



SMART HOME INTRUSION DETECTION AND TRACKING SYSTEM

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Abstract: This paper presents an intelligent system that can identify and recognize faces using Raspberry pi which can be applied for home security to detect the intrusion of people and differentiate them as known and unknown by comparing the data set stored in the Raspberry pi. In case of an unrecognized or unknown person, the real-time video stream is processed, motion is detected and dual-axis pan-tilt servos track that person with the pi-camera. The already existing system is Network video recorders (NVRs) and digital video recorders (DVRs). Although DVRs are more prevalent, NVRs are actually a better fit for IP camera integrations and compatibility. NVRs usually cost slightly more than DVRs, but the high resolution of IP cameras typically outweigh the added cost, to overcome the drawbacks and reduce the cost and human error two simple algorithms are used for face detection and recognition in raspberry pi using the raspberry pi-camera. To train the images of the known people in raspberry pi Histogram of oriented gradients (HOG) algorithm is used and for the recognition of the faces HAAR algorithm is used. The intrusion of people is recognized and differentiated as known and unknown by comparing the data set and an E-mail is sent to alert that the respective person or an unknown person is at the doorstep. This method is cheap, cost-effective and requires a little hardware.

Index Terms - Raspberry pi, Face recognition, Motion tracking, home surveillance, Security

INTRODUCTION

Safety and security are major concerns in modern day era. People employ security mechanisms to safeguard their property be it home or a company. Due to the increasing rate of intrusion and suspicious activities, security systems are highly recommended everywhere. The commonly used security devices are cameras, Infrared sensors, RFID readers. These methods offer continuous monitoring, which results in high power consumption and memory wastage. Most of the time, they are cheap, but these technologies do not provide portable solutions. A human being can memorize and remember immediately. Face recognition used the most important types of biometry. This algorithm helps us recognize the faces immediately with the notification of that person's name on the email and the admin's mobile phone. It will also generate an alert if there is an unknown or suspicious

person. The camera starts recognizing the person in real time streaming with rapid notifications. A maintained database is prepared at back with visiting time, and the picture of the person entered. compared to existing system is more efficient and provides a real time response. This process is beneficial in detecting abnormal behavior or suspicious activity. So, our main aim is to overcome these disadvantages by choosing face detection algorithms and motion tracking and this method will provide real time response with more recognition rate.

The main aim of the paper is to highlight the simplicity of surveillance by using a little hardware while comparing to the other existing surveillance methods.

I. PROBLEM STATEMENT

To develop an intrusion detection system using Face detection and recognition in Raspberry pi and Raspberry pi camera module to differentiate between the known and unknown intruders and alert the owner with the intruder's image in the mail.

It is done using face detection and motion tracking algorithms in open cv using the two algorithms HOG and HAAR by installing the suitable packages along with open cv.

II. METHODOLOGY

Hardware setup: The first step is to set up the hardware components required for the smart surveillance system. This includes a Raspberry Pi board, a camera module, a power supply, and other necessary components like cables and a microSD card.



3.1 Raspberry Pi 2

Software installation: After setting up the hardware, the next step is to install the required software. This can include the operating system (such as Raspbian legacy), and other software packages required for the surveillance system, which includes imutils, dlib, and cmake

Camera configuration: Once the software is installed, the camera module needs to be configured. This can be done using the Raspberry Pi configuration tool by enabling the camera.



3.2 Raspberry pi camera module

Motion detection and image processing: In order to make the surveillance system "smart", the Raspberry Pi needs to be able to detect motion and process the images captured by the camera module. This can be accomplished through software libraries such as OpenCV. The motion detection was done using the algorithm starts working based on background subtraction and at first the test of motion tracking phenomena is using image processing techniques; results are shared in the form of movement indication.

Face detection and recognition: In order to make the Raspberry Pi module to recognize the unknown and the known person the HAAR cascade algorithm and the Histogram of oriented Gradient HOG algorithm is used.

Servo motor setup: The servo motor is connected to the camera module for the 360-degree view near the surveillance area.



