Face Recognition Based Door Unlocking Using Raspberry PI

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Abstract - **Today we are facing security issues in every aspect. So to resolve these issues by using updated technology. In this project, the Face recognition module is used to capture human images and to compare with stored database images. If it matches with the authorized user then the system will unlock the door by an solenoid lock. The user can also unlock the door using the android app on his phone. The need for a facial recognition system that is fast and accurate that continuously increases which can detect intruders and restricts all unauthorized users from highly secured areas and aids in minimizing human error. Face recognition is one of the most Secured System than biometric pattern recognition techniques which is used in a large spectrum of applications. The time and accuracy factor is considered about the major problem which specifies the performance of automatic face recognition in real-time environments. Various solutions have been proposed using multicore systems. By considering the present challenge, this provides the complete architectural design and proposes an analysis for a real-time face recognition system with OpenCV and CNN Algorithm.**

Index Terms - **OpenCV, Android app, Face Detection, CNN, Face Recognition.**

1.INTRODUCTION

Now a days, there is a growing interest in the smart home system using the Internet of Things. Security deft has suggested various preferred approaches like biometric and password to enhance security. But the Technology is developed, and the trends shifted towards face recognition systems. A typical face recognition system is shown in Figure below.
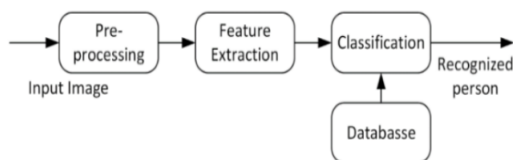

Fig 1.1: Face recognition system

The basic idea behind the project is to use a Raspberry PI micro-controller board for system development, a pi camera module for face recognition and a programmable stepper motor to open the door lock. In this install an appropriate linux based Raspberry pi operating system on raspberry pi micro-controller board. For the door unlocking system, place a stepper motor at the door latch. This motor will be programmed in such a way that when the system authenticates the person in front of the camera, the motor will rotate to open latch, use image processing technology to authenticate the person to enter home. For image processing, use the pi camera module. Pi camera module is attached to Raspberry pi, and it aids to store various faces in the databases. When someone wants to enter home, he should stand in front of the camera. Camera will recognize the face and compare it with the faces stored in the LFW database. If the face matches, the door will be automatically unlocked, otherwise a warning alert msg will be sent to the owner of the house.

2. LITERATURE SURVEY

A.Face recognition using IOT: The basic idea behind the project is to use a Raspberry PI micro-controller board for system development, a Webcam and Zigbee module for face recognition and a programmable stepper motor to open door locks. We will install an appropriate linux based Raspberry pi operating system on raspberry pi micro-controller board. For the door unlocking system, place a stepper motor at the door latch. This motor will be programmed in such a way that when the system authenticates the person in front of the camera, the motor will rotate to open latch. The image processing technology is used to authenticate the person to enter home. For image processing, the Webcam and Zigbee module. The Webcam and Zigbee module is attached to Raspberry pi, and it aids

in storing various faces in the databases. When someone wants to enter home, he should stand in front of the camera. Camera will recognize the face and compare it with the faces stored in the LFW database .If the face matches, the door will be automatically unlocked, otherwise a warning call will be sent to the owner of the house.

B. Building a Raspberry PI security system with facial recognition: The security system discussed in this paper has used several protocols, algorithms Eigenface, Fisherface, Local Binary Patterns Histogram (LBPH). The technologies used here will first be presented to make clear what exactly will be coded, how it works on a general level and what techniques are available. The different ways of how to use the technologies will then be gone through with the intention of showing possibilities of how to implement such a system. As practical solutions have been presented, the choices of available solutions will be made clear with reasoning on why a specific solution was chosen. Each solution chosen will then be explained with it's code throughout the development phases of the project. It will go into detail on how the code

