SPoCS: SMART PET CONTROL SYSTEM

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***Abstract*— In this paper, we discuss about a smart system that helps owners to monitor their pets activity. Many people face the problem of pets spoiling the expensive furniture or other decorative. Sometimes, the pets spill all the trash all around as they search for food in the trash can. All these problems may seem to be of not of great relevance but matter when the costs related to these objects are high. We intend to design a solution for monitoring the pet using Raspberry–pi development board. Additionally, this system also the sends an alert to user whenever the pet tries comes in contact with the objects that it is not supposed. This product comes handy when the owner is not physically present in the house.**

I. INTRODUCTION

Monitoring pets has been a huge problem for a long time now. According to a survey conducted by American Veterinary Medical Association the percentage of people having pets in United States is 57% and the percentage of people having multiple pets are around 50% [1]. Another important reason for monitoring pets is due to the fact that pets can mischievous when un-monitored and also can get into or create unwanted trouble. There are multiple situations like the pet tearing up the couch or scratching the door. Also at times due to their overenthusiasm the pets might push over trash can there by spilling the trash all over the house. At times animals suffer from separation anxiety when owner is not home. This may also sometimes trigger them into doing one above the importance of a having a pet monitoring device. There are multiple products available in the market that can help us monitor the pets but most of them are either very costly or very bulky in size and appearance. We intend to develop a low cost pet monitoring system by using just Raspberry-pi development board. The main motivation behind the project is to help the owners track the pet's activity. Also keep the pet and other home furniture safe and keep the house clear of the unwanted mess.

A. Objective

The objective of this project is to discuss a system created to monitor the activity of pets in the absence of the owner. With the motivation presented above, the methodology to create a smart pet control system will be discussed in preceding sections.

B. Related work

There are multiple pet monitoring products in the market. For instance, Motorola alone has released many devices such as WirelessFence25, Scouttrainer25, TravelFence50, ScoutBark200U, MotorolaBark200U as mentioned in [2] for monitoring pet's. All these products are very pricey and serve different purposes .To completely monitor a pet we need to have all the products mentioned. Our product has most of the above products function in a single package. Also there are numerous pet monitoring cameras in the market as mentioned in [3].All these cameras use high end features night vision, 360-degree view, Wide viewing angle, High-Definition video quality and many-more[3]. Also most of these products use high-end multiple high end software technologies like cloud computing, Internet of things (IoT) and Artificial Intelligence [3]. For using the platforms that provide these technologies are not for free and have to be subscribed on a monthly basis. Our product is purely based on Internet of things (IoT) and we use already existing free licensed online platforms to provide the required which needs no subscription.

C. Methodology

As per the given Fig 1 the inputs are given to the Raspberry-pi. The custom algorithm is loaded into the development board and acts on given inputs and performs the required computation to trigger an output response. The input that we refer here is a live video stream captured through the Raspberry-Pi camera and the output response is an audio command and an email notification with the link to a live video stream.

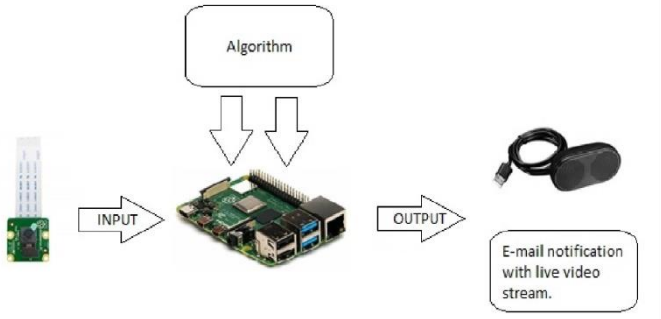

Figure 1: Block Diagram

We will first, in Section II discuss about the necessary hardware that was used to create the smart pet control system.in section III The software components and coding languages used will be discussed and the training dataset used and models of computation for Image Classification, Voice Command output, Message Transmission and Live video streaming of the happenings is elaborated. In Section IV we discuss about the Results obtained. Finally, In Section V the conclusions and future scope of our product is given.

II. HARDWARE

The main hardware equipment used for the project is the Raspberry – Pi development board along with speaker and camera. The main idea behind using this particular development board is that it is cost effective and delivers the required performance. A Raspberry-pi camera is used to get the incoming live feed. In comparison to other products like Furbo Dog Camera, Wyze CamPen or Pawbo pet camera as mentioned in [3], we use a relatively lower-end hardware camera as our main goal to create a relatively cheaper and compact system.

