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Python-Based Species Classification Wireless Camera for Forest Survey and Monitoring

A PROJECT CENTRIC LEARNING REPORT

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CERTIFICATE

This is to certify that the project work titled "**PYTHON-BASED SPECIES CLASSIFICATION WIRELESS CAMERA FOR FOREST SURVEY AND MONITORING**" is carried out by, **G.VAISHNAVI 19BTREC054, A.SREE REDDY 19BTREC004, P.MANIVARDHAN 19BTREC028, P.GIRIDHAR REDDY 19BTREC025, P.HITESH REDDY 19BTREC027** are bonafide students of Bachelor of Technology at the Faculty of Engineering & Technology, JAIN DEEMED-TO-BE UNIVERSITY, Bengaluru in partial fulfillment for the award of degree in Bachelor of Technology in Electronics and Communication Engineering, during the year 2021-2022.

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CONTENTS

ABSTRACT

Nowadays, computers play a crucial role in people's life as they are employed to carry out all human tasks more precisely and effectively. An advanced computer vision job that extracts information from films or digital pictures is visual scene analysis. In the field of computer vision and image processing known as object detection, objects belonging to different classes (such as animals, people, and cars) are sought for in still images and moving pictures. Some of the extensively studied applications of object detection include video surveillance, face detection, car detection, and picture retrieval.

This project focuses on the numerous object identification technologies based on images and videos that may be applied to serve various settings. This study focuses on analyzing the various object recognition technologies that employ images and videos and may be applied in a range of situations. This study's main objective is to look at various image- and video-based items. strategies for identifying and fixing object detection issues in images and videos. This article includes comprehensive information on a wide range of object identification techniques in various contexts.

Finally, comparisons are made between various image and video settings and the various object identification techniques. Animal lives are precious. In order to preserve the stability and balance of the environment, it is our responsibility as global citizens to strive toward ensuring the survival and growth of animals.

Wildlife monitoring gathers information on the types, quantities, behavior’s, and general well-being of environmental conditions that support successful wildlife resource conservation, sustainable use, and scientific management. To assist researchers in understanding the state and dynamics of wildlife resources.

Numerous animal species have become extinct due to excessive hunting; thus, the government has passed legislation and is conducting surveys to protect some of these species. Surveying is a challenging task, especially if the essential resources are not readily available. Surveying is a challenging process, especially without the aid of technology. To solve this, a Species Classification wireless camera is being implemented.

The pre-trained Tensor Flow model is utilized in conjunction with the smart camera and python-based programming. Some species are hard to find, and even when they are, it might be challenging to classify them. From a human perspective, different species found in different places appear in different sizes, shapes, coolers, and angles in chronological order.

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Numerous animal species have become extinct due to excessive hunting; thus, the government has passed legislation and is conducting surveys to protect some of these species. Surveying is a challenging task, especially if the essential resources are not readily available. Surveying is a challenging process, especially without the aid of technology. To solve this, a Species Classification wireless camera is being implemented. The pre-trained Tensor Flow model is utilized in conjunction with the smart camera and python-based programming. Some species are hard to find, and even when they are, it might be challenging to classify them. From a human perspective, different species found in different places appear in different sizes, shapes, colors, and angles. in chronological order

However, user-friendly machine learning software is enabling individuals to apply the most recent algorithms to their own problems and datasets, even if they lack a solid background in computer science. However, it is still crucial to have a rudimentary knowledge of the applied technologies and try to become acquainted with them. Protection of endangered species requires continual observation and knowledge of their presence, whereabouts, and behavioral changes in their environment.

There is an urgent need for a system for automated animal species recognition using picture classification. Species recognition from collected images is a challenging endeavor because to a significant amount of intra-class variability, perspective variation, lighting illumination, conclusion, background clutter, and distortion. Massive amounts of collected images and video require manual data processing, which is time-consuming and expensive. It can help us comprehend animal behavior as well as the development and movement of the forest's creatures and plants.

Figure 1 shows about the animal species classification.