C. Face recognition using OpenCV on IoT for smart door: This paper discusses a face recognition system which is designed and implemented for doors resulting in smart doors based on IoT. The paper intends to provide the information to the user using open source technology which comprises OpenCV2, LBPH algorithm, SMTP, raspberry pi3, Webcam and Zigbee. The implementation area is categorized more on a local level like home, offices and campus. The system provides real time face detection and recognition once the bell is triggered. The captured image is analyzed with the available database and if it is a match, the access is granted and the door will open. On the contrary if the face did not match the captured image is then sent to the user mail using SMTP. The system

will then wait for the response from the user within stipulated time with appropriate messages. The message is retrieved on raspberry pi using IMAP. Based on the retrieved message context either access will be granted or denied. The sys-tem is acting as a base station. The wireless communication is achieved using SMTP and IMAP. The aim of the system is to develop a real time face recognition model having low-cost solutions in security.

D. Smart door using face recognition: The basic flow of the face recognition system is that the image is captured by camera. The Viola jones methodology can establish the face within the image utilizing Haar cascade classifiers and features are extracted from the face. After the extraction, the system matches the captured pictures with information base pictures. The Matching of the captured pictures and information base pictures is finished by LBPH rule. The thought is to not take a goose at the complete image as a high-dimensional vector like in Eigenfaces and also the Fisher Face Recognizer algorithms but it's to depict simply neighborhood parts of a matter. The LBPH rule is additionally correct than the Eigen Faces. The complex calculation inEigen Faces or PCA is reduced due to the LBPH algorithm. The parts you untangle on these lines can have a low-dimensionality verifiably. Within the event that a face is remembered, it's known, else it's obscure. The approach can open doors consequently for the authorised individuals due to the command of the Raspberry Pi to approach Motor.layman. It can act as a boon for a person with motor disability as it does not require any motion but simple eye movements. It can give them a greater controlled over their surrounding and help them in interacting with the world.

2.1 Summary of Related Work
The summary of methods used in literature is given in Table 1.

Table 1 Summary of literature survey

Literature	Advantage	Disadvantage
[1] Sandesh Kulkarni, Minakshee Bagul,Akansha Dukare ,"Face recognition system using IoT" , IJARCET Publications, 2017	New connection like cascade connections, parallel connection, series connection to extend the system.	It does not have a second method for unlocking the incase the face recognition does not work on the authorized user.

	The system can work on both modes online and offline mode. In online mode, the system can use internet at its working time. In offline mode, the system does not use any internet connection.	
[2]Thulluri Krishna Vamsi, Kanchana Charan Sai,Vijayalakshmi M, "Face recognition based door unlocking using raspberry pi" IJARIIT Publications, Feb 2019.	LBPH is one of the easiest face recognition algorithms. It can represent local features in the images. It is possible to get great results (mainly in a controlled environment). It is robust against monotonic gray scale transformations.	Algorithm used is LBPH,.first, the method is very sensitive to scale, therefore, a low-level preprocessing is still necessary for scale normalization. Secondly, since the eigenface representation is, in a least-squared sense, faithful to the original images, its recognition rate decreases for recognition under varying pose and illumination.
David Gsponer, "Building a raspberry pi security system using facial recognition", Haaga-Helie publications,2018.	The sole purpose of this project was to develop a security system at very low cost. It will provide a way for anyone to implement a solution with low-budget hardware.The project's facial recognition is developed in 3 parts: - Data gathering - Machine learning - Facial recognition	It does not have a second method for unlocking the incase the face recognition does not work on the authorized user.
[5]A.D.Deshmukh, M.G.Nakrani, D.L.Bhuyar, U.B.Shinde, "Face recognition using OpenCV on IoT for smart door ",Elsevier SSN publications, February 2019	Face Detection method used is haar classifiers, The key advantage of a Haar-like feature over most other features is its calculation speed. Due to the use of integral images, a Haar-like feature of any size can be calculated in constant time	Its speed of detection by using haar is fast but the accuracy is less than that of the CNN.

