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Door Access using Face Recognition and Sanitization

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Abstract: ***The security currently become a very important issue in public or private institutions in which various security systems have been proposed and developed for some crucial processes such as person identifications, verification or recognition especially for building access control, suspect identifications and many others. There are many face recognition access systems with different algorithms. Privacy and Security are two universal rights and to ensure that in our daily life everyone is secure, a lot of research is going on in the field of home security and house security matters and people always try to make life easier at the same time. This paper reviews about the creation of a smart door, which secures the gateway on the basis of identity. The system is developed based on Raspberry-pi 3, to make the house only accessible when your face is recognized by the recognition algorithms from Open CV library and meanwhile you are allowed in by the house owner, who could monitor entrance remotely. Along with the door access system implementation, a hand sanitizing unit is installed which ensures the safety for people inside the house and limits the spread of corona virus to a possible extent.***
Index Terms: Face Recognition, Detection, Raspberry Pi

I. INTRODUCTION

In a common door lock anyone can open a conventional door lock by duplicating or stealing the key and its simply impossible if we want our friends and family to enter our house, without being actually present over there. Thus why not just eliminate these problems. So, to simply convert this normal door lock into a smart lock, which can open the door whenever we turn up in front of the gate or when we want it to open up for someone else without being physically present, we need to modify the door. So an era has come where devices can interact with its users and at the same time ensure of their safety and keep improvising themselves.

II. RESEARCH ELABORATION

This section summarizes the research woks done based on face recognition methods and detection processes.

The paper ," An Accurate System for Face Detection and Recognition " discusses about the biometric verification and it wide applications. In this paper face recognition technique is done based on Local Binary Pattern histogram with processed data (faces detected before by using a combination of Haar cascade files that uses skin detection, eye detection and nose detection) as input of LBP to increase the accuracy of the proposed recognition system. The modified LBPH method improved the success rate to 96.5% with error rate 3.5%, while using EigenFace only has a high error rate 29% and only 70% recognition rate. Also using LBPH has approximate 84% of recognition rate and 15% error rate. The success rate of the proposed recognition system was better than the EigenFaces[1].

"Home Security System and Door Access Control Based on Face Recognition", reviews on face recognition and along with the Intruder detection system. The advantage of this system is for accessing the door is that face detection and recognition is performed by using face detection technique and the entire face recognition is completed by pressing single and tiny push button switch. PCA is an effective feature extraction method used based on face as a global feature. In this paper, face recognition system is implemented based on standard PCA algorithm. Classification or Recognition is done by the measure method such as Euclidean distance technique. This work proposes an idea of face recognition concept for accessing the door lock system and it is implemented with the help of OpenCV[2].

"Real-Time Implementation Of Face Recognition System", done by Neel Ramakant Borkar , Sonia Kuwelkar defines about the hybrid face recognition algorithm by combining two face recognition techniques by integrating (PCA) principle Component Analysis,(LDA) Linear Discriminant Analysis. Jacobi method is used to compute Eigenvector that are necessary for PCA and LDA algorithms.

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Face Recognition system will be implemented on Embedded system based Raspberry pi 3 board. OpenCV is the software used in this proposed system. The accuracy of face recognition using PCA alone was found to be 91%, the accuracy of LDA alone was found to be 94% and that of proposed method was found to be 97% when implemented on raspberry pi 3 board[3].

Ratnawati Ibrahim, Zalhan Mohd Zin in their work, described about automated face recognition system with the potential application for office door access control. The technique of eigen faces is based on the principle component analysis and artificial neural networks have been applied into the system. Study includes the analysis of the influences of three main factors of face recognition namely illumination, distance and subject's head orientation on the developed face recognition system purposely built for office door access control. The experimental results have shown that the developed system has achieved good performance of face recognition rate of 80%[4].

The paper ,"Web-Based Online Embedded Door Access Control and Home Security System Based on Face Recognition", paper described about the implementation of wireless control system. A wireless network technique ZigBee based and image processing technique. ZigBee module and electromagnetic door lock module combined operate the door accessibility. Sending an email and an alert message about the current home environment status via GSM network. The entire control system was built using ARM1176JZF-S microcontroller[5].

