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Animal Classifier System for Video Surveillance and Forest Monitoring Using Raspberry-pi

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ABSTRACT

Nowadays, wildlife monitoring has become a challenging work and that too without help of technology. To remedy this, we came with the solution of animal classifier camera that will detect the animals in the forests and keep the record of the animals. The system is also useful in zoological parks to maintain the wildlife. The system is also capable of identifying the new species. If any new species is detected it will store its data in a separate database to study further. It is also possible to control the system remotely if an internet is available in the respective area. The system uses a python-based code containing pre-trained *TensorFlow* models. Live footage is provided to the raspberry pi using pi camera. It then uses *OpenCV* modules to cut the images in frame and the obtained frames are compared with the pretrained modules and the label is given accordingly. It is also possible to access the system and the data stored using *Rasp Controller* a mobile application.

KEYWORDS: Raspberry-pi, TensorFlow, OpenCV modules, Rasp Controller

1. INTRODUCTION

Wildlife monitoring is very important nowadays because lots of species of animals are on the edge of extinction and some of the species are already vanished. Thus, it is necessary to keep the record of the wild animals. But it becomes a tough task to keep such records without the help of technology. Traditional method like setting a trap of cameras in the forest and clicking the photographs manually and then classifying and labeling the animals by looking at the pictures takes too much time and efforts. And also, it is not possible for a single person to stay in the forest 24/7 and capture the images.

Thus, with help of modern technologies like *machine learning* we are able to classify animals using their captured images and videos. It is also possible to store the information in the system.

Hence, in our project, we have developed an Animal classification system. Our device is capable to identify animals by capturing their live images and store the data in a database.

We are using python idle, Raspbian OS, *OpenCV* modules, pretrained *TensorFlow* model and Raspberry pi, camera as hardware.

The objectives of this work are aiming to classify animals using their images/ live video and store the respective data to help forest monitoring process

The objectives of this work are:

- To detect the animals and store the data.
- To save the data of new animals/species in the system.
- To wirelessly control the system.
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The system consists of three main parts:

- Interfacing SD card with Raspberry pi.
- Interfacing of camera module with the Raspberry pi.
- Capture the video/images of the animals and classify accordingly.
- Display the output on the computer or in the smartphone and save the information.
- To access the system and get the information from a distance (depends on the network).

Such type of system is useful to monitor the wildlife and it's also helpful in maintaining the wildlife in zoological parks.

2. LITERATURE SURVEY

Rasool and Moorthy [1] highlighted the issue of security of animals in zoological parks who can be escaped from the cage and can cause harm to the humans and also the system can detect any outsider entered into the cage. "The system used a single cable raspberry pi camera Rev 1.3 and raspberry pi B+ board. The raspberry pi camera takes the video of the cage and

gives to the raspberry pi, then the obtained video streaming data is analysed using OpenCV platform. In OpenCV platform the data is classified using Machine Learning algorithms. The data is analysed to check whether any intruder entered the cage or if the animal escaped from the cage." [1]

Dihingia et al. [2], system detects animals which enters into a farm or any household. The system detects and classifies animals in real-time by implementing a Convolution Neural Network (CNN). CNN is a concept of deep learning.

Chavan and Mevekari [3], showed selection of deep learning structure in a flow-wise manner from all other structures for animal classification in real time environment on embedded device by considering the factors like accuracy, embedded device capability.

Paramasivam et al. [4], the paper proposed that CNN (Convolution Neural Network) is able to classify the input image into categories. VNC tool is used to control the raspberry pi board and BLYNK APP is used to create front end tool to operate the detection system in user friendly mode. The system is embedded with Wi-Fi logic to connect IOT cloud and to provide alert mechanism upon detection of animals. Necessary data related to animal detection can be stored in cloud to improve the system with data analytics.

Priya Sharma et al. [5], proposed system for the prevention of clashes between humans and wild animals. Sometimes animals enter the human localities and farms and can cause harm thus in order to remedy this the system is designed to detect the animal entering into the farm. PIR sensor for motion detection and video camera are used to capture images. The images are sent to Raspberry pi and then classification and processing is done using deep neural network and appropriate action is taken according to the type of animal.