3. PROPOSED WORK

In this, we are using Raspberry pi and pi camera. Once we run the program the pi camera acts as a surveillance camera. When the owner comes infront of the camera the door is unlocked and If the face does not match with data stored an alert will be sent to the admin and the image of the person trying to unlock the door the door will be stored in a folder inside raspberry pi. Now if the user wants to open the door for a person when he is not available at the home he can unlock the door using the door unlock app.

3.1 System Architecture

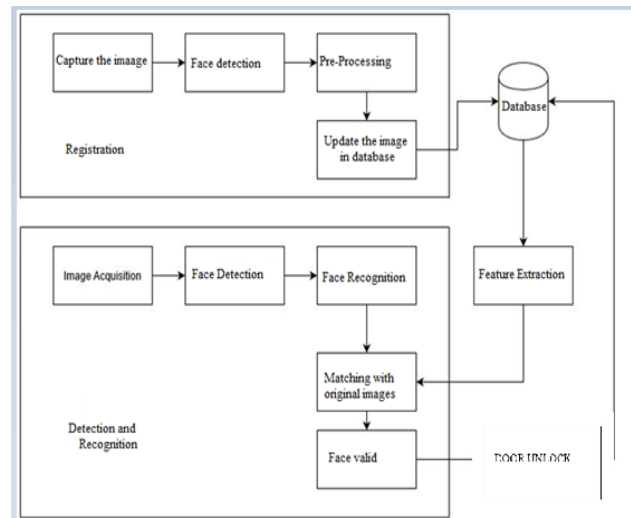The system architecture is given in Figure 1. Each block is described in this Section.

Fig. 1 Proposed system architecture

A. Registration:

1. Capture the Image: The system consists of a camera module that captures the pictures of the individual and sends it to the image pre-processing. Then that image is processed further for face detection.

2. Face Detection: Accurate and efficient face detection algorithms improve the accuracy level of the face recognition systems. If a face is not detected correctly, the system will fail its operation, stop processing, and restart. Knowledge-based, feature-based, template-based, and statistics-based methods are used for face detection. In the most basic sense, the desired objects are firstly found and introduced according to a certain algorithm. Afterwards, they are scanned to find matches with similar shape. The detection algorithm used is CNN.

3.Pre-Processing: The method of PCA is usually used in face recognition for extracting features, but it is easily affected by light condition and facial expression changed and other reasons. So before extracting features we can preprocess face images to improve the face recognition rate.

4.Update the image in Database: After detection and pre-processing the image it is stored in the known folder , that is the folder containing the images of the authorized users who are allowed to unlock the door.

B. Face Detection and Recognition: The detection algorithm used is CNN. CNN stands for convolutional neural network. Accuracy of CNN is better than that of Hog. Now when the home owner comes infront of the camera the face of the owner is detected and then for recognition part it compares with face data stored in the database. The matching of the face is done here. Once the face is matched the raspberry pi send the the signal to the solenoid lock and the door is unlocked.

3.2 System Implementation

This prototype will be made by connecting the modified Pi Camera as a camera module to identify the face of the homeowner connected to the Raspberry Pi 4 Model B where the Raspberry Pi will be connected via WLAN as a process of identifying the homeowner The main objective of the experiment work is to implement a Face Recognition System based on Convolutional Neural Networks (OpenFace) in a real-time embedded system such as Raspberry Pi and demonstrate a practical application in the form of Automated Door Access. Further improvements to the above system include an anti-spoofing technique in the form of eye-blink detection program and an intruder alert mail sent to the owner containing a picture of the visitor at the door.

Convolutional Neural Networks (CNNs) are similar to artificial neural Networks. Many neurons are interconnected and each will receive an input, perform some function on it and then pass on its output to some other neuron. There are four main operations in the ConvNet

1. Convolution
2. Non Linearity (ReLU)
3. Pooling or Sub Sampling
4. Classification

4 REQUIREMENT ANALYSIS

The implementation detail is given in this section.