The paper "Application of attitude tracking algorithm for face recognition based on OpenCV in the intelligent door lock" discusses about an open source software Open CV and an Efficient attitude tracking algorithm (EATA). Furthermore, this article aimed to ensure that a key lock system that is retro and modern simultaneously offers a certain safety and reliability. The experimental results show that the proposed system is more efficient, consumes less power, and cost-effective[6].

The main objective of this study performed by Thulluri Krishna Vamsi, Kanchana Charan Sai, Vijayalakshmi M includes the complete architectural design and proposes an analysis for a real-time face recognition system with LBPH Algorithm. In this algorithm, it converts the image from color to grey scale image and divides into pixels and it will be allocated in a matrix form and those images will be stored in the database. If an image is detected then microcontroller will send power to the motor driver unit then the electromagnetic lock will unlock the door and it will lock again when there is no power supply to that unit. Raspberry Pi was programmed successfully using python with open CV and Micro controller was programmed successfully using Embedded C in Keil vision software to achieve face recognition door unlocking system.Finally, this paper concludes with the advanced implementations achieved by integrating embedded system models against the convention[7].

Priyan Malarvizhi Kumar, Ushadevi Gandhi, R. Varatharajan Gunasekaran Manogaran1, Jidhesh R.1,Thanjai Vadivel,"proposed a cheap, user friendly application which pro-vides precise and quick messages in the form of audio to visually challenged people so that they can navigate easily. The application of the proposed architecture consists of two main modules: Intelligent Navigation Module and Face Recognition Module. Person's face is captured from the real time environment. Features of that face are extracted by measuring the facial component values by using Open CV Library[8].

"Automated access control system using face recognition", was a work based on Face recognition method done by FaceNet algorithm. FaceNet is a deep neural network used for recognizing the face. Facial feature extraction is done by using the Histogram Object Gradient (HOG) method. Then the face comparison and classification is done through the support vector machine (SVM) method. The main advantages attained using this algorithm are accuracy rate, speed of the process and increased storage capacity[9].

The paper "Design and Implementation of the Smart Door Lock System with Face Recognition Method using the Linux Platform Raspberry Pi" helped to understand about OpenCV. It is an open source computer vision software. Haar Cascade classifier is used for the face detection process. Local Binary Pattern Histogram is used the Face recognition process. The Eigenface classifier Is already been trained by pre-stored image library will try to recognize the cropped face and return the confidence of its prediction at the same time[10].

Soe Sandar, Saw Aung Nyein used an idea of a secured door unlocking system. The system consists of face detection, face recognition, a password custom, a GSM module and a door lock. The face is detected using Haar-like feature and face recognition is implemented using Local binary pattern histogram(LBPH). GSM module will send the notification to the owner for the unknown person. The main control circuit on this system is Raspberry Pi. The software used is OpenCV Library and Python[11].

The paper "An efficient face recognition system based on hybrid optimized KELM" ,reviews about an efficient FR system based on hybrid optimized Kernel ELM. The proposed system's performance was analyzed utilizing the face images. The chief contribution of this work is that the initial input video is clipped into the frames, and then removes the noise from the image using MWF. Next, detect the preprocessed image using the V-J algorithm. Finally, the lessened features are inputted to the classification using hybrid optimized kernel ELM approach.

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The performance analysis illustrated that the proposed FR has given an incredible rate of accuracy, sensitivity, along with specificity. The comparison result illustrates that the proposed FR system has higher accuracy sensitivity along with specificity than existing methods[12]. The paper "Face recognition based door unlocking system using Raspberry Pi", discusses about the complete architectural design and proposes an analysis for a real-time face recognition system with LBPH Algorithm. In this algorithm, it converts the image from color to grey scale image and divides into pixels and it will be allocated in a matrix form and those images will be stored in the database. If an image is detected then microcontroller will send power to the motor driver unit then the electromagnetic lock will unlock the door and it will lock again when there is no power supply to that unit. Raspberry Pi was programmed successfully using python with open CV and Micro controller was programmed successfully using Embedded C in Keil vision software to achieve face recognition door unlocking system.Finally, this paper concludes with the advanced implementations achieved by integrating embedded system models against the convention[13].

