moving person. But recently the attack of animals on the crops in the farms have been increased during the absence of the farmer in both day and nighttime even in the presence of scarecrows. Hence, efficient, and reliable monitoring of animals in the vicinity of the field is essential.

Thus, the Smart Security System is identified as an effective measure to resolve the issue of animal attacks, that use image recognition and computer vision. Image recognition (or image classification) is identifying and categorizing images in one of several predefined distinct classes. So, image recognition software and apps can define what's depicted in a picture and distinguish one object from another. Computer vision is the field of study aimed at enabling machines with this ability. Identification of real-time objects through computer vision-oriented research has recently increased due to the widespread application of Convolutional Neural Networks (CNN) based models. Here, in this Security System, YOLO algorithm is used where the animal is determined by a pi camera and the identified animal is searched through the built-in data set and the name of the animal detected is displayed along with its nemesis sound played through the speaker.

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LITERATURE SURVEY

The majority of the buffer zone villages within the Nanda Devi Biosphere Reserve reported substantial issues with crop production losses. In a case study, ten villages in the Chamoli district of Uttaranchal, India's Nanada Devi Biosphere Reserve (1612 km^2) were investigated during 1996–1997 utilizing a questionnaire survey of each household. The total crop yield losses for wheat and potatoes were substantial in all the communities. More than half of all crop losses across all villages came from regions close to forests. For buffer zone villages in the Garhwal Himalaya, the estimated total cost of agriculture yield losses as a result of wildlife damage is approximately Rs. 538620 (US $15,389).

Many animal attack prevention methods have been existing for different kinds of animals since this study mainly focuses on elephants, wild boars, and buffalos. In Sri Lanka, screaming noises, beating drums and trees, and cracking whips are used to scare away the elephants. Commonly buffalos are scared of sudden lights and thunder sounds. Various systems have been developed to detect animal intrusion into the fields.

"IoT in Precision Farming for a Sustainable Future" by Swapna Raghunath, and K. Syamala Devi tells how the Internet of Things (IoT) is applied to precision farming for providing customized farming solutions with the use of real-time sensors and software to collect, organize, process, analyze, manipulate, and store agricultural and environmental data and share it with various farming appliances and systems over the internet. "Automated Animal Detection in Agricultural Fields using Convolutional Neural Networks and UAV Imagery" by Zhou et al. (2019) proposes an automated animal detection system in agricultural fields using convolutional neural networks and UAV imagery. The system detects and identifies animals such as deer and wild boars that cause crop damage in fields. "Automatic Identification of Crop Damaging Animals using Machine Learning Techniques" by Prasad et al. (2020) presents a system that uses machine learning algorithms for animal detection based on camera trap images. The system identifies animals such as wild boars, monkeys, and elephants and can alert farmers to potential crops.

METHODOLOGY

Python is applied to configure Raspberry Pi after installing the Raspbian Operating System on an SD card. The Raspberry Pi is the soul of the system. To process the image, we use Raspberry Pi and library files of the Pi camera have been installed into the system. The model is created using Python 3, and TensorFlow for building the classifier. The connection is established between the Pi camera and Raspberry Pi, by which the Pi camera detects the motion of the object. Fig.1 shows the block diagram of the smart agriculture security system.

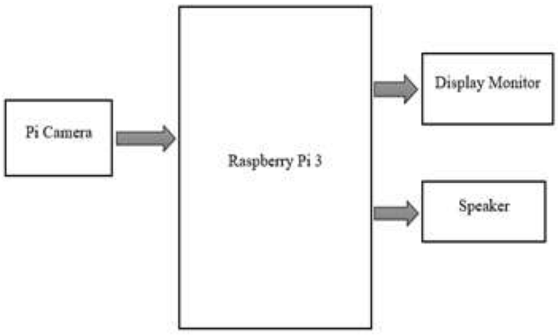

Fig.1. Block Diagram

After starting the operating system when Raspberry Pi will be powered up, it will initialize the Python script. As the Raspberry Pi receives a power supply same will be given to the Pi camera. The Pi camera captures images in frames per second (FPS) and this captured image will be sent to the image processing which happens in the software TensorFlow. The capturing of images is a continuous process that keeps happening every second. TensorFlow is an end-to-end open-source machine learning platform with a focus on deep neural networks. We specifically use TensorFlow for object detection and image recognition. Further processing happens using the YOLO algorithm.

