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SMART DOOR LOCK USING FACE RECOGNITION

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Abstract - In this new-fangled international crime has come to be vital trouble to be resolved. Some of the actual time incidents as of nowadays are thefts at domestic, trespassers, and so on. Though humans don't have any time to appearance up on this stuff as they may be held up of each day life, they always need to make certain their protection in their loved ones and liked things. Sometimes they overlook appearance after their important such things as keys, wallet, credit score playing cards, etc. Without these, they may be not able to get entry to their domestic or any area they need. Smart domestic protection manipulates device that has to turn out to be necessary for everyday life. This paper explains approximately the layout and improvement of a domestic protection gadget, the use of remotely monitoring era and human face reputation generation, to verify the identification of the tourist and to manipulate door accessibility the use of Internet of Things (raspberry pi) and additionally the implementation and deployment of wi-fi manipulate machine and accessibility to domestic surroundings for most effective authenticated human beings.

Key Words: Raspberry pi, IoT, Wi-Fi modem, relay, python, Eigenface, camera.

1. INTRODUCTION

The maximum critical function of any domestic safety manipulate machine is to come across those who input or depart the house. Instead of monitoring that thru passwords or pins, particular faces may be made use of as they're one's biometric trait. These are innate and can't be changed or stolen without problems. The degree of safety may be raised via way of means of the usage of face detection.

Thus, a brand-new hardware gadget for human face detection the use of Raspberry pie has been developed. The Raspberry Pi is a chain of small single-board computers. It is like a completely useful CPU and its capability is just like a computing device computer.

The go with the drift of the face reputation gadget is that first a photo is captured with the aid of using the digital digicam. The snippet code detects the capabilities of an individual. After the detection, the use of the Raspberry pi captured photo is checked towards the snapshots withinside the database. Then it's far determined if the faces are in shape or now no longer. After that SIM300 GSM module sends a safety alert to the legal character if an interloper attempts to go into the premises. The equipment used is without problems to be had and utilized in an extensive sense. Python programming language has been used for the set of rules which goes on a LINUX working device. Access is given best to the individuals of that precise own circle of relatives whose faces could be saved withinside the database. In case of guests (unrecognized face, now no longer especially an interloper) an alert is dispatched to the legal character, and authentication is supplied via way of means of them.

The device which became proposed has been designed to do away with the drawbacks of the formerly stated safety machine and to improve the safety, flexibility, performance of the forthcoming machine. The protection digital digicam gadget can also add now and then be not possible because of the exhaustive expenses incurred at some point of installation. The different implementations of this machine are in banks, attendance, authentication networks.

In a fraction of a second, the human eye can detect any pattern. To distinguish distinct patterns, computers have recently been instilled with better recognition capabilities. Facial recognition was first considered in the late 1960s as a way to improve security by storing data in a database. Facial recognition is the process of recognizing and measuring the many aspects of a person's face. In terms of features, each human face differs from the next. The arches and valleys in a face, as well as the contour of the face, are examples of these traits. These are referred to as nodal points. A computer can distinguish around 86 nodal points on a human face. These include a variety of facial traits such as:

- The jaw line's shape
- nasal width nasal depth
- Cheekbones are defined by the shape of the cheekbones.
- Between-the-eyes space

These nodal points are then numerically transformed into a face print that the computer can interpret.

For various computer recognition procedures, several algorithms have been defined. Principle Component Analysis

is one such technique for face recognition (PCA). It is extensively used since it is both efficient and adaptable. PCA is a statistical technique to face recognition that lowers the number of variables. It takes the most important details from the image's face. Every piece of information in an image's training set may be extracted as a matrix of weighted eigenvectors known as eigenfaces. The eigenvectors are the constituents of this matrix, which is termed a covariance matrix. The weights are calculated using the most relevant eigenfaces.
For the recognition procedure, a subspace covered by the eigen faces is then overlaid with a test picture. The categorization comes into effect after that. Different measurement methods, such as the Euclidean distance, are used to achieve this project.

A two-dimensional picture can be transformed to a one-dimensional vector. Assume that a vector N of size M represents a series of sampled pictures, and that pi represents the pixel value.

$$w_i = (p_1 + p_M)^T, i = 1.,.,,\dots,N$$

Subtracting the mean picture from each image vector yields the mean centered image. Let n represent the average picture.

$$\mathbf{n} = \frac{1}{N}\sum_{i=1}^{N} \mathbf{w_i}$$

The mean centered image will then be yi.

$$y_i = w_i - n$$

A set ei should be chosen in such a way that it has the most projection on each yi.