4.1 Software

A. Raspbian OS: Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Buster and Raspbian Stretch. Since 2015 it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project.] The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

B. Firebase: Firebase is a Backend-as-a-Service (Baas). It provides developers with a variety of tools and services to help them develop quality apps, grow their user base, and earn profit. It is built on Google's infrastructure. Firebase is categorized as a NoSQL database program, which stores data in JSON-like documents.

C. Android Studio: Android Studio is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA . On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps, such as:

- A flexible Gradle-based build system
- A fast and feature-rich emulator

- A unified environment where you can develop for all Android devices
- Apply Changes to push code and resource changes to your running app without restarting your app
- Code templates and GitHub integration to help you build common app features and import sample code
- Extensive testing tools and frameworks
- Lint tools to catch performance, usability, version compatibility, and other problem

D. Python: Python is an interpreted, high-level and general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant indentation. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

4.2Hardware

1.Raspberry pi: To implement such a project, the main and most important step was finding the hardware to use for the device. We have chosen a Raspberry Pi 4 model B to use in our device. We have done a lot of research, and compared elements in different microcontrollers, like, cost, processing, and user friendliness. The main reasons why we have chosen this specific element are the high processing capacity, relatively low price, and its ability to adapt in different programming modes. The device uses Linux as an operating system, which has access to a large number of libraries and applications compatible with it. Raspberry Pi has an Ethernet port allowing us a network connection, as long as we are in the same subnet with the device we want to access and manage, 4 USB ports used to connect devices like a keyboard, mouse, camera, and other devices that connect through a USB port, and an HDMI port giving us access to the interface of the operating system installed, and can also be used the first time while installing the devices. It has 40 pins that allow us to receive and send signals. They are divided in half into two groups: the 3V, and the 5V group. Therefore, one side of the IJIREEICE IJIREEICE ISSN (Online) 2321 – 2004 ISSN (Print) 2321 – 5526 International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering ISO 3297:2007 Certified

Vol. 5, Issue 4, April 2017 Copyright to IJIREEICE DOI 10.17148/IJIREEICE.2017.5434 188 microcontroller gives a voltage of 3V, and the other 5V. Besides the 40 voltage pins, it has pins that are used to receive signals, which in our case was used to connect the button, that will send the signal for the face identification. Raspberry Pi does not have an operating system previously installed, but that can be downloaded from the Raspberry website, and transferred to an SD card, Figure 1 shows the Raspberry pi model B 3 along with its components The foundation provides Debian and Arch Linux ARM distributions and also Python as the main programming language, with the support for BBC BASIC, C and Perl. The system is programmed using Python programming language. by subtracting the sum of

2.Pi Camera: The module attaches to Raspberry Pi, by way of a 15 Pin Ribbon Cable, to the dedicated 15- pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor. The board itself is tiny, at around 25mm x 20mm x 9mm, and weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. The sensor itself has a native resolution of 5 megapixels, and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 video recording. The camera is supported in the latest version of Raspbian, the Raspberry Pi's preferred operating system.

3.Solenoid Lock: The solenoid lock denotes a latch for electrical locking and unlocking. It is available in unlocking in the power-on mode type, and locking and keeping in the power-on mode type, which can be used selectively for situations. The power-on unlocking type enables unlocking only while the solenoid is powered on. A door with this type is locked and not opened in case of power failure or wire disconnection, ensuring excellent safety.

4.Buck Convertor: A buck converter (step-down converter) is a DC-to-DC power converter which steps

down voltage (while drawing less average current) from its input (supply) to its output (load).

5.CONCLUSION

This paper offers an implementation of a low cost yet powerful computing system for face recognition. The availability of OpenCv proves to be advantageous to design Face recognition system more on local level. The authority provided to the user via mail plays an important role. The use of CNN algorithm for face recognition works very well provided that the database should have clear images. The more variations of the face training data the system has, the better face recognition are and also the less chances of naming the unknown face from one of the available database. The use of OpenCv library proves to be very effective for face detection and face recognition. The paper shows the integration of OpenCv library with raspberry pi cab be used to build IoT applications.

ACKNOWLEDGMENT

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