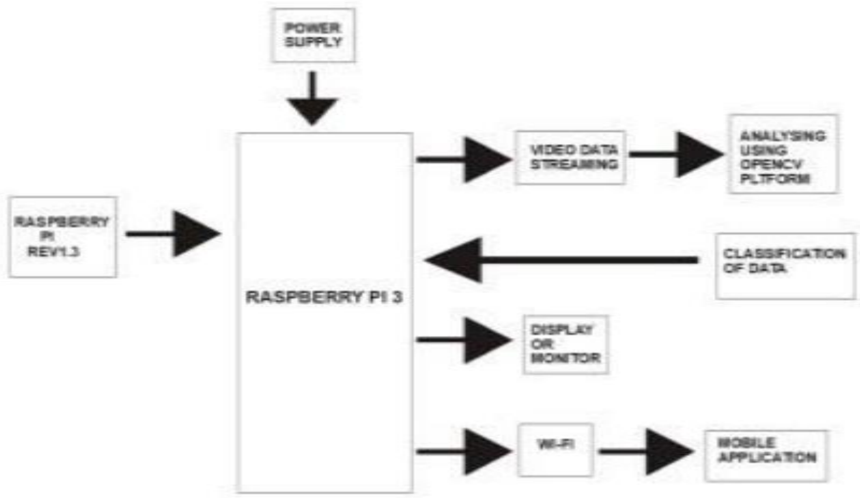

Figure 2 explain about the components in the form of a block diagram.

The block diagram for animal categorization is seen in figure 2. A moving item is identified from the frames after the camera takes the video, after which the video is transformed into frames. Animals are identified from the frame using the animal detection method. To identify the animal that was in the frame, the identified animal is categorized. Figure 2 depicts the categorized pictures.

One of the challenges is the computer-based analysis and interpretation of visual situations. A high-level activity that extracts knowledge from movies or digital pictures is visual scene analysis, which is a subfield of computer vision. Computer vision uses information and image data to make decisions. Image data includes digital photographs, a sequence of photos, multi-view images, and more. For many computer vision applications, object recognition from several scenes is a crucial need.

A system that can easily differentiate one kind of item from another is the human visual system. Applications including autonomous data processing, Human-Computer Interaction (HCI), automated processes, smart cars, and wild animal identification typically make use of object detection. According to various research, object detection has uses in the fields of automobile detection, face detection, picture retrieval, and video surveillance.

Examining several object identification methods in diverse contexts is the major contribution of this article. Animal identification is a significant and developing field because of the wide range of practical applications. To show animal welfare on roads or in neighborhoods, several detection techniques and warning systems will be deployed. Real-world needs include avoiding animal-vehicle crashes on roadways, avoiding harmful animal incursions into homes, and being aware of specific animal locomotive behavior. All of these technologies may be boiled down to three main fields: animal detection, tracking, and identification. Numerous real-world applications made advantage of the first field of animal detection.

CHAPTER 2

LITERATURE REVIEW

Fang. Y suggested a technique for moving animal detection that uses global patterns of pixel motion. Using optical flow methods, the motion vectors of each pixel in the dataset, which depicts animals moving against a background, were calculated. A coarse segmentation eliminates the bulk of the background using a pixel velocity threshold. To eliminate undesirable candidates who could come from the background, a different threshold was used to the split areas.

G. Jasko showed off a technology that can identify several huge wild animals in busy areas. Visual data was gathered using a monocular color vision camera. In order to discover animals on the road who could cause an accident, the objective was to assess the traffic scene image, determine the regions of interest, and suitably classify them. The traffic scene image was converted into a saliency map using information on intensity, color, and direction. The conspicuous locations on the map were considered to be interesting areas. A database was built utilizing a massive collection of images of various four-legged wild animals. From these, pertinent characteristics were chosen, and Support Vector Machine (SVM) classifiers were trained.

H. Nguyen investigated a significant barrier to ecologists' and scientists' ability to observe animals in the wild. Based on recent developments in deep learning techniques in computer vision, a framework was presented to develop automatic animal detection in the wild with the aim of an automated wildlife monitoring system.

Parham. j introduced a 5-component detection pipeline for an animal recognition system based on computer vision. With labels for species and opinions, this strategy produced a collection of interesting unique annotations. This approach aimed to provide better ecological data to conservationists while also increasing the precision and automation of animal censusing studies.