III. METHODOLOGIES AND WORKING PRINCIPLE

A. Face Recognition

Our system involved a Raspberry Pi 3, a Pi Camera , a Matrix Membrane Keypad, a solenoid lock and a relay unit. Besides these, we useD 2 touch screens for user interfaces. Raspberry pi, provides most services of our door lock system. It is connected with the pi camera, keypad,a touchscreen and power supply. The facial image is taken by the pi camera and passcode is entered using the keypad, . All these functions are triggered by pressing corresponding touch buttons on the screen. The Pi camera is directly connected with Pi via the camera slot. Attach matrix 7-pin interfaces to 7 free GPIO pins. 3 column pins are set as output which are directly connected with GPIOs, while 4 row pins are set as input with pull-up resistors. Users could operate on a touch screen to select entering the house by recognizing face or entering passcode. For face recognition, an image will be captured by pi camera and pre processed by Raspberry pi like converting, resizing and cropping. Then face detection and recognition are performed. Once the face is recognized by the classifier based on pre-stored image library, the image will be sent to a remote console waiting for house owner's decision.

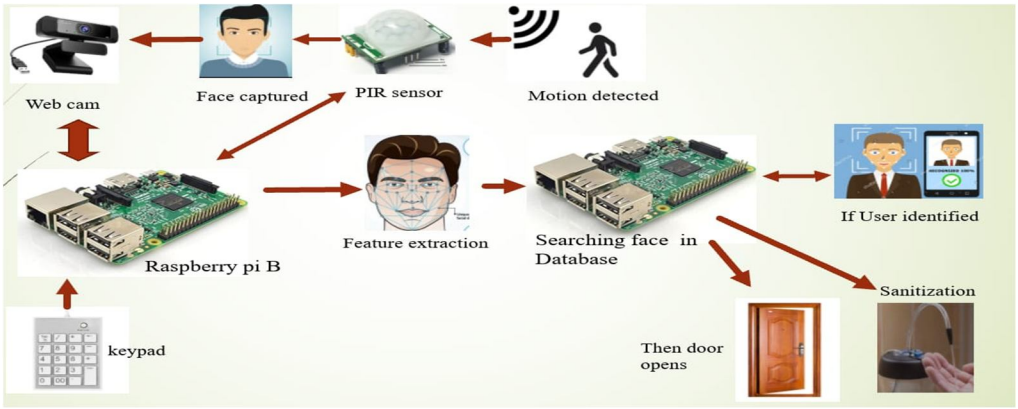

Fig 1. Block Diagram

B. Face Detection

OpenCV (Open Source Computer Vision Library) is a programming functions mainly aimed at real-time computer vision. Originally developed by Intel, OpenCV is a cross-platform and free for use under the open-source Apache 2 License. OpenCV is written in C++ and its primary interface is in C++, but it still retains a less comprehensive though extensive older C interface. All of the new developments and algorithms appear in C++ interface. There are bindings in Python, Java. Wrappers in several programming languages have been developed to encourage adoption by a wider audience. The Cascade Classifier class of the OpenCV library is used to identify the face . Cascade Classifier can be used to detect objects as it is created from an XML file that contains the representation of the trained model. OpenCV provides some premade models for various usage cases, such as face detection, eyedetection, full body detection, etc. Receiving a black and white image, Implementation of the Face Recognition function returns the bounding rectangles of the potential boundaries of the face. For processing, the first best result is taken and the separated part of the image that is in this rectangle is rotated. Image files are processed alternately by creating a training sample. The Figure 5 represents the face detection code.Training of cascade classifier: OpenCV provides some useful applications to self-traincascade classifier, that are: opencv_createsamples and opencv_haartraining.

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Training the classifier, requires positive images (images with faces) and negative images (images without faces). In our proposed system, 100 positive images and 1000+ negative images are used for classifier. It is always suggested to maintain at least 1:10 ratio of positive and negative images. The steps involved areas follows:

1) *Step 1:* Create positive and negative data files from the images.
2) *Step 2:* Create Samples data file using opencv_createsamples.
3) *Step 3:* Convert Samples data file to vector format using mergevec.
4) *Step 4:* Generate temporary haarcasade file using opencv_haartraining.
5) *Step 5:* Convert haarcascade file to .xml (Extensible Mark-up Language) file

Python and OpenCV library was installed for the algorithm implementation. To train the faces into the library, we use the "train.py" algorithm in the OpenCV library. The training data should be loaded into the script. These images will be captured using the code "capture-positives.py". This code will continuously capture images into the training data folder. The training data also requires a negative training images that are built into the Raspberry pi library. Sets of 10 images for each person is trained at a time and "train.py" script is executed.

