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Farm Protection and Monitoring with the Smart Animal Intrusion System.

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ABSTRACT

Human survival depends on food production. However, when there are impediments, a chain is broken, which might cause long-term issues. Although food production is the prime goal, farmland preservation is equally crucial. Several instances have surfaced of animals causing crop damage in various parts of the world, either by devouring plant components or simply trampling the crops as they race through the field. As a result, farmers face enormous financial losses. Another factor to consider is that protecting crops from wild animals necessitates extra caution. Every farmer should be aware of and recognize that animals are living beings who must be protected from pain while maintaining harvests. Thus, we devised a technique to protect farms from animals using accessible devices, which can be used along with existing methods to boost protection efficacy. With this project, we created a prototype species detection camera to aid in farm monitoring and surveillance. A Python script with pre-trained TensorFlow models will operate the camera. These models identify images in frames and match and map them to the model's training data. As soon as the buzzer senses movement, it will ring or emit a beeping sound. The proposed system will constantly monitor the field for the presence of any animal. This strategy guaranteed the absolute safety of crops against animals, so protecting the farmer's loss.

Keywords: animal detection, camera, image processing, buzzer, GSM module, DNN

INTRODUCTION

India is mostly a farming country. India's most important economic sector has traditionally been agriculture. Despite the fact that agriculture employs the majority of India's population, farmers nonetheless confront numerous challenges. Human-animal conflict is a huge issue that results in the loss of vast amounts of resources and puts human life in jeopardy. These kinds of clashes have become more common in recent years. As a result, this zone must be constantly watched to prevent the introduction of such creatures or any other unwelcome intrusion and damage caused by them.

Ecologists and biologists have conducted a wide range of studies in order to ensure a healthy and diverse ecosystem. Radio-tracking, animal speech pattern recognition, wireless sensor network tracking, and motion sensitive camera traps are just a few examples of wild animal monitoring technologies that have been created. The intended animals are equipped with a tracking device in the form of GPS tracking, satellite tracking, or VHF radio tracking. VHF accuracy is good, but it is labour-intensive and weather-dependent. Satellite tracking is less time-consuming, but it is more expensive and has a shorter life expectancy. GPS trackers are also usually employed by larger animals or birds. In conclusion, the technologies outlined above are appropriate for a range of applications that require logistical tracking over long periods or across large geographic areas.

Animal causing the damage	Crop damaged	Percentage crop damage
Wild Boar	Cereals (maize, wheat, oats, Barley)	46.48
	Vineyards	13.71
	Durum wheat	13.84
	Hazelnuts	12.92
	Grassland	11.62
	Sunflower	8.62
	Chestnuts	3.26
Monkeys, Porcupine, Goral, Deer, Bear	Maize	38.90
	Potato	29.60
	Millet	18.60
	Wheat	6.70
	Paddy	3.80
	Pulses	0.23

Fig 1- Percentage crop damage in Italy and Nepal.

Wild animal	Crops	Percentage crop damage
Elephant	Coconut, plantain, paddy	72
Gaur	Mulberry, sandal	62
Sambar	White sapota	17
Wild boar	Tapioca, tubers, paddy	16

Fig 2-Percentage Crop damage in Kerala (India).

The main purpose of our project is to build a security-based system that would safeguard crops from animals when deployed on farms. This system will continuously monitor the field for any animals entering it, detect intruding animals, and use an alarm to draw the farmer's attention. It will secure the protection of the crops while posing no risk to animals or humans.

LITERATURE SURVEY

Agriculture is one of the most pressing economic issues confronting the country, as it employs roughly 54 percent of Indians. This sector is still underdeveloped and plagued by numerous issues, resulting in low crop productivity.

IoT solutions for crop security against wild animal assaults has become an intrinsic reality. The Internet of Things (IoT) has grown in popularity across a wide range of industries, receiving major research attention from both academia and business.