A novel approach to object recognition built on hybrid local descriptors was put forth by S. Matuska. This approach, which is broken up into two portions, incorporates multiple techniques (SIFT, or Scale-invariant feature transform, and SURF, or Speeded Up Robust Features). The value of the offered hybrid techniques was shown on a few images from the collection. On Slovak soil, the wolf, fox, brown bear, deer, and wild boar are some of the more common creatures.

A two-channeled perceiving residual pyramid network was proposed by C. Zhu and colleagues for automated wild animal recognition in low-resolution camera-trap pictures. In order to train a network and extract depth cue from the original pictures in this article, a two-channeled perceiving model was used as input. Three-layer residual blocks were utilized to combine all the data and get full-size detection results. A fresh, high-quality dataset representing the complex natural environment was also produced using dataset design principles.

It was suggested in the I Boon Tatt Koik (2012) Survey to find, monitor, and identify creatures in some of these branches. Numerous practical applications can benefit from research on animal detection. The locomotive behavior of the target animal may be studied using animal detection techniques, and they can also be used to keep dangerous animals out of residential areas. The first concern is illumination, where a quick change in lighting might have an impact on how well you can detect animal entry, especially in indoor settings. Additionally, the outdoor monitoring scheme's detection may be impacted by the brightness problem caused by changes in the environment from day to night. Furthermore, sedentary animals that are stationary for an extended period of time may be seen as a background picture whereas changing backgrounds, such wind-blown leaves, may be interpreted as foreground images by the algorithms. SVM was utilized to categories the object representations that were created using visual descriptors (SVM).

A fully convolutional neural network was created by Eric T. Psotaet al. (2019) and is capable of detecting the position and orientation of multiple pigs in a group. The network's goal is to provide each component of the pig with its own picture space and a method of connecting them to create complete instances. A brand-new dataset with 2000 images and 24,842 pig cases is used to train the network. The dataset is divided into two parts: a training set and a testing set. The testing set is further divided into two subsets: one contains photos depicting the same surroundings as the training set, while the other contains images depicting novel contexts not included in the training set.

CHAPTER 3

PROBLEM STATEMENT

- Numerous animal species have been driven to extinction by relentless hunting, and the government hasn't done anything to stop it other than create a few laws and conduct a few surveys.

- But carrying out surveys is a difficult task, particularly without the aid of technology. We are creating a prototype Species Classification wireless camera to help with monitoring and surveillance of forests in order to solve this. Our smart camera uses TensorFlow models that have already been trained and is Python-programmed.

- We employ pre-trained tensor models to match and map the image in the frame with the model's learnt data in order to identify the image in the frame.

CHAPTER 4

OBJECTIVE

Numerous animal species have been exterminated by excessive hunting, and the government has made minimal changes except from passing a few regulations and carrying out a few surveys. But carrying out surveys is a really challenging undertaking, particularly without the aid of technology.

To fix this, we're planning to create a wireless camera prototype for species classification that will aid in the monitoring and surveillance of forests. TensorFlow models that have already been trained are used in our smart camera's Python-based programming. We may match and map the picture in the frame with the training data of the pre-trained tensor models to detect the image in the frame.

A Raspberry Pi equipped with a camera module was utilized. The Raspberry Pi uses its camera to capture the footage, which it then frames splits using the OpenCV package. Then, it processes the image recognition of the species in the picture using OpenCV and other modules and tries to map it with a category and trained detection model. The discovered species' outcome is then displayed. The image with the data and date is saved in the database folder so that it may be subsequently investigated if the output is "none" if the identified species in the image is not included in the category list.

If the detected species is listed in the category list, it outputs the name and ID of the species along with the date and time in a text file called survaydb.txt and saves the image along with the detected label in the database folder for future use. Thus, our smart camera maintains tabs on everything and builds a database with images of every species found in the forest. Additionally, it can assist us understand animal behavior and the development and movement of the forest's flora and animals.