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YOLO is an acronym for "You Only Look Once" and this has that name because it is it real-time object detection algorithm that processes images very fast and accurately. A tensor as compared to a one-dimensional vector or array or 2-dimensional matrix can have n dimensions as in fig.2.

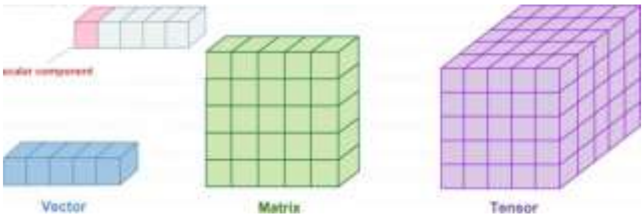

Fig.2. TensorFlow Matrix

In the TensorFlow Python library, the shape corresponds to the dimensionality of the tensor in simple terms the number of elements in each dimension defines a tensor's shape. YOLO algorithm locates the existence of an object in an image using a bounding box and assigns the name of the object found. The tensor matrix forms the bounding boxes on the captured image hence giving it a grid-like appearance as shown in the fig.3. YOLO focuses on the entire captured image dividing into a grid matrix and then simultaneously confining the bounding boxes and classifying the probability map to finally give the label around the box.

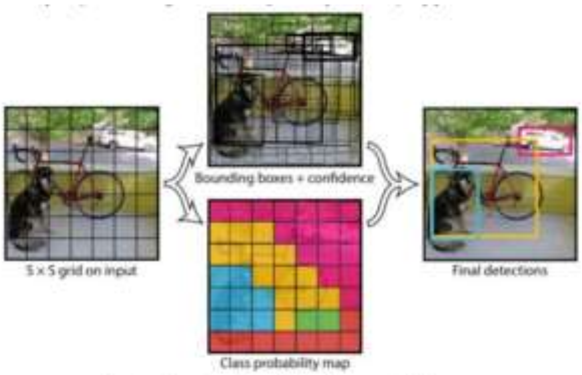

Fig.3. Bounding box, Object Detection, and Localization

Once the object is detected, each object is attached to a nemesis, given as input in the code. The nemesis names have audio files saved in the same library as the primary code. So as the motion is detected and the image is recognized immediately the nemesis sound is played through the speakers

CIRCUIT DESIGN

Fig.4 shows the hardware arrangement of the agricultural security system consisting of:

- Raspberry Pi 3 B model
- Pi Camera
- Speaker
- A Monitor

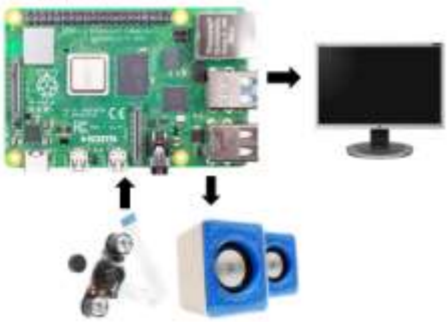

Fig.4. Hardware Arrangement of the Security System

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Here, Pi Camera is connected to the Camera Serial Interface(CSI) port, the monitor to the 5V micro-USB Port, the speaker is connected to the 3.5mm, 4-pole Composite Video and Audio Socket, and another cable of the speaker are connected to the USB Port of the Raspberry Pi 3 B+ model. Fig.5 shows the circuit connections of the proposed system.

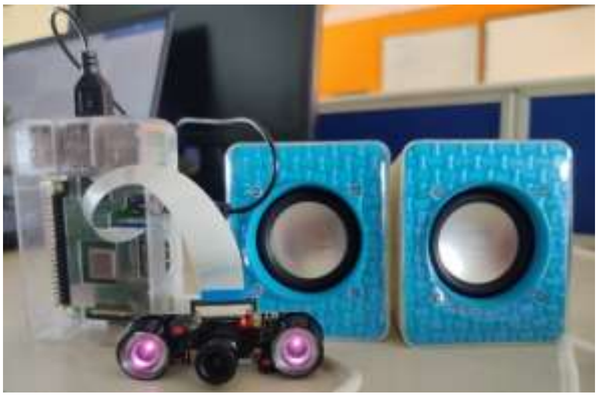

Fig.5. Connections of the Proposed System

FLOWCHART

The camera is an essential part of this system, as its primary work is to capture real-time images. Raspbian is an operating system based on the Linux distribution for the Raspberry Pi family. Fig.6 shows the flow of the agricultural security system. Here Pi camera plays a vital role in capturing the images. The captured image is then processed using TensorFlow for object detection.