IoT adoption in the agriculture sector has resulted in intelligent farming and precision agriculture. This study discusses the development of Internet of Things applications for crop protection to avoid animal invasions into farmlands. A repelling and surveillance technology is given to prevent potential crop damage from wild animal attacks and weather patterns. [1].

Bindu D and Dilip Kumar M D et al traces crop field protection as a major and complex problem in this paper. Animals from protected areas [PAs] have periodically infiltrated crop fields throughout the years, making crop field protection a crucial issue. They provide a practical method of scaring them away by constructing a gadget that analyses the animal's behaviour, detects the animal, and emits the precise sound that annoys the animal, as well as sends a message to the chosen individual. They also have several categorization systems that provide zero false alarms and reliable species identification. [2].

According to Kshama s. Bhise, the concept is employed to map the position of animals within national parks or wildlife reserves. For this, they chose RFID (Radio Frequency Identification Device) module and a GSM (Global Network Mobile) modem. These SMS messages describing the area of the animals must be received by forest officials or individuals with government power.[3].

The security system developed by M. Sathishkumar et al. is built on an embedded system, sensor networks, and GSM. Human movement is detected using PIR sensors. When the system identifies the presence of a person within a certain time interval, it raises an alarm and communicates the count of intruders via SMS through GSM Modem. When the security system is turned on, the CCTV camera is activated. The computational requirements for this highly reactive approach are low. As a result, it's ideal for home security systems. PIC microcontroller, the camera, GSM, and sensors are used to implement this surveillance security system.[4].

METHODS AND HARDWARE

Methods

The fundamental goal of image detection is to provide a label to an image based on a collection of predefined categories. The project as a whole is a software and hardware solution for detecting species in separate photographs or a single image. The two steps of the experiment are the development of an identification framework and the field deployment of trained architecture. For the field application, the model with the greatest accuracy is chosen. This work is an example of supervised learning, in which the algorithm is given a set of inputs and a set of targeted outputs.

A. DNN (Deep Neural Network)

A deep neural network is a complicated neural network with at least two layers. Deep net improves the precision of a model's performance. They enable a model to accept a collection of inputs and produce a result. DNN's functions include uploading the dataset, classifying and tagging images for training, splitting data into training and testing, and verifying the training network. To avoid overfitting, the network is trained on essential features and reviewed during the validation phase. After obtaining sufficient accuracy via many training and validating stages, the model is assessed using a completely separate dataset to assess the network's performance.

B. Dataset

The dataset for an image classification issue is a collection of pictures, each of which represents a data point. The picture data of the desired animals will be acquired from established datasets such as Zooniverse, Kaggle, and others. Kaggle is a web-based data science environment where you can search for and upload data sets, analyse and build models, engage with other data scientists and machine learning professionals, and compete to solve data science challenges. The dimensions and resolution of the image may vary, and it will be adjusted to appropriate pixels. At the operation stage, the original data will be employed in the DNN architecture.

C. Pre- processing of Data

To prepare a dataset for the DNN model, it must be formatted. The initial step in dataset pre-processing is to format, clean, and sample the dataset to increase the classification algorithm's ability to extract data from it. Data sampling can be used to reduce processing time and memory needs by picking a smaller representative sample of the requested data. To increase classification accuracy, image pre-processing procedures could include image scaling, standardizing image inputs, noise removal, data segmentation, and morphology. Scaling allows you to resize the dataset in equal widths and heights while retaining the aspect ratio. Several random image adjustments, such as vertical/horizontal flipping, rotation, translation, zooming, or colour desaturation, can be applied to improve an image.

D. Environment and Tools used

The Python programming language is used for this project since it offers strong and easy syntax. TensorFlow, a higher-level framework, is used for making developing, testing, and adjusting models in an easier and more stable manner. Importing images from storage, displaying them on our screen, and performing image processing operations will all be done with OpenCV2. The camera will be connected to a Raspberry Pi to perform DNN calculations in the field, providing the most up-to-date complete solution for developing AI applications. For camera applications, the Raspberry Pi can use TensorRT, OpenCV, and the Multimedia API package.