Patil and Ansari [6], highlighted the issue of the wild animals entering the farms and societies which are close to the forests. The proposed system uses PIR sensor to detect the motion and camera. After the motion is detected, camera turns on and the video is sent to raspberry pi then classification is processed using YOLO V3 with Darknet architecture model.

K. S. Murugesan et al. [7], the proposed system highlights the issue of damage caused by the animals to the crops in the farm. The system uses image processing techniques and motion detection techniques which are used to detect the animals. Once the animal is detected the information is passed on to the nearest forest officers and the framers in the village to be aware. The system also uses Tranquilizer gun to control the animal. But this method of using Tranquilizer gun can be harmful for the animals.

William H. S. Antônio et al. [8], the paper mainly focuses on the problem of collision of animals and vehicles on the roads. The system uses cameras to get the images along the roadside of the forests and if an animal is detected drivers are warned. The system mainly classifies in two classes that is animals and non-animals, machine learning model is used to perform this operation. The system is very useful in Brazilian roads as there are more such cases of animal and vehicle collision. But the method used to warn the drivers when an animal is detected is a traditional method of displaying message on the display. Instead of using this they can use mobile applications and IOT application to pass on the message with drivers.

Iniyaa K K et al. [9], proposed a system in order to prevent the loss of farmers due to animals' presence in their farm. The system uses Convolutional Neural Networks for the purpose of image processing and this is most efficient way of animal detection. When an animal is detected, a repellent sound is produced by the system to drive away animals from the field and also a message is sent to the farmer. This type of system is also cost efficient, reduces the human efforts and protects the crops from animals.

Rung-Ching Chen et al. [10], developed the pet monitoring system for the people those who cannot pay attention to their pets using YOLO v3 tiny model. The system captures images of the pets and after collecting images of behaviour of animal it decides when to send message to the owner for example if cat goes in toilet for too long or if it is biting anything which it should not. It is not possible for the user to continuously monitor their pet when they are not at home this type of research is very useful.

3. MACHINE LEARNING

Machine learning (ML) can be defined as a category of *Artificial Intelligence*. Algorithms of machine learning use historic data as input to guess the new output. Machine learning algorithm uses such historic data which can be termed as training data to build a model which is going to be really helpful in predictions and to take decisions accordingly.

Machine leaning builds such algorithms which can study from the past data. The accuracy of the prediction given by the machine leaning algorithm depends on the amount of data given to the algorithm at the time of training. More the data better is the performance of that algorithm in other words it can predict more accurately.

There are four elementary machine learning methods: supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning.

Supervised learning: Supervised learning is a method of machine learning in which already labelled data is provided to the model and using this type of data model is trained. To verify whether the model predicts the correct output values(labels) or not a random un-labelled data is passed. In this method of machine leaning 80% data of total data is used to train the model and 20% data is used for testing purpose.

Unsupervised learning: In this method of machine learning, unlabeled data is provided to the model. Using this data, the algorithm is able to classify the data and label it. Unsupervised learning method uses unlabeled dataset and is allowed to take actions on its own.

Semi-supervised learning: This method of machine learning is a combination of supervised learning and unsupervised learning methods. In this method generally labelled data and huge amount of unlabeled data are provided to the algorithm but the model is capable of labelling the data on its own. This

method also uses certain unsupervised learning algorithms.

Reinforcement learning: Reinforcement learning consists of a learning agent. This method of machine learning is trained with the help of feedback received by learning agent. In this, learning agent gets certain points after each correct decision and also some points are deducted after every wrong decision. This learning agent interacts with the environment. More the points of learning agent higher is the performance of the model. However, for the most part, the algorithm selects what actions to take along the road.

4. OPENCV

OpenCV is a massive open-source library which we can use for machine learning, computer vision and image processing. It is recognized for its real-time functioning, which is critical in today's system. OpenCV can studies photos and videos to classify faces, objects, and even writing that belong to certain persons. It can process the OpenCV array structure for analysis when joint with other libraries such as NumPy and Python. To recognize an image pattern and its many features, we apply mathematical operations and vector space.