The goal is to discover a collection of N orthonormal vectors for which the equation holds.

$$\lambda_i = \frac{1}{N}\sum_{m=1}^{N} (e_i^T y_m)^2$$

should be enhanced by

$$e_1^T e_k = \delta_{lk}$$

The eigen value and eigen vectors of the covariance matrix C are λi and ei, respectively.

$$C=AA^T$$

Here, A is a column matrix of neighboring column vectors yi.

Face space is created by transforming recognized faces. The projection of a facial picture onto N is calculated.

$$\Omega = [v_1 v_2 \dots v_{M'}]^T$$

Were, $v_i = e_i^T y_i$

As a result, vi is the image's its co-ordinate in face space. vi takes over as the main component. In addition, ei is the eigenface.
The collection of these eigenfaces is called. For face recognition, i.e., determining which face class best fits a given image, a face class, say k, should be picked in such a way that the Euclidean distance between them is reduced.

$$\epsilon_k = \|\Omega - \Omega_k\|$$

denotes is a vector in where k the face class.

The face image is considered to belong to face class k when k is smaller than a predefined value. This is how PCA recognizes a person's face.

2. OBJECTIVE

To create a door lock that can be unlocked and locked from anywhere in the globe using a smartphone.
To create software that sends a notice to all of the specified smartphones whenever the door locks or unlocks.
To recognize the image from the database and unlock and lock the door.
Make a programmed that does the following:

- To activate the door lock with the servo motor.
- To set up smartphones.
- To deliver notifications to all of the devices that have been setup.
- To open the door by detecting the saved image from the database.

3. INTRODUCTION TO PROGRAMMING

What is face recognition and how does it work?

Facial recognition is fascinating and successful pattern recognition and pictures analysis application. For intelligent visual interaction between humans and computers, facial pictures are required. Facial processing is based on the idea that information about the user's identity may be collected from a picture and used by the computer. From entertainment to information security to biometrics, facial recognition has a wide range of applications.

Eigen Face Recognition's content is as follows:

The way module's function is as follows:
The suggested system is made up of five modules that each perform one of the following procedures to interpret the Eigen Faces from the input image:

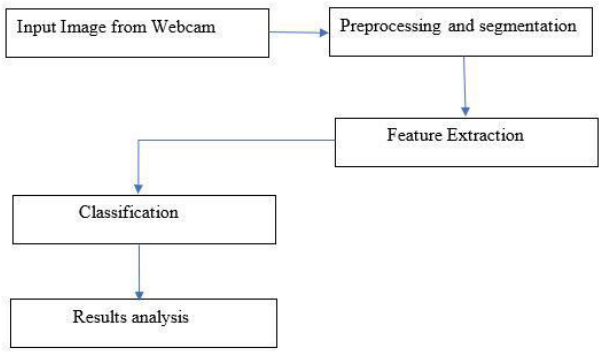


Fig -1: A five-module overview of the proposed system

1. Webcam Image Input:

To get a clearer image with Voila Jones, the image (facial) was recorded using a laptop or external device webcam('haarcascade_frontalface_default.xml').

2. Image preprocessing and segmentation:

To enhance the image, it is important to do image processing. The RGB picture will be greyed out during pre-processing. Please smooth and filter for best results. The picture is essentially split in order to detect faces.

3. Feature Extraction:

This step is required since specific traits must be retrieved in order for them to be unique in their area. Consider the frame and the final characteristics after establishing the existence of letters. Feature extraction may extract features from all photos (from the face) in the facial training data form, and then use the self-face technique to extract annotated features from the "eigen trained data.xml" feature model.

4. Classification:

Several pre-calculated characteristics are used to classify the region. As a result, a 5-bit binary sequence is constructed to identify and exploit these individually identified internal areas in the PCA technique to facilitate human-computer interaction. According to the intersection with the threshold line, feature extraction encodes the active peak as 1 and the invalid peak as 0.