The training data given will produce an output named "training.xml" file which contains the positive data processed into it. This process can also be done using a full fledged computer to shorten the training time. Finally, ports are initialized using the terminal in root mode to access the GPIO pins. To run the code, the terminal window on the Raspberry Pi is opened and the python code "box.py" is executed.

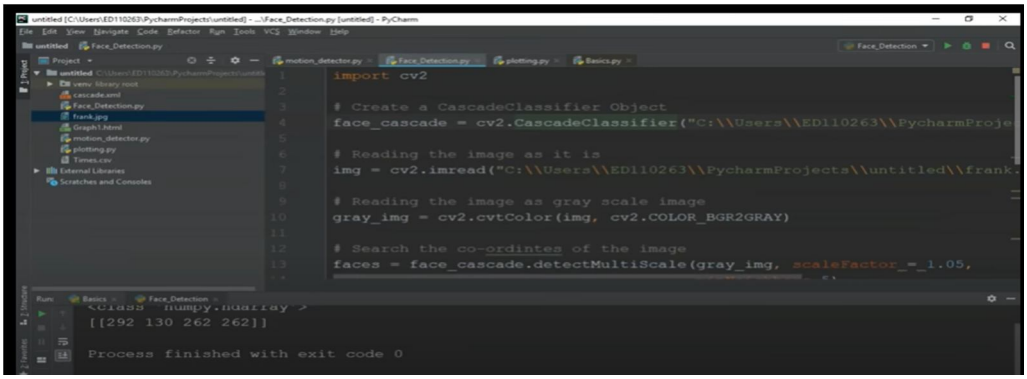

Fig 2. Face Detection Code

C. Sanitization

Viruses like corona virus disease (COVID-19) spread when mucus or droplets containing the virus get into your body through your eyes, nose or throat. Most often, this happens through your hands. Hands are also one of the most common ways that the virus spreads from one person to the next. The spread of the virus, can be stopped by frequently washing your hands or by washing your hands using hand sanitizer. In this project one step forward by setting up a contact free hand sanitizer dispenser along with a reminder and alert system, which reminds people passing by to sanitize themselves. This system will ensure that every person who enters your house remembers to wash their hands, and you will be able to fight off the COVID-19 disease. The sanitizer dispensing mechanism allows our system to dispense sanitizer without contact. Sensor will detect the hand of the user and dispense the sanitizer till the user has kept his hand below the sanitizer mechanism.

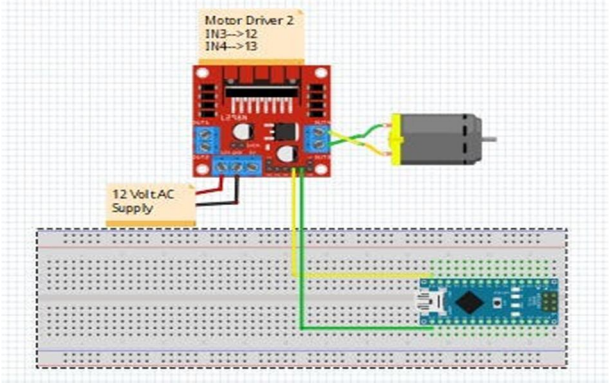

Fig 3. Santizing Mechanism

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IV. CONCLUSION

In this paper door access using face recognition and sanitization was discussed. This system mainly focuses on security to a greater extent with the implementation of face recognition system. The system also keeps track of the visitors by storing the date and time of the visit along with their name in the database. The end goal is to improve home security, providing better resource management. This implementation is cheap, fast, and highly reliable as Raspberry pi takes less power with enough flexibility and also reduces the database and maintenance costs, giving more control to the user. Hand sanitizing unit is installed which drops the liquid whenever a hand is placed beneath it. It ensures the safety for people inside the house and limits the spread of corona virus to a possible extent. It also create an awareness about the virus among the society. There are other potential researches that could be done to improve the performance of face recognition rate such as the increase number of training images, characteristics of the lighting source, the background in front of the camera, etc.