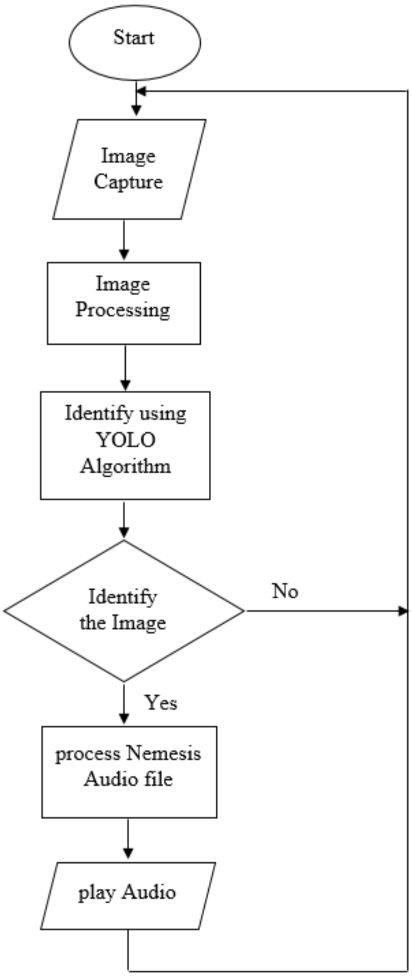

Fig.6. Flow Chart

 http://doi.org/10.36893/JK.2023.V13I05N02.170-175

After the detection of the image, it is recognized with the help of the YOLO Algorithm. This algorithm helps in recognizing real-time images. The image recognition is done by dividing it into a matrix grid format. Once the image has been recognized by swotting through the datasets, it will display the label. Then the cognize nemesis sound will be processed and it will be played via speakers.

RESULTS

One of the many uses for the Raspberry Pi is in agriculture, where it has been used to develop a system that aids farmers in defending their crops against animals and intruders. The prototype is based on a Pi camera that is connected to the Raspberry Pi and is capable of capturing and recording the movement of animals and intruders. Once the animal or intruder is recognized, the system emits a corresponding Nemesis sound through the speaker attached to the Raspberry Pi.

Fig.7. Result Window

The Pi camera here recognizes and records a movement, as seen in Fig.7. When movement is detected, the monitor shows the message "MOTION DETECTED" along with the name of the detected object as mentioned in the dataset, and in the above case it is a "person". We get the green boundary around the detected object if that object is present in the dataset, whereas the object detected in the white box is not present in the dataset. FPS in the figure indicates frames per second that is used to measure frame rate which is the number of images consecutively displayed each second and is a common metric used in video capture and playback when discussing video quality. Here the FPS in Fig.7 is 0.14. In Fig.8, image recognition is occurring, although the image sharpness is not as clear. So this prototype has an excellent accuracy of up to 80%, which means it can recognize any kind of image. This prototype can detect multiple animals and intruders simultaneously, as shown in fig 8. Since the captured image is of a person, it emits a siren sound representing that person's nemesis. For instance, if the recognized image is that of a cat, the corresponding nemesis sound emitted is that of a dog, and so on. Overall, the Raspberry Pi-based system provides an effective and low-cost solution for farmers to protect their crops from animals and intruders, ensuring their livelihoods are safeguarded during both day and night.

Fig.8. Multiple and Blurred Inputs

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CONCLUSION AND FUTURE SCOPE

Since wild animals continue to destroy crops, communities are finding it difficult to find a solution. The objective of this application is to identify wild animals that are entering fields and making the corresponding nemesis sound. This allows farmers to produce more crops and promotes their economic prosperity. This application currently requires human input to function as the processors used are not sufficient, the cost of this project is a bit high and not all farmers use it. Also, this prototype consumes a lot of energy to function and requires protection during rain. Therefore, implementing efficient and advanced processors in the future will allow this application to run without human intervention. Solar energy can also be used for application functionality. It can also be made cost-effective so that it can be used by all farmers.

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