A. Raspberry-Pi Development Kit

The main hardware component of the project is the development board. This is where all necessary computation is done performed. The required algorithm is loaded into the kit which works with the input to produce the necessary output. We have used the Raspberry-pi development kit version 3.0 which has 1.0GB of RAM and Quad Core 1.2GHz 64bit CPU [4]. It also has an on-board Wi-Fi (BCM43438) and Bluetooth low energy (BLE) module. It also has a 40 pin GPIO and also has a full-size HDMI port [4].

Figure 2.1: RaspBerry Pi – 3 [4]

B. Pi Camera

This is another important hardware component since the input live feed is captured and recorded using this camera.

This camera uses 8MP (Mega pixel) native resolution Sony IMX 219 Image sensor. It is capable of capturing 3280 x 2464 pixel static images [5]. Also it captures video at 1080p30, 720p60 and 640x480p90 resolutions [5].

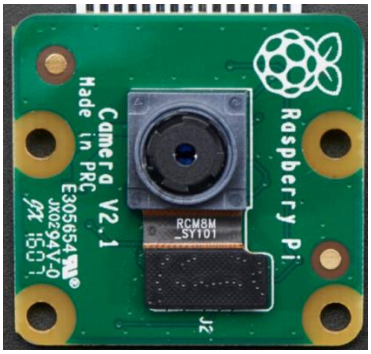

Figure 2.2: Pi Camera

C. Speakers:

The next important component used is speaker. It is used to relay the message from the user to the pet. We have used. The reason for choosing the pi speaker module is that it is compatible with the Raspberry-pi development kit. It is also quite compact and cost friendly. It is a 3W speaker which uses I2S digital sound standard [6]. Therefore, provides a great sound clarity.

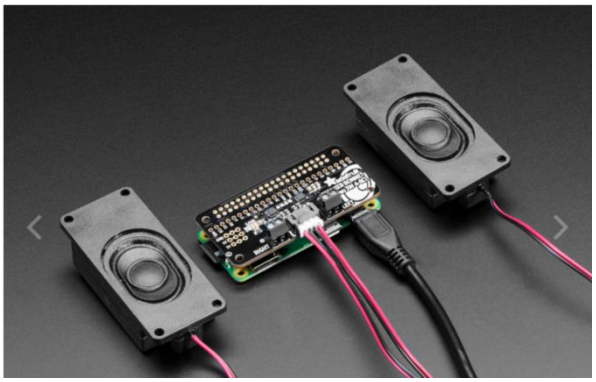

Figure 2.3: Speakers [6]

III. SOFTWARE

The main objective of the software was detect the pet and multiple flagged objects (Furniture, Curtains, Trash Cans, etc) and trigger an automated voice command when the pet moves very close to the flagged object. At the same time the machine should also send an automated email to the user about stating an alert with live video feed from the house.

A. Image Detection & Classification

As a starting point of moving towards achieving our project objectives we have started with face detection. We have used a machine learning approach called "Haar cascading" where in a set of inputs are used to train a cascading function for Face Detection. This model works for the detection of grey scale images only. It needs only input image, scale factor and Minimum Neighbors as input factors. We can observe the Face recognition in Figure 3.1.

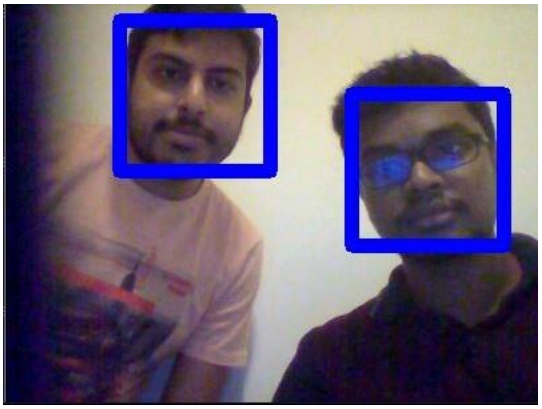

Figure 3.1: Face Recognition

Moving ahead towards our goal and building upon this, we have used the Tensorflow's object detection API to detect pets and objects in the house [8]. It is an open source

framework which is built on top of Tensorflow [7]. The Tensorflow model that we have used for object detection is "SSDLite_mobilenet_V2_coco" [9], [7]. In Figure 3.2 we can observe the Raspberry–Pi detecting the furniture present inside the house. It has successfully identified a "Sofa", "Chair', "Table" with a confidence percentage of 93.66, 86.57, and 51.55 respectively.

Figure 3.2: Object Detection

The reason behind selecting the particular model is because of both its high execution speed and relatively better accuracy in comparison to RCNN or Inception models. This model seems to be perfect fit for our project, since we use low cost Raspberry pi development board.