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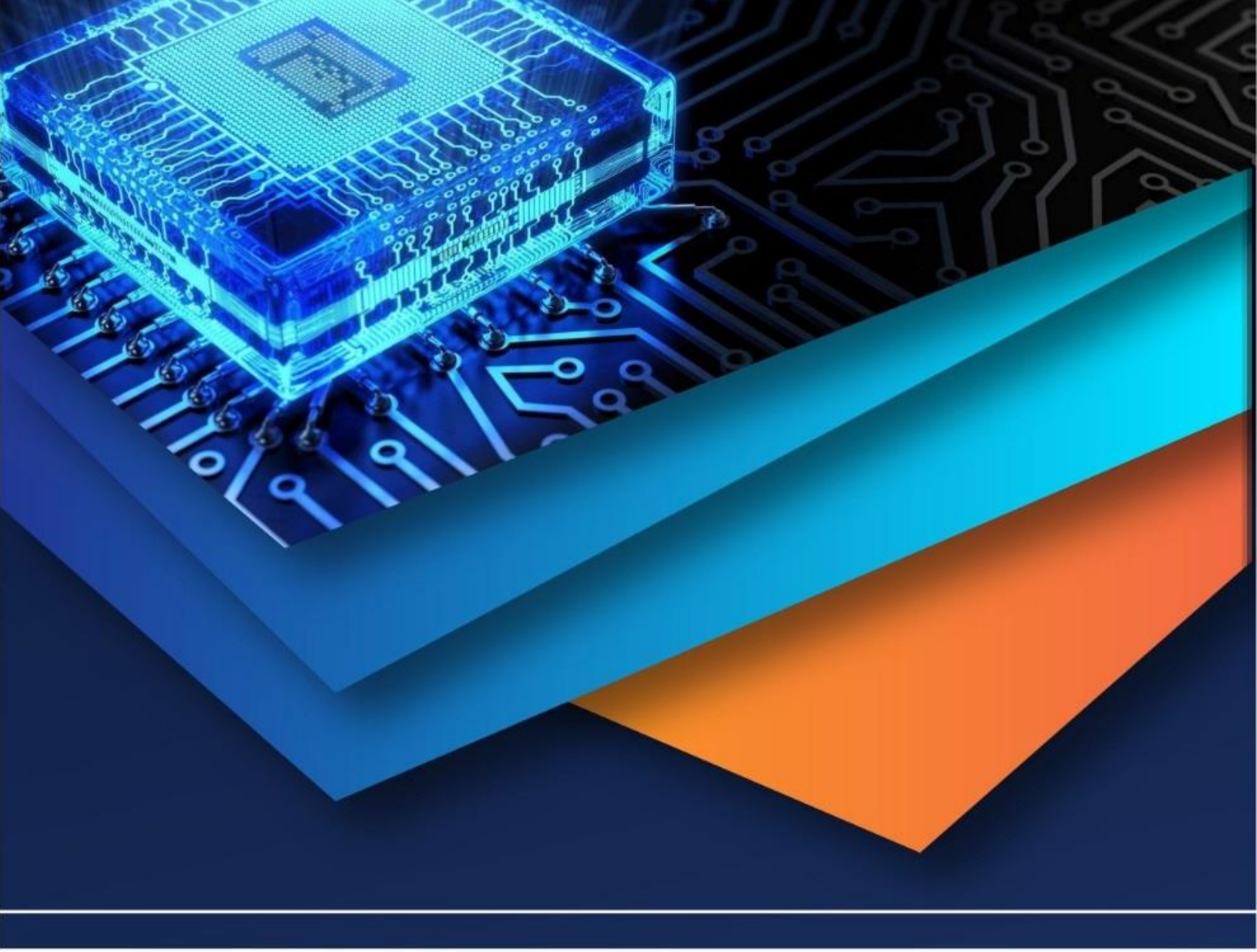

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