CHAPTER 5

METHODOLOGY

Cameras are positioned at particular locations throughout a nature reserve or forest area in a grid pattern. The Raspberry Pi module receives the pictures as input. These images are processed by a convolutional neural network's layers. In order to recognize the photographs in the dataset, CNN learns their key characteristics. Each layer removes a potential result when compared to the photographs offered in the dataset. The animal is then recognized, and if it is a dangerous animal, an alert is raised. The algorithm for identifying species includes the following.

steps, acquisition of images and videos using the camera algorithm. Make a video converter frame-by-frame. Save the images of each animal in the database that will serve as the algorithm's training set. Compare the camera's captured frames to the database. The imread function is used to read the picture, after which preprocessing is conducted. Perform Blobs in the frame are identified, and they are compared to images from the training database. Check to see whether it matches as well. Whether or whether the identify of that animal is desired. An array is created, and software is constructed to identify each animal. When it is recognized to obtain the count, we employ if statements to increase count. Step 9: We get the results of the Livestock Identification and Reckoning.

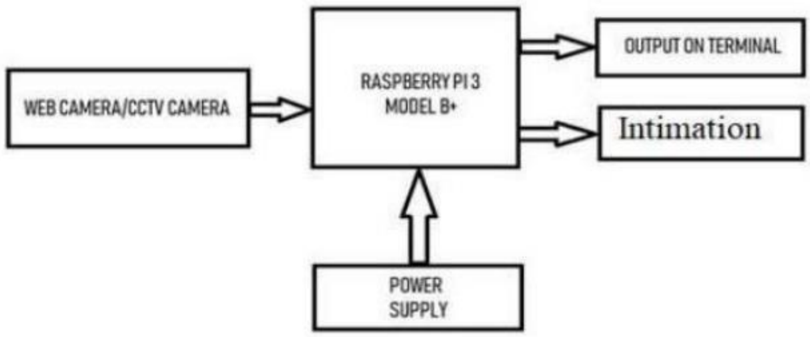

Figure 3 shows the Raspberry pie interface for the species detection.

THE ARCHITECTURE OF WILDLIFE MONITORING SYSTEM BASED ON WIRELESS IMAGE SENSOR NETWORK.

The continued existence and growth of animals maintains the equilibrium and stability of the entire ecosystem. With the help of wildlife monitoring, researchers can better understand the status and dynamics of wildlife resources and lay the groundwork for their effective protection, wise use, and scientific management.

Wildlife monitoring can provide a wealth of information about wildlife species, numbers, habits, quality of life, and habitat conditions. The cornerstone of managing and protecting wildlife is wildlife monitoring. The most widely used technology in the information industry today is wireless sensor networks (WSN).

Wireless Image Sensor Networks (WISN) technology, which combines wireless sensor networks with image sensors, has become an option in monitoring applications due to advancements in CMOS image sensor technology. One of its most potential uses is to monitor animals.

To address the drawbacks of conventional monitoring techniques, a system architecture for a wildlife monitoring system based on wireless image sensor networks was given in this research. Particularly, a few important aspects have been researched and presented, such as the design of wireless image sensor nodes and software process design.

The development of an aggregation node and a self-powered rotating wireless infrared image sensor node based on ARM technology. Additionally, the relevant software for them was created. The suggested system can correctly, automatically, and remotely monitor animals in all types of weather, which sets the groundwork for the use of wireless image sensor networks in wildlife monitoring.

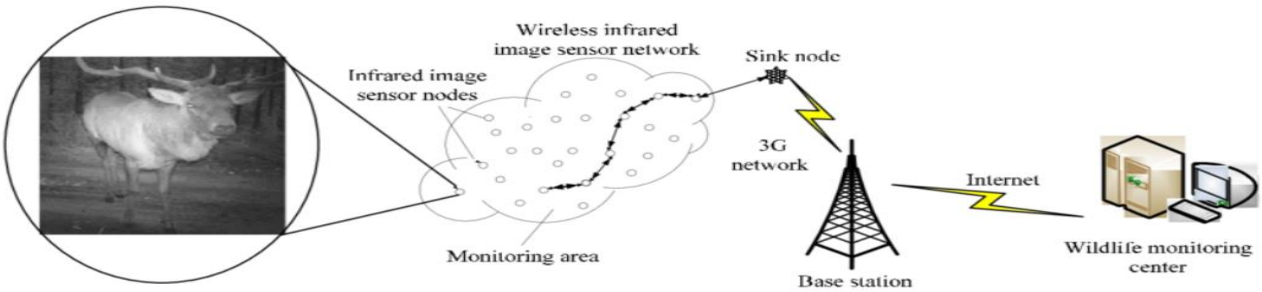

Figure 5 the architecture of wildlife monitoring system based on wireless image sensor network.