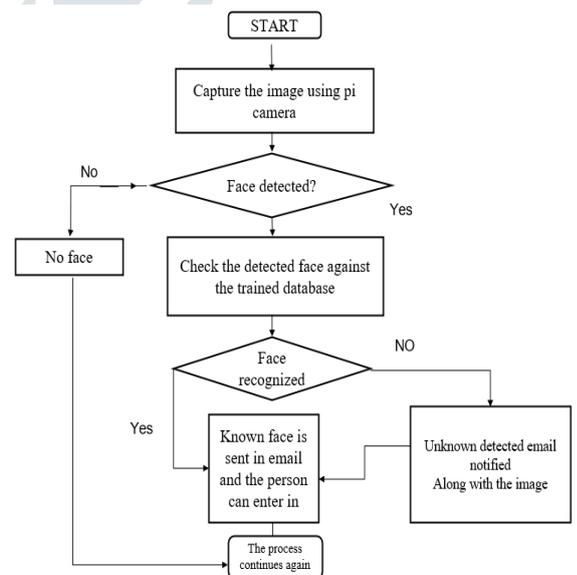
3.3 Servo motor

III. DESIGN CONCEPT

When a person enters near the surveillance area of the house, motion detection algorithm starts working based on background subtraction and at first the test of motion tracking phenomena is using image processing techniques, results are shared in the form of movement indication. For person tracking on a 360 degree view a full tilt servo motor is used. Efficient motor control using pd algorithm which is used to find the center of contour of the unknown body to the half angle of camera resolution. Then the facial recognition algorithm starts processing the detected face with the test data sets and if the detected face is not recognized the system will send the alert notification through email along with the recognized face in image format.

Face detection and recognition is done using Histogram of oriented gradient (HOG) and face recognition, imutils, cmake, dlib. Exporting the details of unknown through email to the user

Furthermore pan-tilt servo motors are attached to the camera to record their activities. We can also plan to add tensor flow in future extension to get more details in face recognition, and also to detect anomalous and suspicious activity using the crime dataset.



4.1 Proposed flow diagram

IV. ALGORITHMS, SOFTWARE, AND HARDWAREIMPLEMENTATIONS

Motion Detection and Background Subtraction: The algorithm of motion detection is implemented for an unknown person. It merely works on differentiating one frame from the other. Several methods are available for motion detection used previously, like edge analysis and optical flowing all the present methodologies available for motion detection on small available for motion detection on small hardware boards. Researchers find background subtraction as the best solution for motion detection. Among all the solutions available for motion detection, Background Subtraction requires the lowest computational power; therefore, it also boosts the speed. Motion detection usually compares blobs (pixels) of two frames and confirms motion if there is a difference. It is difficult to detect the movement of slowly moving objects, but an image threshold can be adjusted to cater to such issues. In background subtraction, pixel coordinates of the image(t) image(t-1). If there exists a difference called threshold, then motion could be detected. The above process can be explained with the help of the Equation

$$|Image(x, y, t) - Image(x, y, t-1)| > \text{threshold}$$

Person tracking using servos mechanism: The dual-axis servo pan-tilt mechanism is used for tracking of an unknown person. The mechanism will follow the person using the idea of servo positioning. In a designated frame area, the servo will move, tracking all unrecognized individual's activity. The panning and tilting together will produce a 360° view.

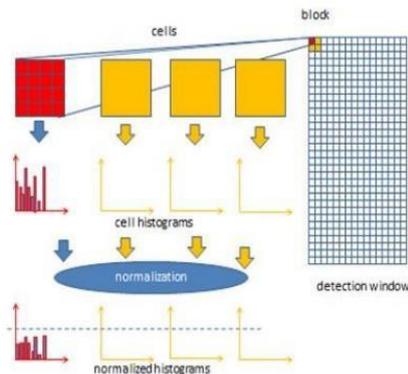
Face Detection and Recognition: Here, two algorithms are used HOG (Histogram of oriented gradients) for training the dataset in the raspberry pi and at next HAAR is used to detect and recognize the trained faces. The HOG algorithm is based on analyzing the gradient orientation and the magnitude of the image getting the histogram and normalizing it.

