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IOT BASED DOOR ACCESS CONTROL USING FACE RECOGNITION

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Abstract - *In recent years, it is important to own a reliable security system that can secure our assets as well as to protect our privacy. The traditional security system needs an individual to use a key, identification (ID) card or password to access an area such as home and workplace. However, the present security system has many weaknesses wherever it is simply cast and taken. Most doors are controlled by persons with the employment of keys, security cards, countersign or pattern to open the door. The aim of this paper is to assist users for improvement of the door security of sensitive locations by using face detection and recognition. The proposed system mainly consists of subsystems namely image capture, face detection and recognition, email notification and automatic door access management. Face Recognition supported openCV is brought up because it uses Eigen faces and reduces the scale of face images without losing vital features, facial images for many persons can be stored in the database. The door lock can also be accessed remotely from any part of the world through GSM Module installed by sending message from the phone. The captured image from pi camera will be sent to the authorized person through email for safety purposes.*

Key Words: *OpenCV, Raspberry pi, GSM Module, Email, Eigen faces*

1. INTRODUCTION

Human beings are recognized by their distinctive facial characteristics. In the face recognition approach, a given face is compared with the faces stored in the database in order to identify the person. The aim is to search out a face in the database, which has the highest similarity with the given face. In the field of bio science, face recognition technology is one among the fastest growing fields. The need of face recognition in security systems is attributed to the rise of commercial interest and therefore the development of feasible technologies to support the development of face recognition. Major areas of commercial interest comprises of bio science, law enforcement and surveillance, human computer interaction, multimedia management (for example, automatic tagging of a particular individual within a collection of digital photographs) smart cards, passport check, Criminal investigations, access control management. However, face detection is more challenging because of some irregular characteristics, for example, glasses and beard will results in detecting effectiveness. Moreover, different sorts and angles of lighting will make detecting face generate uneven brightness on the face, which will have influence on the detection and recognition process. To overcome these issues, the system primarily used openCV based face recognition system using Haar classifiers for face. The main processing element is Raspberry pi. The pi camera is employed to capture the image and send it to the authorized person for security purposes. The authorized person can remotely control the lock and unlock mechanism of the door using GSM Module by installing Subscriber Identification Module (SIM). The entry log of every unidentified person is captured using pi camera and picture is sent to the email address of the prescribed user.

1.1 PROBLEM IDENTIFICATION AND PROJECT OBJECTIVES

A) PROBLEM IDENTIFICATION:

a. POSE VARIATION:

Comparing pose is another fundamental challenge for face recognition system. Some unavoidable problems appear in the variety of practical applications such as the people are not always front of the camera, so the pose problem is a big problem for the face recognition system to be detection. The difference between the different persons under the same poses, it is difficult for the computer to do the face identification when the poses of the gallery images are different. Pose variation still presents a challenge for face recognition.

b. OCCLUSION:

The face recognition context, occlusion involves that some parts of the face cannot be find. For example, a

face photography taken from a web camera could be partially hidden behind column. The recognition process couldn't find of a full input face. Hence, the absence of some parts of the face may lead to not find full face. There are also objects that can occlude facial features goggles, beards, certain haircuts, hats etc.

c. EXPRESSION:

Comparing faces with different facial expression is another problem for some face recognition applications. Faces undergo large deformations under facial expressions. Human can easily handle this variation, but the algorithms can have problems with the expression databases. Face recognition under extreme facial expression still remains an unsolved problem, and temporal information can provide significant additional information in face recognition under expression. The performance of face recognition system significantly decreases when there is a dramatic expression on the face. Therefore, it's important to automatically find the best face of a subject from the images. Using the neutral face during enrolment and when authenticating, so that we can find the neutral face of the subject from the six universal expression like Happiness, unhappiness, anger, horror, surprise.

d. AGING:

Face recognition across aging is most challenging in that it has to address all other variants as well. Pose expression and illumination changes are bound to happen for two images of a person taken years apart. In addition to this, textural properties of the skin can be different as well makeup, eyeglasses, weight loss/gain, hair loss, etc. The facial changes that occur due to aging are influenced by numerous environmental factors like solar radiation, smoking, drug usage, stress level, etc. The different biological and environmental factors can either delay or expedite the process of aging. Aging results in changes in both the hard and soft facial tissue of an individual. Loss of tissue elasticity and facial volume and alteration in skin texture are some of the other changes with aging. Drifts in facial landmarks appear to reasonably characterize the shape variations associate with aging, especially in ages 2-18.

e. TRANSFORMATIONS:

The same face can be presented to the system at different scales. This may happen due to the focal distance between the face and the camera. As this distance gets close the face image gets bigger. Head orientations may change due to translations and rotations.

f. ILLUMINATION:

Comparing two faces with different illumination is one of the fundamental problems for face recognition system. Face images of the same person can be taken under different illumination conditions such as, the position and the strength of the light source can be modified like the ones.