CHAPTER 6

ALGORITHM

- Step 1: Image/video acquisition from the camera
- Step 2: Convert video to frames.
- Step 3: Store images of each animal as database which is used as training set for our program
- Step 4: Compare camera captured frames with the database.
- Step 5: Use imread function to read the image and Preprocessing is done on that image. Perform Blob detection on the frame and blobs are matched with images from training database images.
- Step 6: And check if it is matching or not.
- Step 7: To identification of that animal is desired or not. An array is created and program is written for each animal to be identified.
- Step 8: To obtain the count- we use if statements to increment count when identified.
- Step 9: we obtain the results of Identification and Reckoning of Livestock

CHAPTER 7

TOOL DESCRIPTION

- RASPBERRY PI
- RPI CAMERA
- HDMI/RCA CABLE
- WIRES

RASPBERRY PI

One of the most innovative computers on the market right now is Raspberry Pi, a line of compact single-board computers created by the Raspberry Pi Foundation in collaboration with Broadcom.

The Raspberry Pi's bright green circuit board begs you to fiddle with it, play with it, start programming it, and use it to build your own software from the minute you first see it. The Raspberry Pi was first meant to teach fundamental computer science in schools, but because to its low cost and open architecture, the model eventually gained far more popularity than was initially envisaged.

It is frequently employed in the production of gadgets for fitness, weather stations, and many other things. However, aside from that, thousands of individuals of various ages utilise it to begin their study of computer science.

One of the most popular computers in Britain, the majority of the boards are produced in the Sony facility in Pencoed, Wales.

the Raspberry Pi Zero W was launched, a version of the Zero with Wi-Fi and Bluetooth capabilities

Figure 5 Raspberry Pi 4/zero w

RPI CAMERA

A lightweight, portable camera that supports Raspberry Pi is called the Pi camera module. It uses the MIPI camera serial interface standard to talk to the Raspberry Pi. It is typically employed in projects involving image processing, machine learning, or surveillance

This 5-megapixel camera module with OV5647 sensor can capture still photos and 1080p video and connects straight to your Raspberry Pi. The most recent Raspbian operating system is plug-and-play compatible, making it ideal for time-lapse photography, video recording, motion detection, and security applications. You may get started by connecting the provided ribbon cable to the Raspberry Pi's CSI (Camera Serial Interface) port.

With dimensions of around 25 x 23 x 9 mm and a weight of little over 3 g, the board itself is incredibly small, making it ideal for mobile devices or other applications where size and weight are critical.

The sensor includes a fixed focus lens and a native resolution of 5 megapixels. The camera can capture still photographs with a resolution of 2592 x 1944 pixels and also supports video in 1080p30, 720p60, and 640x480p90 resolutions.

RPI CAMERA FEATURE

- 5MP color camera module without microphone for raspaberry
- Supports both Raspberry Pi Model A and Model B
- MIPI Camera serial interface
- Omni vision 5647 Camera Module
- Resolution: 2592 * 1944
- Supports: 1080p, 720p and 480p
- Light weight and portable (3g only)

Figure 6 Rpi camera

HDMI CABLE

An HDMI-compliant source device, such as a display controller, can transmit uncompressed video data and compressed or uncompressed digital audio data to a compatible computer monitor, video projector, digital television, or digital audio device using the High-Definition Multimedia Interface (HDMI), a proprietary audio/video interface. A digital alternative to analogue video standards is HDMI.