5. Analysis of the results:

I evaluated several photographs and discovered that the new rating technology's accuracy was 70%. Some photographs were evaluated utilizing images from different databases, according to the findings analysis. Real-time facial recognition using functions like facial recognition and facial recognition utilizing Voila Jones (hair cascade frontal face default.xml) is the result of the results analysis. Take test photographs (face-to-face) to compare the feature "eigen trained data.xml" while starting the camera in real time (if it matches the dataset after the displayed process).

4. ALGORITHM DESCRIPTION:

The goal of this algorithm was to create a real-time facial recognition system utilizing appearance-based approach. For identification, we employ the Viola Jones algorithm. We employ a PCA-based Eigen object method for face recognition. Face recognition requires real-time data sets. We took 100 images per individual for the data training group and processed the feature values to match them with known persons.

1. Eigenfaces:

In image processing, selfies are used to detect human faces. Your face is a disaster. The approach of facial identification based on appearance is known as Eigen faces. To convert and match images or personal modifications, capture face image data sets. The private face is the most important aspect of face mapping. The self-facial component of the face recognition system's performance is crucial. Self-facial is utilized for two purposes: 1) acquiring related face data and 2) effectively creating facial pictures. To decrease the complexity of the area and the quantity of calculation, each image is given in the least number of sizes possible. The term "your face" refers to a general alteration in the appearance of the face. Then, using the feature faces subset, estimate the picture that corresponds to the item with the highest value. These individuals are to blame for the greatest disparities in training. We must efficiently encode and connect the face to the picture record in order to extract meaningful information from a facial image. The process of coding is the same. It is important to get the changes in the data set, encode them individually, and compare them with each facial image in order to obtain the information in the image. A linear blend of internal planes can be used to differentiate each cleanly delineated section. With its "best" face, any face with the highest intrinsic value and data provided for a face image may be evaluated.

The fundamental concept was to employ different faces. A unique collection of face photos is utilized to compress the image with PCA (Major Component Analysis), and the optimal coordinate technique is determined. All of my coordinates here are basically a self-portrait picture. By keeping a little amount of weight for each face, each collection of facial photos may be reproduced. A one-sentence self-sentence is required. By showing each image separately, these weights may be calculated. The size of a facial picture

may be reconstructed using features. This is an excellent approach to create characteristics via practice in order to learn and recognize the person's preferred face. As a result, each individual will be assessed based on a tiny subset of the elements that must be reconstructed or the weight of their own image. This is a pretty accurate approximation of the image when compared to the data set.

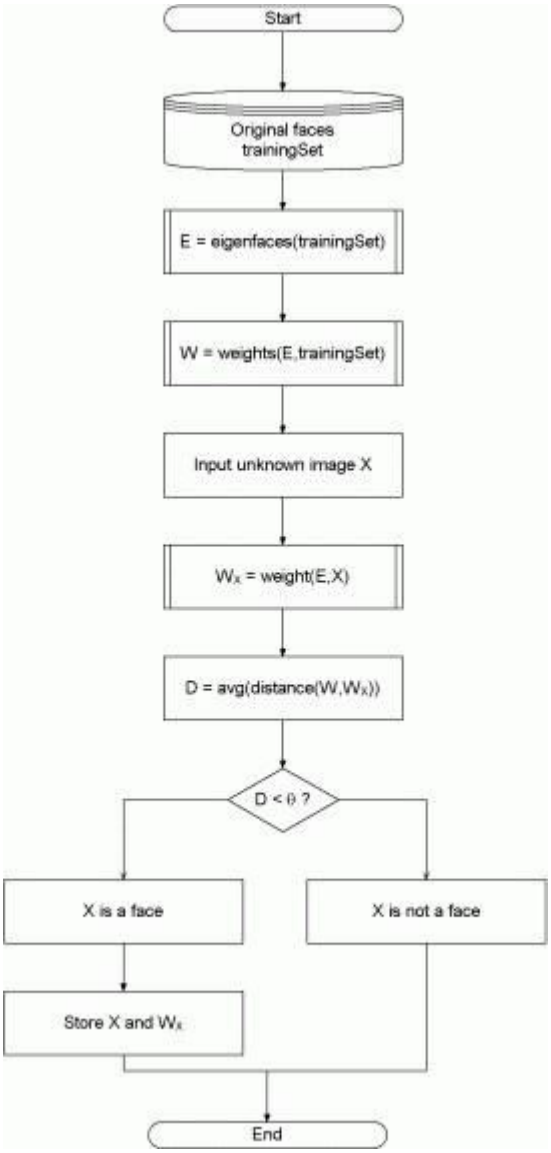


Fig -2: Flow Chart of Eigenface Algorithm

2. Training:

Step 1: Practice images [I1.1....1.5, I2.1....2.5]. N * N is the size [.1.... 5]. An example of a first-person perspective picture is I 1.1... 1.5 ss. The sample's face for the second individual is 12.1... 2.5, and so on. This yields a dimensional training set with the dimensions * 2 * 5 * m, where m is the number of picture samples.