B) PROJECT OBJECTIVE:

There are few objectives design face detection system. The objectives of face detection are:
1. To design real time face detection system.
2. To utilize the face detection system based on Haar classifier.
3. To develop face detection system using open CV.
4. Users could operate on a touch screen to select entering the house by the house by recognizing face or entering password. For face recognition, an image will be captured by

2. BLOCK DIAGRAM

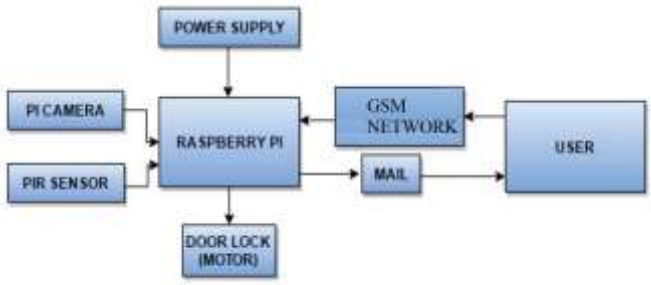

Fig -1: Block Diagram of of IOT based door lock or unlock system using face recognition

The proposed system was built using a high performance processor i.e., Raspberry Pi model which runs on a Debian based Linux Operating system called Raspbian. Initially, the PIR sensor senses the presence of human at the door. As and when a human is detected, the Pi camera captures the image of the person and sends the image to the remote user through mail. Haar face recognition algorithm is run on the captured image using OpenCV in the Raspbian on the basis of the images saved in the system. If the face is recognized it implies that an authorized person is trying for the door access and hence, the door lock is

opened, if the face is not recognized, then the remote user can check the mail for the image of the person trying to access the door and allow or deny the access of the door through normal message from the mobile. If the user sends "allow" from the mobile, the door is opened and if the user sends "deny" from the mobile, the person trying to access the door is denied from accessing it.

Raspberry Pi Module*:* The Raspberry Pi 3 model B is considered as a portable mini-computer. It is a quad core 64-bit Cortex- A53 processor with a very high performance. It features a Broadcom SoC that has an ARM compatible CPU with a speed of 1.2 GHz and also has an on-chip GPU. It has an on-board memory of 1GB RAM. The processor generally runs on a Debian based Linux Operating system called Raspbian but also can be run using other third party operating systems like Windows10 IOT, Ubuntu, etc., An SD card is used to store the OS and program memory. The Raspbian OS supports programming flexibility as it provides a variety of programming platforms like C, C++, Python, Java, etc., The processor has a number of GPIO pins for lower level input/output. It also supports protocols like I2C. The processor has slots for USB, HDMI, composite video output, and a 3.5mm jack for audio output, ethernet, etc,.

PIR Sensor Module*:* The PIR(Passive Infrared) sensor used is HCSR-501. the sensor is usually used for human and motion detections. it is a digital sensor that senses the presences of human beings. human body emits thermal radiations of the range 0.8- 0.14nm. the PIR sensor captures these thermal radiations and gives 1 or 0 for presence or absence of a human being. the range of the sensor is 10-15cm.

Pi Camera Module: Pi camera is a camera module specially designed for Raspberry Pi. It is an 8MP, 1080p resolution camera. it is mainly used for HD video recording and to capture still photographs. It is attached to the Raspberry Pi via a 15cm ribbon cable to the CSI port. While programming, Picamera python libraries are added to access the camera.

Servo Motor*:* It runs with a 12V DC power supply. It is a rotary or linear actuator for controlling angular, linear position, velocity and acceleration. It makes use of the closed loop control mechanism. They are used in various applications like robotics, machinery, etc.,

OpenCV*(*Open Source Computer Vision*):* OpenCV is an open platform for programmers for real time computer vision and computations. It supports many libraries of programming functions. It is built on C++ and has bindings with Java, Python and MATLAB. It runs on a huge variety of platforms like Windows, Linux, Android, iOS, macOS, and many more. Image and Video processing are two of the main applications of OpenCV.

GSM MODULE: GSM module is used to send a message to the authorized people based on the output. If the output is positive "Information matched Access granted" message will be sent to the authorized people, otherwise in case of unauthorized access it will send an "Access denied. Some unknown person is trying to unlock the door". Message to the certified users of the system. As with any system, the initial stage is to visualize the core modules, inputs, outputs and interrelations among them; this can be effectively done using a flow chart, above is a graphical representation of the proposed system it can be installed and used on any devices. It is a fast, secure and an easy application.

2.1 Viola-Jones Face Detection Method

This method consists of three main steps. The first step of the Viola-Jones face detection algorithm is to turn the input image into a new image representation called an integral image that allows a very fast feature evaluation. The used features are reminiscent of Haar basis functions. The Viola-Jones method analyzes a 24*24 sub-window using features consisting of two or more rectangles. Each feature results in a single value which is calculated by subtracting the sum of the white rectangle(s) from the sum of the black rectangle(s). The different types of features are shown in below figure.

Fig -2: Different types of features

For a fast processing of these features, the integral image representation is used. This is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel. It is calculated by the following equation

$$(X,Y) = \sum_{x' \le x, y' \ge y} i(x', y') \quad [1]$$

Where (x' , y') is the integral image and (x , y) is the original image. The integral image can be computed in one pass over the original image by using the following pair of recurrences:

$$s\,x , y = s\,x , y - 1 + i(x , y)$$

$$x , y = ii\,x - 1 , y + s(x , y)$$

where s x , y is the cumulative row sum, s x , −1 =0, and ii −1 , y =0. The second step is constructing a classifier in order to select a small number of important features using AdaBoost learning algorithm. AdaBoost is a machine learning boosting algorithm capable of constructing a strong classifier through a weighted combination of weak classifiers. where x is a 24*24 pixel sub-window of an image, f is the applied feature, p indicates the direction of the inequality, and θ is a threshold that decides whether x should be classified as a positive (a face) or a negative (a non-face).The final strong classifier is obtained after applying the ada boost algorithm detailed. In the third step, the cascaded classifier is used to determine whether a given sub-window classifier is definitely not a face or maybe a face. The cascaded classifier is composed of stages in which each consists of a strong classifier.

3. CONCLUSION

The project is good example of Raspberry pi and pi camera with Open CV.A face recognition system using Raspberry Pi was developed. The system was programmed by Python programming language. Both Real times face recognition from specific images, i.e. Stored images. The efficiency of the system was analysed in terms of face recognition rate. The analysis revealed that the present system shows excellent performance efficiency.

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