B. Voice Command Output

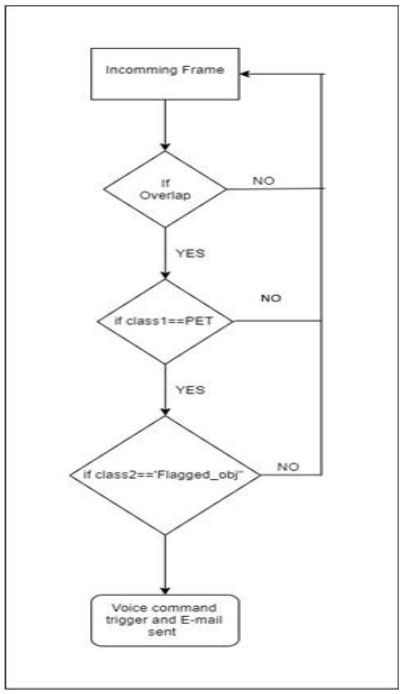

Figure 3.3: Flow diagram for Voice Command Output

Initially, the pre-defined voice files are added to a predefined path with specific class names. Then we obtain class of the detected object from the trained model. Certain classes are already defined in a flagged list. Once the object class of dog or cat comes nearby to the object with a class name that belongs to a flagged list, then certain functionalities are triggered. [The term nearby has the following meaning: if the overlap between the bounding box of a dog/cat and the flagged object is more than 40% then the object is considered to be nearby]. In Figure 3.3, you can observe the functionality of Voice Command Output.

C. Message Transmission

A notification email is then transmitted to the user. This functionality is achieved by using Python's inbuilt E-mail transfer module called the smtplib [12]. The Simple Mail Transfer Protocol (SMTP) module uses the RFC 821 protocol for SMT. In this project we have used Gmail's SMTP server for sending E-mail notifications which contains the link of the live video, to the user.

Firstly, for sending the E-mail notification, we are setting up a secure SMTP connection. This is done to ensure that our messages and login credentials are safe and could not be easily gathered by others. To encrypt the SMTP connection we have used the SSL (Secure Socket Layer) and TLS (Transport Layer Security) protocols. This way we have established an secure SMTP connection with the Email server using SMTP_SLL( ) of smtplib to initiate a TLS –encrypted connection. The default context from the SLL module will enable host name checking and certificate validation.

Secondly, after establishing an secure connection, we have used the sendmail() functionality to send the required message along with the hyperlink to the video stream. A sample output of an E-mail notification is shown in Fig 3.4.

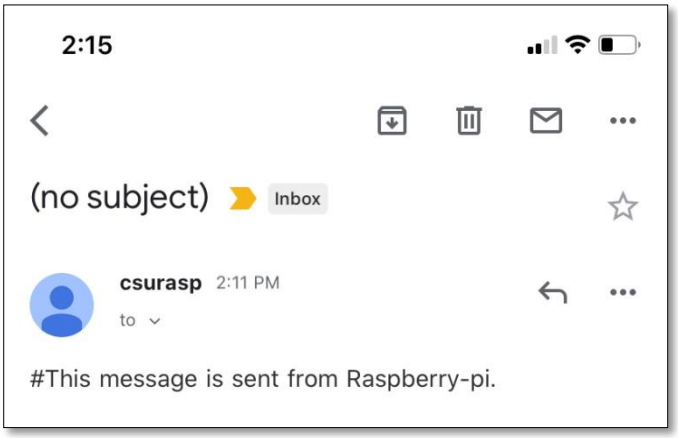

Figure 3.4 – This is an example E-mail sent from the Raspberry –pi board without the link to live stream.

D. Live video streaming

We are live streaming the real time happenings inside the house by using a Raspberry-pi camera and web interface (RPCWI) provided in [13]. The interface provides nice features like pause and restarts of a live preview. It also allows the user to record the live stream. This enables the user to capture some cute moments. The RPCWI has

options to select between Apache and Nginx web servers. For this project we have used Apache web server to run the RPCWI. As we are transmitting the live video of someone else' house we have to be concerned about the security of the transmission. Keeping the fore-mentioned point in mind we have made the connection password protected by enabling the *apache_security* feature. The user is now sent with an hyperlink of the webpage. the link that is sent to the user will look like this " *http://127.0.0.1/* ", where in place of 127.0.0.1 the IP address or the domain name of the raspberry-pi board is specified.

IV. RESULTS

All the four functionalities which were elaborated as subcategories of Section III are combined together to implement our prototype. For implementation we have used all the hardware which was mentioned in Section II. In Figure 4.1 we have showed the setup that was used for Prototyping.