The original version of OpenCV, 1.0, was out under the BSD License. It is accessible for both commercial and academic use at no cost. It works with operating systems like Linux, iOS, Mac OS, Windows and Android, as well as languages such as Python, C++, C, and Java. The main goal in developing OpenCV was to generate a real-time application for computing productivity.

5.TENSORFLOW

TensorFlow is an open-source toolkit for mathematical calculation and large-scale machine learning developed by the "Google Brain team''. TensorFlow combines an excess of machine learning and deep learning models and algorithms and makes them functioning through a common paradigm. Python is being used by TensorFlow to provide a manageable front-end API for developing applications using the framework, while running such apps in high-performance C++.

TensorFlow is one of the popular libraries which is used for deep learning. We can actually train, test and also can deploy our machine learning model using TensorFlow. Not only in python but TensorFlow can also be used in other languages like Java, C++ and JavaScript. TensorFlow can be used in medical industry to detect certain diseases, in social media application and websites, also google uses TensorFlow in their search engine to give good experience to their users.

6.RASPBERRY-PI

The Raspberry Pi is an affordable, small-sized computer but having low performance than laptops and desktops which connects to a computer display, mobile phone screens and works with a regular mouse and keyboard. Raspberry pi comes with the Raspbian OS which a official OS for raspberry pi but there are also some third party OS that we can install and run like Ubuntu, Archlinux, Windows 10 IOT core etc., This small sized computer can be used in robotics application, real time image and video processing operations and other normal activities that we perform on a desktop like playing games, watching videos, browsing on internet etc.

Additionally, Raspberry Pi contains ram size ranging from 512mb up to 4gb depending upon the model of Raspberry pi. Unlike our desktops and laptops Raspberry pi also has a clock frequency/CPU speed which can ranges from 700MHz up to 1.2GHz again depending on the model of Raspberry pi.

7. METHODOLOGY

The first step in the methodology is to make setup of Raspberry pi by installing Raspbian OS and interfacing of SD card with it.

Installing the python idle in it as our system is totally based on python code and install the required libraries like NumPy, pandas and TensorFlow.

Clone the required TensorFlow models by using git commands. To get the expected results we first need to preprocess the data using OpenCV and the other libraries like NumPy and pandas. Images captured by the camera are then sent to the raspberry pi. After obtaining the images OpenCV then converts the images in frame.

