Implementation of Security System using Computer Vision and Temperature Detection

Aryan Dali
Department of Electronics and Telecommunications
Sardar Patel Institute of Technology
Mumbai, India
aryan.dali@spit.ac.in

Anand Mane
Department of Electronics and Telecommunications
Sardar Patel Institute of Technology
Mumbai, India
anand_mane@spit.ac.in

Husain Challawala
Department of Electronics and Telecommunications
Sardar Patel Institute of Technology
Mumbai, India
husain.challawala@spit.ac.in

Jai Damani
Department of Electronics and Telecommunications
Sardar Patel Institute of Technology
Mumbai, India
jai.damani@spit.ac.in

***Abstract*—For corporate and private groups, providing security and secure access to workplaces has long been a top priority. From keypads to fingerprint sensors, there have been advancements in the way security is delivered over the years. Even these, though, have their flaws and weaknesses. Computer Vision is a more powerful and modern technique which can be integrated into a security system for the purpose of increasing the overall level of security. This project aims to create a security system that utilizes this software as well as a temperature sensing module to enable secure, monitored and contact-less, access. The facial authentication is achieved with a help of a webcam connected to the system and a python program on which this is executed, after which the main control is transferred to the Arduino UNO Microcontroller board which tests the two incoming inputs and provides access based on its decision. A training model is employed which studies the given images of the users and detects them when entry is requested.**

***Keywords*—** Facial Authentication, Security System, Temperature detection, OpenCV, Arduino UNO, Computer Vision

I. Introduction

In this current era, physical security breaches and risks are at an all-time high. Corporate premises ranging from residential homes to commercial buildings require trustworthy and high standard security to prevent breach and theft. Hence, designing a modified and improved security system to grant access only to authorized people seemed of utmost need.
This system is considerably more efficient than a password-based system or a fingerprint system and it also eliminates all the need for any physical contact with the system which is of utmost importance in today's day and age owing to the COVID-19 pandemic. The proposed system is a facial recognition security system with a temperature sensor that will be able to protect people's personal spaces as well as their health. It can be deployed in protected or public areas and can serve as an effective security solution.
It consists of the following components:
1. A facial recognition system implemented using python's Computer Vision.
2. A temperature sensing system with the help of LM-35 temperature sensor.
3. Arduino Microcontroller which oversees the logic[1].

A. Motivation

As security breaches become more common, a foolproof method is required to prevent attacks and improve the overall security of a system. Traditional methods of security, such as the use of a keypad or a fingerprint, while effective, can be easily compromised. In such cases, a stronger form of protection is required, one that recognises and authorises people based on their faces. Systems in smartphones and other devices already include a facial recognition system. Furthermore, the recent pandemic has highlighted the importance of contact-free systems and temperature checks at all entrances. This system is more scalable and can be expanded to other areas. The goal is to create a secure system that provides access through facial recognition and no contact. This system has greater complexity in implementation and thus ensures higher protection against security breaches and offers a better solution for private as well as public properties.

B. Literature Survey

The following research papers were studied for the sake of the current project-

- **Contactless Attendance Tracking using Face Recognition and Sensor based Techniques: A Pilot Study**[2] The aim of this paper is to provide a technical review on technology which will do multiple functions like detecting faces of people with their masks on and reading their body temperature involving various techniques computer

vision and deep learning using Python, OpenCV, and TensorFlow/Keras and also some sensors like Infrared Temperature Sensor.

- **Automatic temperature Control System using Arduino**[3]
  Using Arduino Uno and LM35 temperature sensor the author creates a control system based on the room temperature
- **Autonomous Face Detection System from Real-time Video Streaming for Ensuring the Intelligence Security System**[4]
  This research paper describes an effective method for detecting and recognising facial data using OpenCV and Python, both of which are part of deep learning. A system is proposed that aids in the identification and analysis of human faces in real time which can be implemented across multiple platforms in a variety of software applications. In this paper the face detection is done by the Haar-Cascade algorithm which is also used for designing the proposed system.
- **Convolutional Neural Network Based Smart Door Lock System**[5]
  Due to the Covid-19 pandemic Locking systems which had means of physical touch such as bio-metric systems were banned in India. Therefore in this paper with the help of Convolutional nueral networks which recognizes a the snap of any persons face a smart locking system has been developed.