Figure 4.1: Hardware setup

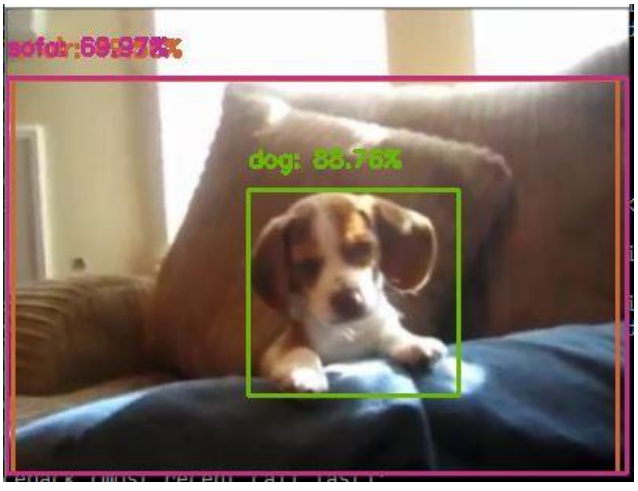

Figure 4.2: Dog sitting on a Sofa

As we don't have a pet at home we had to give an video as the input to our prototype. We can see that our model has successfully identified the dog sitting on the sofa. As the dog's entire bounding box is inside the sofa's bounding box it has triggered the audio command for sofa i.e. "Scooby get down the sofa". In Figure 4.3 you can see the email notification that was sent to my mail id as i am the user in this case. You can also observe the hyperlink that is present in the figure. Once I click the hyperlink it navigates me to a new browser where I can view the live video this is shown in Figure 4.4.

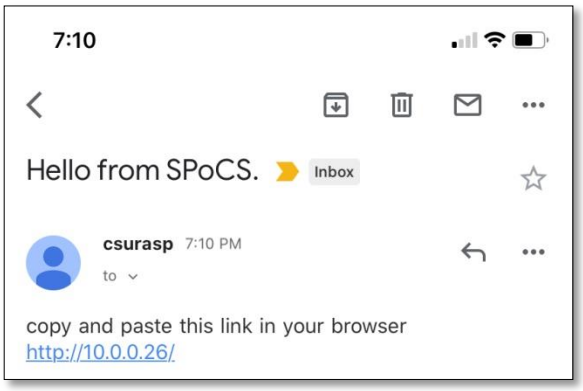

Figure 4.3: Email from the Prototype

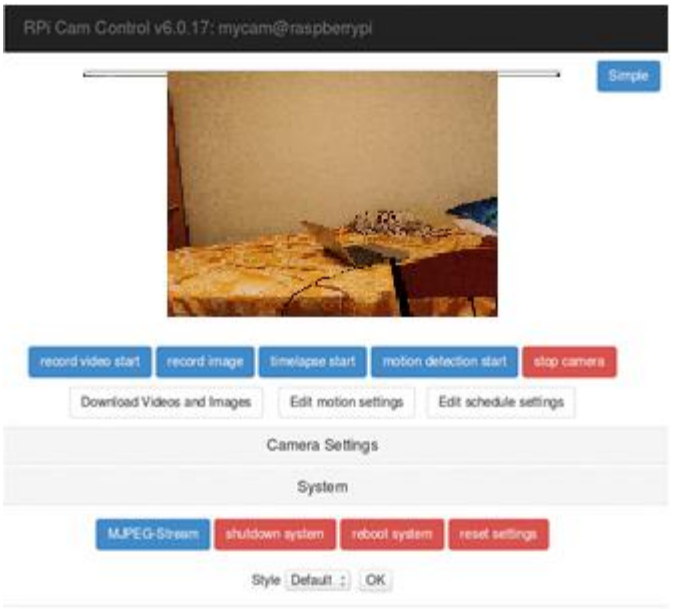

Figure 4.4: live streaming

This is a small use case of what can be achieved with image classification and can be extended to develop different ideas. Some of them are mentioned the coming section.

V. CONCLUSIONS AND FUTURE SCOPE

In this paper we have implemented a simple and user friendly prototype that can effectively monitor the pets. It helps the user keep their pets and as well as their expensive home decor safe. With this prototype we have tried to implement a non-invasive and cost effective pet monitoring device which can be more than beneficial to the majority of the pet loving masses with the least compromise in performance with comparison to the products of the same

class.

Image classification and Object detection have been one of the most prominent areas of research for the past few years [10], [11], [12] and [13]. The introduction of such pre-trained models, have paved way for the applicability of the above mentioned technologies across various domains and will help to develop innovative solutions.

In future we would like to enhance the capabilities our prototype for outdoor implementation in places like Parks, Barns, Stables, etc. Also we could use the same functional algorithm by linking it to the tracking feature of e-commerce platforms like Amazon or E-bay for detecting the delivery of the products you order. We could also implement VoIP (Voice over internet Protocol) in order to facilitate the real-time communication between the user and their pet. The fore-mentioned approaches are a few ways in which the existing prototype can be enhanced to cater for a wider range of applications.

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