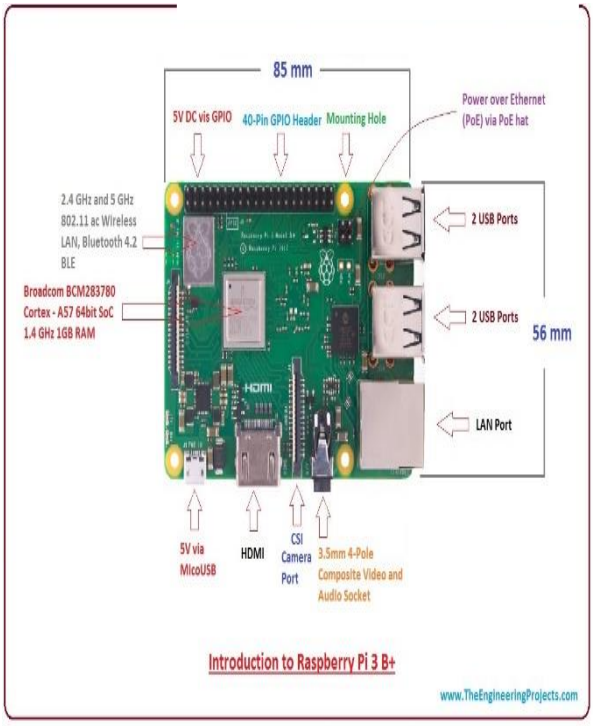

Fig.1. Raspberry-pi 3B+ board

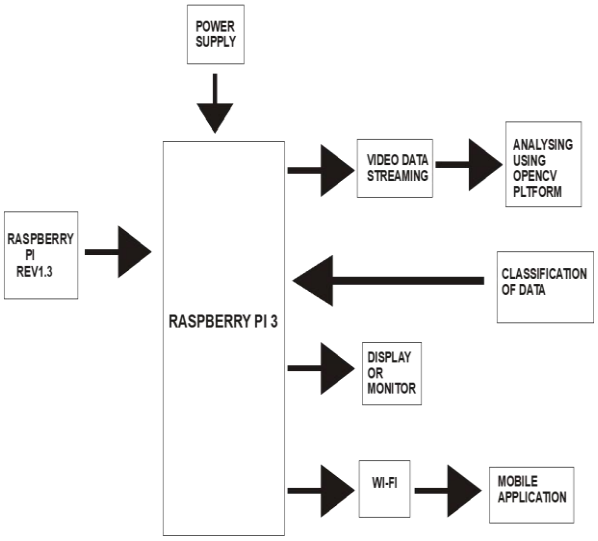

Fig. 2. Block Diagram

Algorithm:

- Image/video capturing from the camera.
- Convert video into frames using OpenCV.
- Compare camera captured frames with the pretrained model.
- Store the data of animal that is its image and name, id with timestamp attached in a database.
- If animal is not present in the database store its names as {none} in a different database with timestamp attached.
- Display the output on the monitor/ smartphone (using Rasp controller).

1.Capturing Images/Videos
Capturing of images is done using Raspberry pi camera or a usb camera can also be used. First, we need to set the camera in the area from where we have to monitor the forest animals for example a lake in the forest can be best place to observe because almost each and every animal from the forest need water so they will come in the area of lake at that time it is possible to record the videos.

2. Processing the obtained images
In the processing of images OpenCV breaks the images into frame using NumPy and pandas and further classification is done by the TensorFlow.

3.Comparing collected data
Comparison of the frames obtained from the OpenCV is made with the help of TensorFlow and then the animal is labelled accordingly. If the animal is not present in the database, then it is labelled as {none} and stored in a different database as it's a new species according to the system.

4.Storing the collected data
After processing and comparing the data, the obtained data is then saved in a database with the date and time of appearance and also captured images are stored.

5.Displaying the data
The obtained results are then can be displayed on a monitor of our pc/laptop or it can be displayed on a smartphone using Rasp controller application.

8. RESULTS AND DISCUSSION

After the image classification and detection of an animal the data is first displayed on the monitor or mobile application and simultaneously according to the name of detected animal data is stored in a database. If any new species is detected its data is then stored in separate database for further operation and research on that data. After storing the data, we can access data using BLYNK application if system is available online and if it is not online, we need to remove the SD-card of Raspberry-pi. Using pretrained machine learning model it becomes easier to classify animals. To check whether our system works fine or not it is not actually possible to test system in forest, we used the LCD monitors and played videos of animals. The accuracy of the prediction of an animal depends on the amount of data used to train the model. More the amount of data more accurately the model will predict.

The system designed is able to classify the animals along with the counting of number of animals/objects in the frame.

Fig.3. Elephant detected and data displayed

9. CONCLUSION AND FUTURE SCOPE

Due to increased hunting of animals, it has become necessary to keep the record of wildlife animals and protect environment. Also, it's difficult to implement the tadeonal ways of keeping the record. Hence, proposed system works to keep such records with the help of Machine Learning.

This type of system is really useful for the wildlife researchers and also in zoological parks. It can be used by wildlife researchers and the forest officers to keep the data of animals to study them. It can be used in zoological parks to monitor the animals inside the cage and to protect them from any outsider which can enter the cage. Wildlife researches can use the system even if internet is not available in the forest. This is one of the major advantages. Unlike other relate work it uses pretrained machine learning model that is MobileNet v3. It has large number of data so that it predicts more accurately.

Proposed system is able to classify animals but in future after some modifications it also can be used to send message and to warn people. In future, such system can be useful to study the various species of animals on land as well as under the water. This type of system is also useful for pet monitoring for those people who cannot pay attention to their pets because of their job. System also reduces the human efforts required to count the number of animals in forest.

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