Step 2: In the long vector u: add all the grey levels. (I1.1... 1.5) = u I2.1... 2.... 5IM, 1... M.5) I2.1... 2.... 5IM, 1... M.5) I2.1... 2.... 5IM, 1... M.5).

Step 3: From the matrix A (NN X pn), collect n samples (observations) from each participant p: A = [u11... un1, u12... un2, u1p... un]

Step 4: Determine C, the feature vector.

Step 5: Subtract the feature vector C from the feature vector L to get the feature vector L.

Step 6: For facial identification, choose a few of the most relevant vector L features.

Step 7: For each training image, calculate the parameter coefficient.

Step 8: The coefficients will create a cluster for each person.

3. Face Recognition:

Step 1: To recognize a picture, create a vector. u= (I1.1... 1.5) T
Step 2: Find the u parameter vector.
Step 3: Determine who this image belongs to by calculating each person's distance from the average mass.

Fig -3: Eigenface Datasets

4. Face Detection:

Viola Jones' facial recognition system was employed. Some pre-trained workbooks in system objects can recognize some face traits. Face outline, front, nose, eyes, ears, and so forth. These workbooks can be altered because to the limits of facial recognition technology (such as lighting, motions, and so on).

The "Training Cascade Object Detector" function may be used to train these custom workbooks.

5. Flow Chart of Eigenfaces:

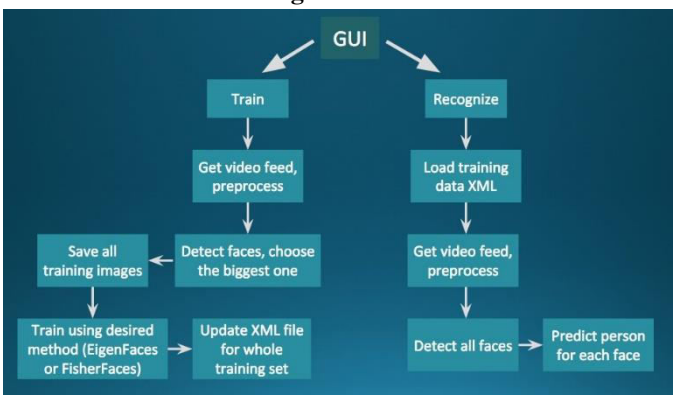


Fig -4: Flow Chart of Eigenface

4. METHODOLOGY

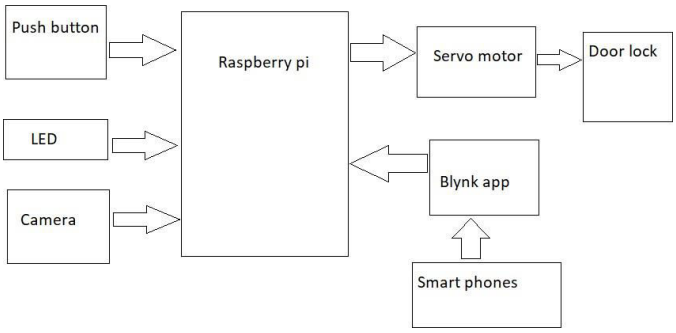
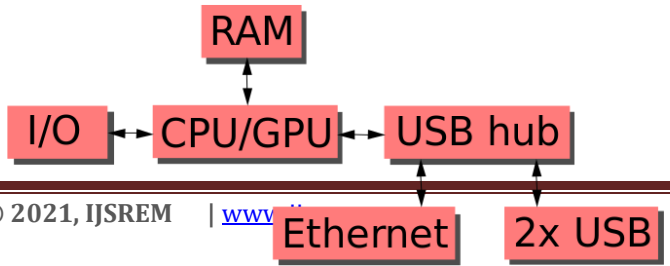


Fig-5: Block Diagram of Connections

The system's operation is depicted in this block diagram. The Raspberry Pi is the central component that controls the entire process, and all other components are connected to it through cable or the internet. Reset the state of the door lock with the button, and see the status of the door lock with the LED. To operate the door lock by actuating the latch, a servo motor is attached to the Raspberry Pi (door lock).