The EIA/CEA-861 standards, which specify the waveforms and formats for video, the transmission of both compressed and uncompressed LPCM audio, auxiliary data, and VESA EDID implementations, are implemented by HDMI. p. III The CEA-861 signals utilised by the Digital Visual Interface and the CEA-861 signals delivered by HDMI are electrically compatible (DVI). When a DVI-to-HDMI converter is utilised, no signal conversion is required, and the video quality is not diminished. When appropriate, HDMI devices may communicate with one another via the Consumer Electronics Control (CEC) functionality, which also enables users to control numerous devices with a single handheld remote.

RCA CABLE

Radio Corporation of America is referred to as RCA. It is a long, three-colored connector that attaches to the back of a TV, projector, or other output device and connects to three outputs there. The component device sends audio and video signals to an output device through RCA connections.

The RCA cables may be used for a variety of purposes. The RCA cable is still quite significant and serves a variety of functions, even though HDMI cables are acceptable for the same purpose. The cables may be used to connect camcorders to a variety of output devices, including speakers, TVs, and stereos.

Three RCA jacks are seen in high-end camcorders. As a consequence, the camcorder has three RCA jacks: one for audio and two for video, via which any signal can enter or exit. A high-quality transmission of audio and visual signals is the end result.

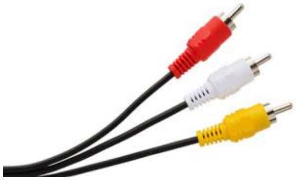

Figure 7 RCA cable

Figure 8 HDMI cable

CHAPTHER 8

FINANCIAL PLAN

Component name	Quantity	Description	Cost
Raspberry PI4/zero W	1	Any version of RPI	4500
RPI Camera	1	Camera module	300
HDMI/RCA Cable	1	For video output	200
wires	Depends	For connection	30
Total cost			5030

CHAPTER 9

MARKETING PLAN

- In today's increasingly competitive world, which is characterised by constant change and innovation, entrepreneurship is crucial. By creating jobs, encouraging invention and development, and creating and improving procedures and processes, it encourages economic and social progress and ultimately leads to improved efficiency through competition.

- The entrepreneurial process needs the help of the company plan. A business plan is a written document that lists every internal and external element that affects the beginning of a new company. It is a fusion of numerous functional techniques from the fields of HR, manufacturing, finance, and marketing.

CHAPTER 10

ADVANTAGES

- System for camera-based surveillance the major advantages of using a Raspberry Pi are for monitoring and making it simple to identify species for forest surveys.

- It keeps an eye on situations and actions, which is useful for gathering information and spotting any unexpected activity taking place in the forest, such as smuggling and deforestation.
- It simplifies tasks and reduces the amount of manual labour required in their absence.

- It aids in reducing the number of extinct species by monitoring and surveying those that are dwindling, which helps to assist them in dangerous situations.
- It is affordable and simple to purchase on the market.
- It is portable in that the code and other components may be modified to meet the needs.

CHAPTER 11

FUTURE ENHANCEMENT

- The use of this wireless camera can be expanded in the future to include forest surveys and species monitoring.

- It can be updated with minor adjustments, such as using a different memory device to solve storage problems or upgrading to a more advanced sensor to improve image analysis and detection.

- Alternatively, data that is no longer useful or that is damaged can be automatically deleted.

- This problem can be updated for upcoming changes.

CHAPTER 12

CONCLUSION

- The block diagram's representation of the Wild Animal Detection and Counting System is used to find and count wild animals. The Raspberry Pi may be used by both small- and large-scale livestock producers to make the system portable and affordable. The method of identifying certain animals and counting them in line with the results is shown in the flowchart. To compare the image to the values in the current data set, the image is first captured using a camera and then converted to a greyscale image.

- Current options like bar code scanning and hand animal counting are expensive and ineffective. We developed a real-time system that does such a work effectively and affordably in order to get around these difficulties. The accuracy and performance of this system may be greatly enhanced with improvements in portable computers like the Raspberry Pi in terms of memory, processing speed, and networking capabilities. For instance, the deep learning method consumes a lot of resources with the Raspberry Pi 3 b+'s present specs, slowing performance and reducing accuracy to a certain extent, and increasing processor temperature.

CHAPTER 13

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