C. Contributions

The primary objectives of the project are as follows-

- To develop an efficient and secure security system using modern technologies like Computer Vision.
- To incorporate a contact-less temperature sensing system to determine the temperature thus preventing users with high risk of COVID-19 [6][7].

D. Outline

- The paper gives a basic idea about the design of the project, along with the algorithm and the implementation.
- The main objective is to design a face detection system that works with a temperature detection unit to improve security.
- The use of Python and OpenCV along with Arduino are also discussed.
- Lastly, the results that were obtained at the output were discussed

II. Body

A. Working and algorithm

Designing a Facial Recognition based Security System has several intermittent stages. The system basically checks the users face for a match thereby sending a signal to the microprocessor (using the binary system of 1s and 0s) to allow or deny the user permission. After this the Arduino microprocessor has been used for receiving the signal from OpenCV [8] and executing the conditional check and displaying the results of the test cases. Arduino can essentially be described as an open-source platform that is used for simulating electronics projects. It consists of an IDE (Integrated Development Environment) that can run on a computer and is used to write and upload computer code to the physical board. For the purpose of this project, an online simulation software called Proteus has been used instead of a physical board.
If the signal received is '1' and if the temperature check performed by the LM35 temperature sensor falls under the threshold range, a "Access Granted" prompt would be displayed on the LCD screen attached to the simulation circuit. Conversely, if there isn't a match in the face and the system sends a '0' to the Arduino circuit, then this implies that it's an unregistered person and thus should not be granted access. And thus, an "Access Denied" prompt is generated on the screen. The LM35 is used to sense and display the temperature of the test case. After giving us the temperature, a conditional statement is constructed in the Arduino code which combines the two criteria for allowing access to a user by using an 'if' statement. This implies that even if the face of the person matches that with the entry in the database, if the temperature lies above a certain value (which is to say that he or she bear the risk of being COVID positive), access would not be granted to the person by the message "Temperature is too high" being displayed on the LCD screen.
In this way a double security check is established in the system by integrating a temperature check and a facial recognition check and combining it with the circuit using the set of applications mentioned above.

B. Simulation

The system is ready for simulation after the circuit has been designed and the necessary software applications have been used. The system is first completely virtualized for testing and debugging. Python's Haar-Cascade algorithm is employed for analyzing and detecting the facial data. It is an object detection algorithm that employs edge and line detection features. The facial recognition data is sent to the Arduino board by the Python script. The Arduino takes this input and further decides whether to grant or deny access to the current user based on the temperature sensor input, which is provided by the subject. Depending on whether the system is run as a simulation or through hardware, two additional software applications may be required. Proteus Simulation Software is used to build the circuit during simulation or system testing. The system is completed by adding all of the required components and programming the microcontroller according to the set logic executed via code. A Virtual Serial Port Emulator is also used in conjunction with this. It is a tool for emulating serial ports for communication purposes [9]. It enables the connection of the computer's various ports thus allowing Python and the microcontroller to communicate and exchange data. During hardware implementation, this is accomplished by manually connecting the Arduino to a computer and selecting the appropriate port to send data. The circuit consists of the