A 15-pin ribbon cable connects the camera card to the Raspberry Pi. There are only two connections to make: the ribbon wire to the camera board and the Raspberry Pi itself. Otherwise, the camera will not operate if the cables are not connected correctly. The back of the wire should be blue away from the plate on the camera board, and the cable should encounter an Ethernet connection on the Raspberry Pi (if Model A is used, the location of the Ethernet port must be located). Although the connectors on the PCB and the Pi are different, they function in the same way. Pull up tabs on both ends of the connection on the Raspberry Pi itself. It should be able to glide up and around effortlessly.



1. Raspberry pi 3 model B:

Fig -6: Block Diagram of Raspberry pi controller

Raspberry Pi is a card-sized computer with a keyboard and mouse that can be connected to a PC or TV screen. It can do everything a regular computer does, including watching films on the Internet, producing spreadsheets, and participating in writing, games, and programming.

It also interacts with the outside world, such as recording and activating inputs, making it a more popular choice for projects all around the world. We can program particular activities or control associated components as needed. ARMv 8-A (64bit) Architecture, 1.4 GHz quad-core ARM cortex –A53 CPU, 1GB memory shared with GPU, USB ports 4via ob. Board and Video outputs (HDMI, TRRS, MIPI display).

2. Raspberry pi Camera

Fig -6: Raspberry pi Camera

The Raspberry Pi Camera Module is a small, portable camera that works with the Raspberry Pi. MIPI Camera Serial Interface Protocol is used to communicate with the Raspberry Pi. Image processing, machine learning, and monitoring projects are common applications. Because the camera's payload is so small, it's frequently employed to keep an eye on drones. Pi may also utilise conventional USB web cams that are often found on desktops in addition to these gadgets.

3. High Torque Servo:

Fig -7: Servo Motor

A servo motor is a rotary motor that can offer useful angles, acceleration, and speed. Because we can regulate their rotation and acquire input to manage their location and movement, these motors are utilized to install stepper motors. The input might be analogue or digital, depending on the output.

5. FUTURE SCOPE

- Advanced communication technologies, such as WI-FI, can be used with this system.
- Iris scanners and other biometric recognition systems can be installed.
- The use of a DSP processor can greatly improve this system.
- The Internet of Things (IoT) may be used to improve access.

6. EXPECTED RESULTS

- The project was completed and is currently operational as described in this proposal. The technology allows the authorized user to monitor and control the door's access from a distance.
- If an intruder is found after image processing on the Raspberry Pi, the image is collected and transmitted to the authorized person's email address as an alarm.
- If the administrator wishes to grant remote access to a user, he or she may use web IO Pi and woven IoT to access the raspberry pi's GPIO pins and so control the door opening and shutting from a web page.
- Eigenfaces is used in a face recognition experiment for a door lock system, and the accuracy is substantially better than previous algorithms.
- The accuracy of this system employing the Eigenface technique is improved as seen in the figure below.

7. CONCLUSION

The design and development of an interactive smart home security system employing the Raspberry Pi, Web-based control systems, and Eigenface technology is proposed in this study. In the current automation industry, web-based system monitoring and control is creating a trend. We can replace PCs with low-cost processors, allowing administrators to obtain parameters for all distant devices and deliver control information to all equipment at all times over the web. The surveillance system was created in such a way that it can meet the user's needs for a specific surveillance region. It has a plethora of applications based on various surroundings and circumstances. For example, any anyone working in the industrial sector may use the system to keep track of what is going on at their workplace while they are away, and it can even be used to spy on people in their homes and bank lockers. Another application is to offer users with information about what is happening in the surveillance region through notification. The entire system is protected by a login E-mail and Webpage password-based authentication scheme. The system is totally wireless and linked with software to create a low-cost, reliable, and simple-to-use solution. As a result, a completely automated security system will be created.

7.CODE

https://drive.google.com/drive/folders/164SaeGfsUOST5NZe_1Rj2g3gBOobx89z?usp=sharing

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