Hardware

A static IP address is used to connect the Raspberry Pi to your laptop or desktop computer directly. As compared to WIFI an

enormous improvement is observed in speed and stability of the system. Pi stays connected for a longer duration without getting disconnected or getting network time outs.

A. Raspberry pi

Raspberry Pi 4 Model B is used here. The total memory of the SD card is 16GB and the slot is used for installing the operating system, booting, and long-term storage. The USB power port supplies 700ma at 5A. The RCA Video out is used to carry audio and video signals to connect to the internet, utilizing the Ethernet port. Most recent TVs and computer displays have HDMI input ports that are compatible with the HDMI output port. It is a 700 MHz processor and is the GPIO (General-Purpose Input/Output) physically interfaces with the raspberry pi and the outside world.

B. Web Camera

The Logitech webcam is used in the project. The primary reasons for choosing this product are its durability, handy features, variable parameter setups, and low cost. The lenses have a 60-degree field of view that covers all of the action. The video supports HD 720p at 30fps. It runs on Windows 7 or later, macOS 10.10 or later, Chrome OS, and has a USB port.

C. Buzzer

A beeper or buzzer is a mechanical, electromechanical, or piezoelectric aural signalling device. The primary goal is to convert an audio signal into a sound signal. With a scripted Python program on Raspberry Pi the buzzer produces a repeated beep on required results. The predefined frequency of the buzzer is about 2300Hz. Ideally, it operates at 5V.

RESULTS

A static IP address is used when connecting the Raspberry Pi to laptop or desktop computer. When compared to connecting over WIFI, a significant improvement in speed and stability is observed. Pi can be connected indefinitely without being disconnected or experiencing network time outs. On the Raspberry Pi, image recognition is performed using the OpenCV Library. The system contains two Python scripts, one of which is a training programme that will analyse a group of images of a certain animal, and the other is the Recognizer programme, which recognises the animal and specifies the name and recognition efficiency. A video feed from a webcam is a long series of images that are modified one after the other, and each of those images is merely a collection of pixels of varied values arranged in their respective positions. We begin the project by importing the modules that we have defined. The cv2 module is used for image processing, while NumPy is used to convert pictures to math equivalents and the OS module is used to explore directories. To optimise the classifier, data from the original training (1000 images) dataset was divided into 80% training (800 images) and 20% validation (200 images). The accuracy percent value for validation is 70.

This project provides us with a one-of-a-kind method for defending the farm from animal trespass while also causing harm to the fauna. As a result, this project keeps track of the animals, and if any are discovered, the owner/farm keeper is notified via an alert. The owner will be able to simply find out where the animal is thanks to this technology. Farmers will benefit from this project since it will help them secure their crops and orchards, avoiding them from suffering economic damage and conserving them time and effort in the process. This will also assist them in generating higher crop yields, which will improve their financial situation.

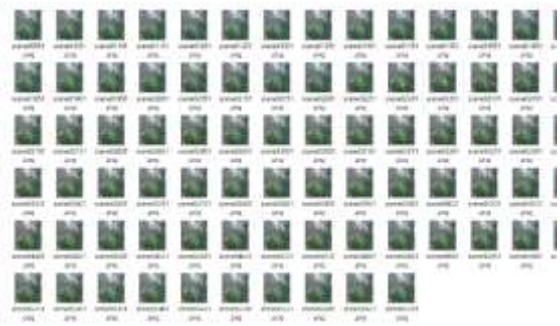

Fig 3- Image sequence for real-time animal recognition.