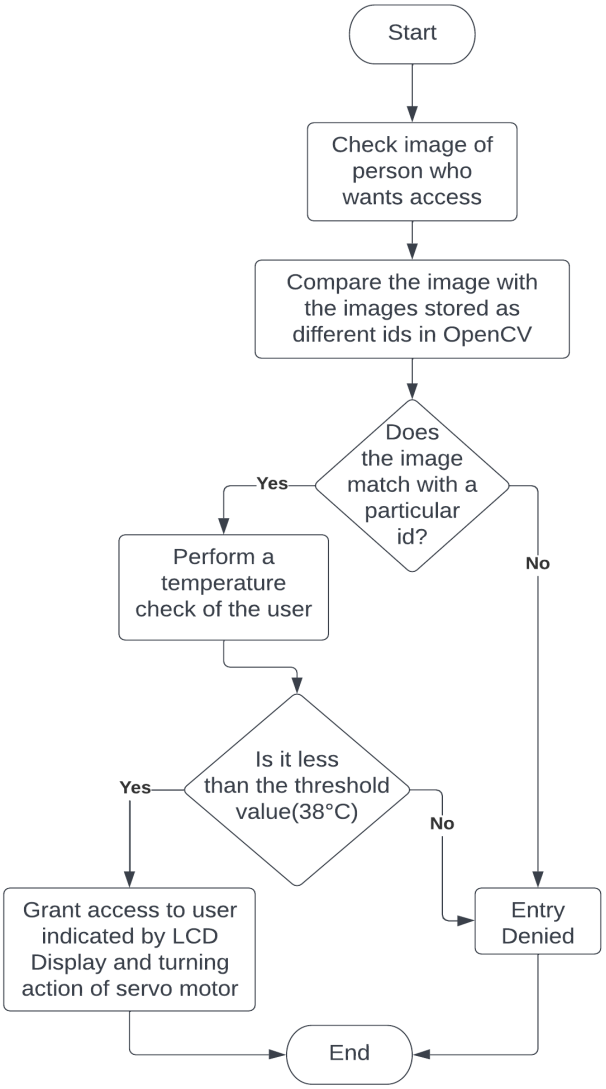

Fig. 1. Flow Chart

microcontroller, LCD Screen, Servo Motor, LM-35 and a few LEDs.

The LCD and LEDs are used as visual indicators for granting or denying access[10]. A servo motor is used to emulate the opening and closing of an automatic door to allow entry. It rotates back to its original position within a few seconds.

C. Methodology

1) Facial Recognition System: The facial recognition system was made using OpenCV library installed in Python wherein the following steps take place [11].

- Datasets are created based on the data collected. Each dataset is assigned a unique identifier.
- With the gathered data set the recognizer is trained using the Haar Cascade machine learning-based approach where a lot of positive and negative images are used to train the classifier.
- To train on, the algorithm is given a large number of positive images with faces and a large number of negative images with no faces.
- Haar cascade employs the cascading window to compute features in each window and classify whether it is an object.
- Now that the recognizer is trained if the if there is an input of a face to the system then the system will compare it

