SMART DOOR LATCHING SYSTEM USING FACE RECOGNITION

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Abstract: *This research paper will describe the process and methodology of creating a Smart Door Locking System. It will also describe the system architecture of the whole project. In addition, the future scope, advantages, and relevance will also be discussed. As a part of the literature survey, we reviewed six research papers and tried our best to implement the features and filter out the limitations of the project. This project will be relevant as it will help safeguard countless households from thefts and burglary. It will have a fair amount of strength. Anyway, strength is not the main characteristic of this implementation. The main aspect we have worked on during its implementation is the accuracy of its face detection model. Face detection comes with many vulnerabilities and needs to be implemented quite accurately. A database will be made use of to store the faces of only registered users. Different angles of the user's face will be taken to increase accuracy.*

Keywords *–Smart Door Locking, Face Recognition, Arduino Uno, Database, Smart Phone.*

I. INTRODUCTION

Imagine yourself being constantly called by some call center person identifying and representing himself from some insurance company, local firm, Sim card company, and so on. It can certainly be very irritating. You don't even know if this is a fake/scam call or a genuine call. People get scammed thinking these people are actually from call centers selling genuine products. Then there is somebody who identifies this problem and starts devising a solution for this problem. Soon he comes up with an app that can automatically identify spam callers and immediately block and blacklist them. How convenient! Our project is somewhat analogous to the situation mentioned above. We have created a Smart Door Latching System using Face Recognition Technology that can help prevent potential thefts, burglaries, or security breaches.

Today, big techs all over the world have collected such an enormous amount of data from activities going on by users on their apps that they need giant rooms stacked with machines to store all that data. Access breach to such data rooms could be a blunder. That is why there are tough security systems used which would provide access to authorized people only. The implementation will include OpenCV library to create machine learning models with ease and maximum accuracy. Development boards like Arduino UNO, ESP32 will be used which will be explained in detail in the methodology section. A popular algorithm which is Haar Cascade will also be used with the help of OpenCV library.

II. LITERATURE REVIEW

There were five articles which we referred to while making our project. These five articles which were based on face recognition and vehicle door locking system has some features which we implemented and some limitations which we tried to avoid.

Shizhen Huang et al [1] mentioned about doubling the security filter using double face recognition. When a person uses card to gain access, a CCTV immediately captures the face of the person. Meanwhile the photo of the person on the ID card is recorded and searched for in its database. If the photo is present in the database, it checks if the photo matches the photo captured on CCTV. This way, security is doubled.

Suguna Thanagasundram et al [2] mostly explains the working of the of the mechanism behind the latch of the car. It mentions about the movement of stepper motor when it is automatically unlocked. It also states about manual unlocking of the door. Since we have used Arduino in our project, the components and its movement is limited so only a servo motor is used and when it detects the face, it will automatically open the latch. Manual function is not added as of now. In Figure 1, you can see how the mechanism is built. It has a stepper motor and a wireless module which on command, rotates the motor by a few centimeters.

Wee Lau Cheong et al [3] mentions about building a real – time surveillance system using face recognition. Using CCTVs to identify faces from far away and recognizing them is their main objective.

Figure 1 – Door Lock in a Car

It also talks about optimizing speed of systems by refining the algorithm used. This is also known as Smart Vision. As an effort, we will be using OpenCV to make the model and capture more than 200 images at different angles. Different angles of the face help improving accuracy the model. 3503

G. V. Wheeler et al [4] and **Varad Pandit et al [5]**, talk about User Recognition in a crowd and ‘difficult to identify situations’, and storing and arranging information each time the door was locked or unlocked, respectively. This made the task of keeping track of the status of their security much easier.

Our project is a vague mix of all the learnings of these research papers. We have used Arduino Development Kit and ESP32 as it is convenient because of its inbuilt WiFi and Bluetooth connectivity. The door latch will be quite simple and have linear bi-directional movement. It will also have a breadboard based connection and whenever the latch is unlocked, a blinking diode will be attached to indicate the same.

III. METHODOLOGY

There is lot of automation these days in security systems. It can be also termed as ‘hands – free’ security system. Our project is a set of manual operations, where the procedure will be as follows:

A) Create a function of data collection which will first capture the photo of the user which will be used for further operations. About 250 – 300 photos will be captured while asking the user to tilt his face at different angles.

Figure 2 - Arduino Board

B) Next we will set up Arduino and ESP-32 with the required components. ESP-32 has an integrated video camera. The image output is JPEG, BMP, Greyscale. It also also has an inbuilt WiFi and Bluetooth module which will make connecting the computer with it easier.

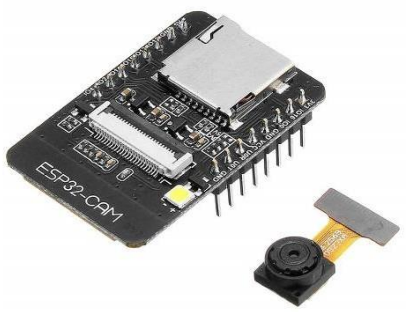

Figure 3 - ESP32 with camera

C) Coming to the crucial part, the Haar Cascade Classifier algorithm is the main algorithm implemented. The figure above (Figure 3) shows how the algorithm identifies lines and edges, which divide the block into negative and positive parts. It is to point out areas where the resolution of the image changes suddenly.