Fig 4- Kaggle Image Search API animal images

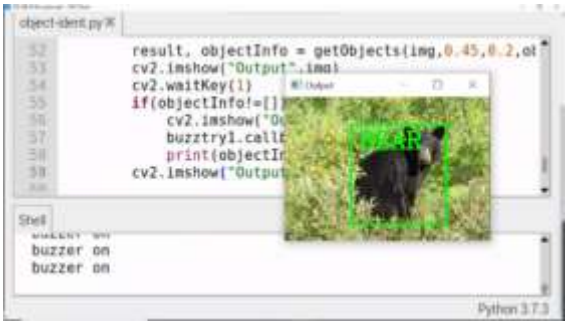

Fig 5- Identification of wild bear in daylight.

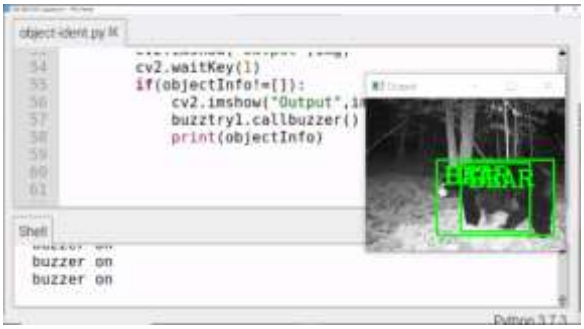

Fig 6- Identification of wild bear at night.

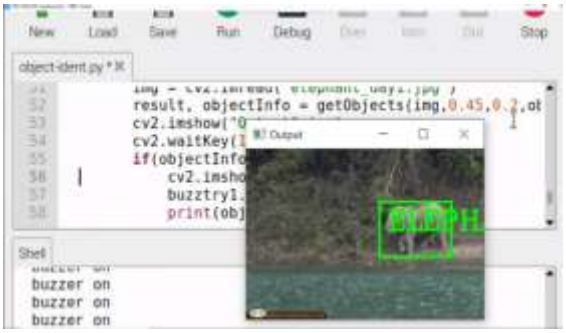

Fig 7- Identification of Elephant in daylight.

Fig 8- Identification of Elephant at night.

CONCLUSION

Animal crop vandalism has become a major social issue in recent years. It needs immediate attention because there is currently no effective answer to this problem. As a result, this project has a lot of societal significance because it tries to solve a problem. To address this problem, we devised a system in which sound is produced to startle the animals and birds, causing them to flee. The devised method is both economical and beneficial to farmers. The method is designed to be safe for animals and people, as well as to protect farmland.

To summarise, this project exceeded our expectations, and all of the futures functioned as expected. This project was both tough and enjoyable to work on. In India, this technology will revolutionise the way people farm. Farmers can access the farm remotely and obtain all pertinent information. Animals and unlawful entry will be kept out of the farm.

LIMITATIONS

1. The present model restrains itself from identifying the intruding animal in a few aspects, like capturing the video at night. According to existing gadgets, it's difficult to capture images or videos in complete darkness. The slight presence of light for processing images is required. The issue can be overcome by placing a light source in the vicinity of the model.

2. Weather stability cannot be guaranteed, particularly during adverse conditions such as heavy rain and storms. The model will be protected from damage by the waterproof hard covering.

3. Utilizing raspberry pie on a regular basis causes excessive heating, which can be alleviated by using the raspberry pie fan.

4. Because it is difficult to supply electricity in remote sections of the farm, the power source functions as a barrier, therefore power failure can be prevented by employing Lithium polymer batteries.

FUTURE SCOPE

1. We can use the Day/Night camera to increase the functionality. These cameras are suitable for outdoor surveillance since the inbuilt infrared illuminators serve the purpose and boost efficiency, allowing the user to function in both normal and dimly lit conditions.

2. The PTZ Pan Tilt & Zoom Camera can be used to expand the surveillance area. The camera may be moved left, right, up, and down, and the user can also zoom in and out for a better view.

3. The owner can be notified about the animal intrusion using the GSM (Global System for Mobile communication) module through Short Messaging Service (SMS). The farmer can be given information such as the name of the animal recognised as well as the image.

4. More storage, higher video definition, safer data backup, customised reports, easier access, and remote maintenance require cloud-based video surveillance.

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