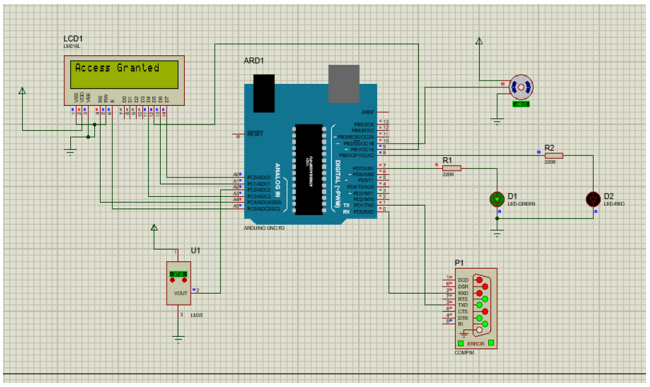

Fig. 2. Case 1: Access Granted

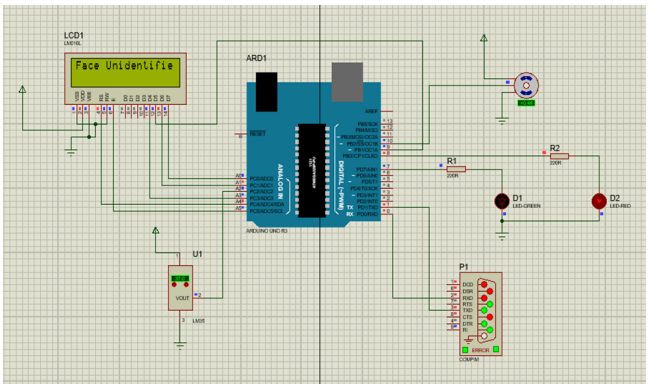

Fig. 3. Case 2: Access Denied since face is unidentified

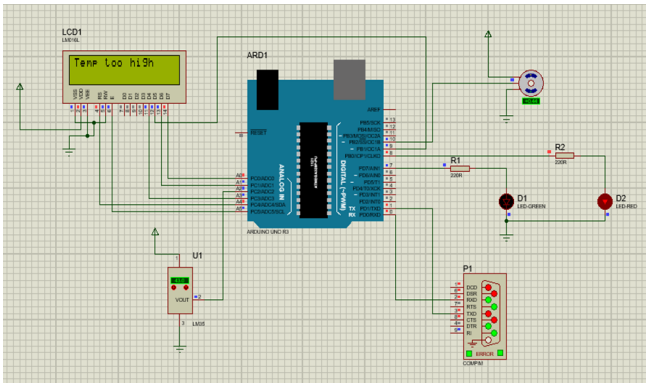

Fig. 4. Case 3: Access Denied since temperature is too high

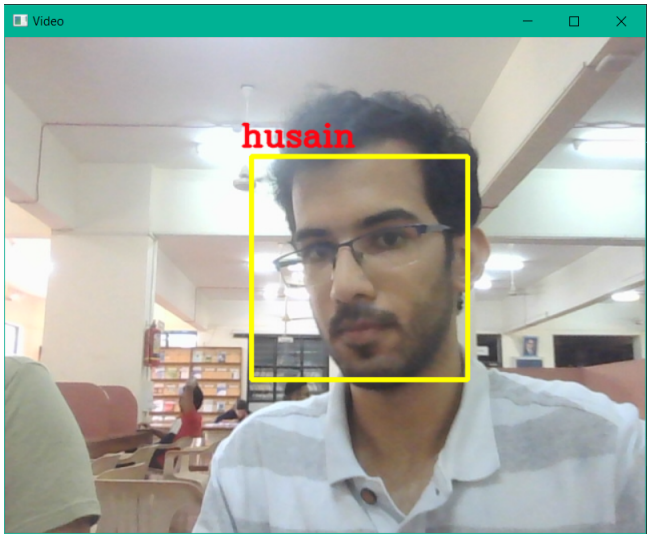

Fig. 5. Case 1: Identified Person 1

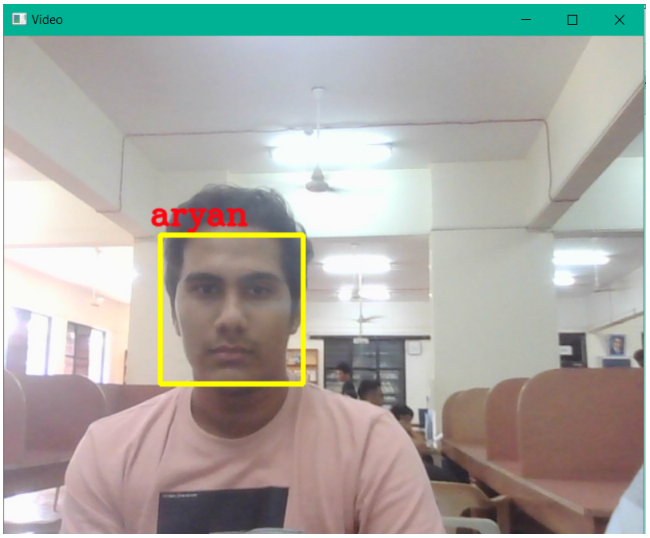

Fig. 6. Case 2: Identified Person 2

to the dataset.

- If there is a match with any id in the dataset with the recognize, the face will be recognised and the user is prompted towards the next phase.

2) Temperature Sensing System: The temperature sensing stem with the help of LM-35 temperature sensor functions in the following steps [12].