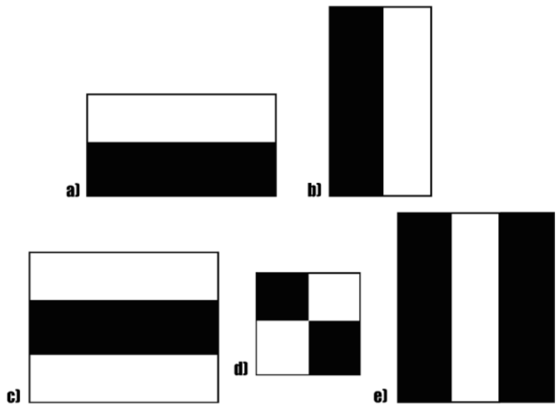

Figure 4 - Working of Haar Cascade Algorithm

This is useful when using high quality images which have a blurred background and focused image of the person. This then becomes a machine learning algorithm where a lot of similar cases are fed to the algorithm to make it smarter and more accurate. Another way is that after feeding several images of people, area of the block which accurately covers the face is calculated and the block is moved throughout the photo in a linear way to identify the face. It generates the signal if the face is identified correctly. Another way is to feed photos of different parts of the face i.e. eyes, jaw, chin, nose, ears, etc. separately.

Feeding hundreds of such photos to the computer makes it effective while detecting faces.

D) Lastly, integrating Python with Arduino to use the door latch. The Arduino code will consist of moving the servo motor after the detecting the face.

IV. SYSTEM ARCHITECTURE

Our project touches simple ideas and concepts of face recognition. It is a simple face

recognition algorithm that detects 'not-a-face' and 'face' with the help of OpenCV library. So, the System Architecture is quite straightforward.

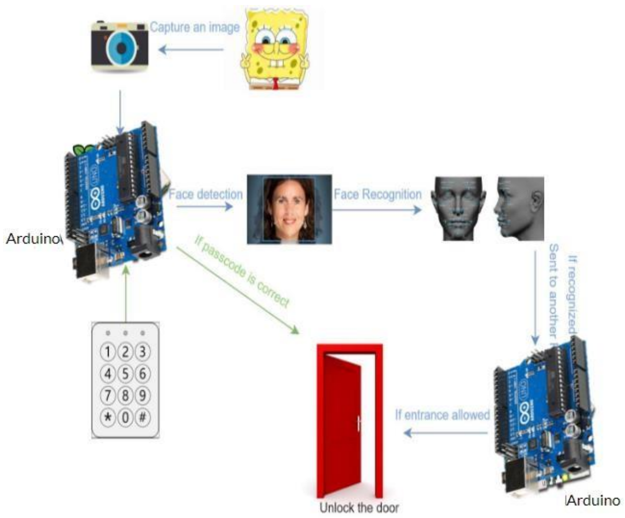

Figure 5 - System Architecture

With the help of ESP-32 camera, image will be captured. First images will be taken with the help of a data collector module. It will take around 250-300 photos of the person who wants to be registered as the user. Only one user can store his photo at time. Now, another block of code will run which will scan for the registered user's photo in its database. The algorithm will run quite efficiently due to the number of photos taken at slightly different angles. If the face does not match, the square block around the face will turn red indicating that this is not the user. When the actual user appears in front of the camera, the square block will turn green indicating that the user's photo is matching with the face. As a result, a diode connected to the breadboard will start blinking indicating that the latch will unlock. After 15 seconds, the latch will automatically close.

If the given procedure fails to happen due to some bug or malfunctioning of the servo motor, there is no need to worry. A password generated system will be adjacently available. Only user would know the password and the same procedure will take place. The latch will open for 15 seconds once the correct password is entered. Otherwise, there will be no response.

V. RESULTS AND DISCUSSIONS

In this system with the use of face detection we have successfully implemented the Smart door locking system by integrating all the algorithms, components, on-Board logical units as mentioned above and the data of the user. It is a Arduino microcontroller based smart security model. The system is now able to recognize and detect the authorized face and passkey. This system informs the owner if a wrong pass key is detected more than twice. It also displays the name of the user by detecting his/her face who has unlocked the door. In this model the face detections works very well when only one face is present in the frame, when more than one face are visible in the frame the face detection can be affected. It also keeps the record of time at which user unlocked the door and closed it and also the duration till the door was open. This is the proposed model as shown in the image below. We have made this prototype at a minimal cost.

VI. FUTURE SCOPE

Adding a microphone with the lock outside the door will allow the visitors to communicate with the user. The android application will offer more convenience in operating such home appliances. A cloud database can be used to store the footage of the people entering the house. We can send the data to the user whenever anyone unlocks the door. RFID tags can be used in addition to this system. An emergency sensor can be added to unlock the door during any kind of emergency situation. Fingerprint scanner can also be added.

VII. CONCLUSION

Such security systems based on face detection are making progress in Iot field. There is a growth is this technology which is increasing day by day. This system accurately performs it's tasks and provide security. It also helps to reduce frauds and thefts where high security is required. The implementation of this system is less expensive and it provides double security, so that this system can be affordable for average salaried person and whose implementation is simple. These systems are taking us towards the use of futuristic technology and many improvements and innovations would be seen the future. The applications of this system are it can be used in homes, offices, hospitals lockers, etc.

VIII. ACKNOWLEDGMENTS

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