The gradient magnitude at each pixel (x, y) is defined as:

$$G(x, y) = \sqrt{G_x(x, y)^2 + G_y(x, y)^2}$$

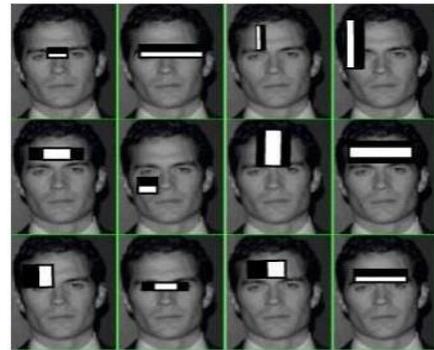
The gradient orientation at each pixel is defined as:

$$\theta(x, y) = \text{atan}(G_y(x, y) / G_x(x, y))$$



5.1 HOG cell sectoring

HAAR algorithm works on HAAR wavelet transform which is the mathematical method of analyzing the signals and detecting the patterns, the below diagram shows the edge and line features of HAAR



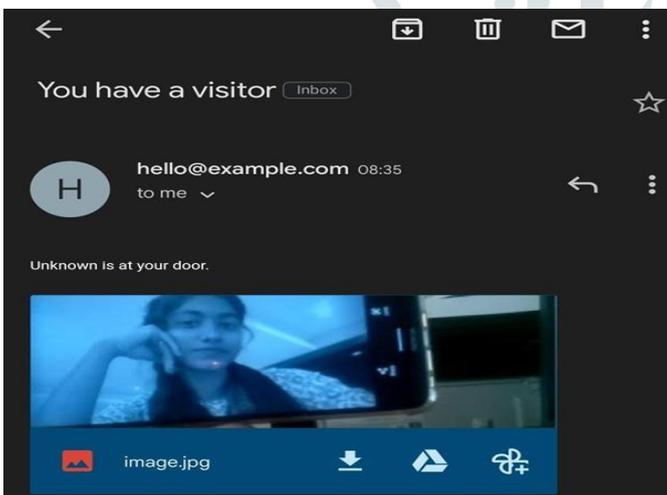
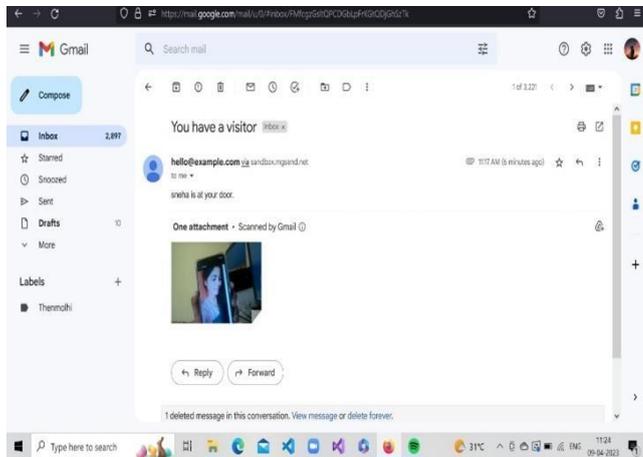
5.2 HAAR image classification

And hence, HOG algorithm is used to detect the objects and here it is used to create the known dataset and train the raspberry pi that is when the camera starts running the hog algorithm starts and takes picture of the person at about 15-18 times and store in a folder with the name given by us in the dataset folder and once when the face recognition algorithm HAAR starts the faces which matches with the data set folder are identified as known and others are unknown.



5.3 Known and unknown recognized

Alert Notification: The alert notification is sent to the user when the unknown person is recognized through the email along with the image of person identified. If the known is identified then their image will also send a known person name saying that this person is at your door. The given image shows the email alert along with the persons image.



5.4 E-mail notification

V. CONCLUSION AND FUTURE WORK

Thus, we have designed a smart surveillance system capable of recording/capturing video/image and transmitting to a smart phone. It is advantageous as it offers reliability and privacy on both sides. It is authenticated and encrypted on the receiver side; hence it offers only the person concerned to view the details. Necessary action can be taken in short span of time in the case of an any kind of intrusion in the home or any kind of anomalous activities near the surveillance area. Surveillance system can be installed in anywhere that is in concern of the elderly people to take care, like emergency conditions such as elderly person falling sick, smart home, industries etc for intrusion of unknown people and any kind of abnormal activities .

VI. REFERENCES

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