- The LM-35 temperature sensor senses the temperature of the user.
- The analogue temperature voltage is transformed to a digital value and delivered to the Arduino UNO for processing.
- The Arduino compares the temperature to the set threshold temperature (100 F or 38 C).
- If the temperature of the user is less than the threshold temperature only then will it be presumed safe to grant access.

3) Servo Motor: The Servo Motor utilised is a regular motor that simulates a precise and regulated circular rotation in a system [13]. It is used as mentioned below:

- Only when both of the needed requirements are met, namely a match in the facial scan and a body temperature below a specified threshold, is the servo motor engaged and ordered to rotate precisely 90 degrees.
- This rotation is used to imitate the unlocking of the door, allowing the user to gain entrance.

III. Results

Since OpenCV is used for the system, which requires a dataset of images as training models [14], 100 images of 3 people were added to the directory. These were analyzed by the algorithm as a set of coordinates and the images were compared with the faces on the webcam. For test purposes, 2 of the faces were detected since they matched with the data in the directory and one was detected as unidentified, thus posing as a security threat.

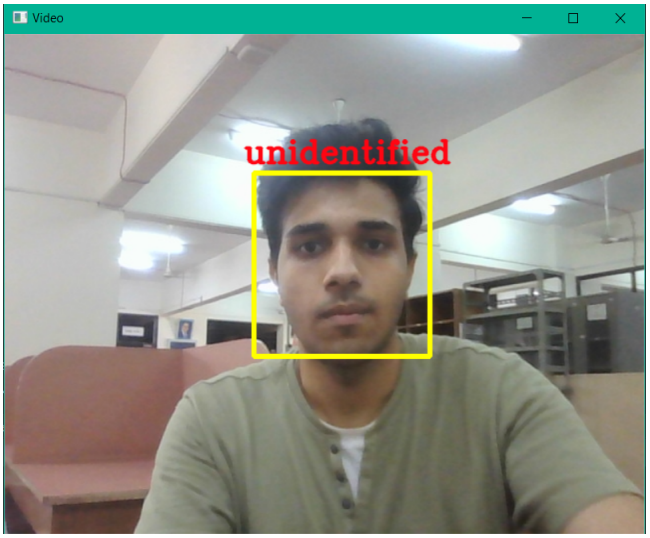

Fig. 7. Case 3: Unidentified Person

The values of accuracy are an approximation after running various tests. The loss in accuracy comes primarily from the algorithm used via the face recognition system. Its accuracy can be improved by using a camera with better resolution, deploying the system in a well-lit place, altering the algorithm used or using a better one, and providing a greater set of data to train the model to improve detection. The following table shown below depicts the accuracy of the system observed under various lighting conditions- Ideal, Normal and Dim scenarios. The tests were run 20 times for each condition to correctly estimate the efficiency of this system.

Accuracy Table:

Lighting Conditions	Number of Attempts	Accuracy
Ideal Lighting	20	95%
Normal Lighting	20	85%
Dim Lighting	20	60%

IV. Conclusion and Future Scope

The primary objective of this project was to provide a security system that eliminated the use of passwords (which may be forgotten and are relatively unsafe and can also be compromised) and fingerprints that can act as a means to spread diseases which is highly unsuitable given the current COVID-19 pandemic situation. The facial recognition system proposed is much more accurate as compared to a fingerprint-based system and since it is combined with a temperature sensor, it provides an additional check for body temperature which is now a mandatory security parameter in malls and offices worldwide. It also provides for a cost-effective and user-friendly design.

We have used several platforms for the system that perform their specific tasks. The main component was the OpenCV library, which was used to detect and recognise the faces of people. The next main component is the micro controller, which performs the conditional check and authorises the entry of the person. The entire system is simulated on Proteus for the sake of this project.

The project's future scope would include implementing the system with physical components and integrating it with voice recognition-based software to boost security and complexity while reducing security breaches[15]. It might also be possible to eliminate the requirement of a temperature sensor entirely by introducing a Machine Learning model that can detect approximate temperature based on a colour-temperature correlation approach [16].

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