Development of Security System to Prevent Tail-Gating

D. Nikhil Reddy, B.Mahadev, K.V.Achyuth and Sharmila Nageswaran

***Abstract*—The Electronic controlled access is a system that provides power to restrict the movement in any restricted location. The efficiency of the system depends on usage by the one who is granted with the access. The biggest flaw of such electronic control device is the lack of a system to prevent a common practice of "tailgating" or "piggybacking". The research is aimed to tackle such security issue by using body mass index & image detection technology. An example for this tailgating practice – when two persons entering a same room with single entry/id card. However, this research aims to implement the tailgating/piggybacking detection security system on an embedded system with limited resources. The detection system developed for this research consists of two main components, four camera's and a processor. First image of a moving object is extracted using image detection and stored in the system for future reference. Then two images are taken at the next stage which undergo body mass index (BMI) analysis. To detect tailgating/piggybacking process, in third stage we used the principal component analysis algorithm along with a geometric approach for face recognition. The result of study done with one such embedded system developed by the authors revealed that it can be used to identify the tailgater successfully in various situations and can be implemented in real time scenario.**

***Index Terms*—Body Mass Index (BMI), Edge detection, Facial Detection, Face Recognition, Principle Component Analysis(PCA),Success Rate(SR),Tailgating.**

I. Introduction

THE main purpose of the security system is to prevent unrestricted access of an unauthorised person. A system that provides control and restricts entry to a secured area is termed as access control such controlled access can be found in private places like banks or office. This system would grant the access based on the credentials provided by an individual. Traditionally, this access is a physical key used to unlock a door. However, for electronic access control, credentials can be of various types such as pass-code, fingerprint.

D. Nikhil Reddy, B.Mahadev, K.V.Achyuth and Sharmila Nageswaran are with the School of Electronics Engineering, Vellore Institute of Technology, Vellore-632014.
Email:nikhilcratosncm@gmail.com,mahadev.bvs@gmail.com, achyuthkunchapu@gmail.com, sharmila.n@vit.ac.in

When the access is granted, the door opens and when access is rejected it remains closed. The entire entry/exit log can be recorded and stored in a database. Most of the existing systems at present don't have control over the number of person's entering the restricted area. When a valid credential is provided by any authorized person the door opens and anyone can take the advantage of the authorised person to access the restricted area; similar practice is used by intruder to exit the building. The major limitation of automated entry control systems is the lack of a system to avoid this practice entitled as "tailgating" or "piggybacking". Tailgating is a particular situation where an individual following through the door without the knowledge of the person who has opened the door to a secured area, Where Piggybacking implies that the person who has opened the door with their credentials knows that an individual is are following him through the secure door. Tailgating and piggybacking are two major security issues. The implementation of such system is necessary to prevent tailgater and provide access to people with authorization. The challenges faced includes focal distance calibration, making the system to work with various camera resolutions and database comparisons.

The rest of the paper is organized as below. The related work and proposed methodology are described in section II and III respectively. The experimental results are discussed in section IV. At last, section V concludes the paper.

II. Related Work

When compared with traditional fingerprint method, the modern biometric features, such as face information has the numerous advantages and can be distinguished easily. Face detection and face recognition as a research has achieved great success in recent times. In the very beginning, the research was concentrated on face recognition to identify based on the facial information. There are two major types of face detection methods: knowledge-based and statistics-based. Knowledge based face detection methods: Face features, shape and edge, texture and colour characteristics. Face recognition technology analyses and obtains the feature information from facial image which is then compared with the feature information with already stored

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details in database to obtain the final recognition result. Traditionally face recognition is mainly achieved by PCA and other facial features. Although, researchers have proposed various algorithms but the results were not very satisfactory in practical applications. The security system developed is based on face detection, Body Mass Index comparison face recognition which is proposed in this paper will greatly prevent tailgating and has good robustness.

III. Proposed Methodology

A. OVERVIEW

Overview of the system design is shown in Fig.1 and description is provided in subsequent paragraphs.

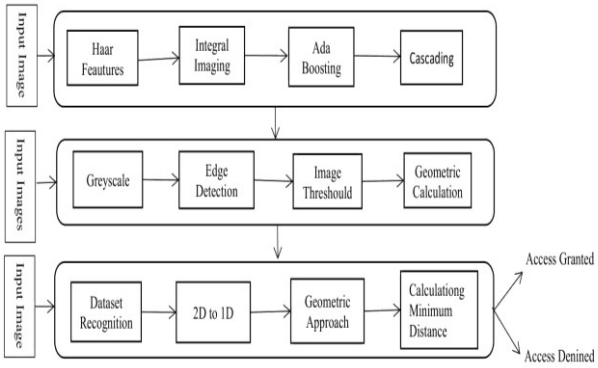

Fig. 1. Overall System Design

B. FACE DETECTION

In this technique we used features that are similar to Haar features. This kind of feature of any particular size could be calculated in with respect to constant time 't' by the concept of integral imaging, which would create a larger set of features and would also use the boosting algorithm known as 'AdaBoost' to select the crucial features. In their simplest form these features are considered as a set of pixel intensity. Then the total amount of the luminance of the pixels in the white region of the feature is subtracted from that of which is present in the remaining set of grey intensities. A hypothesis about the regions in an image is formed by integrating these feature values, the difference from the pixel luminance used as feature value. Here instead of counting each pixel while performing calculation it sums the pixels left and top of it to produce an integral pixel which can reduce the execution time, when such rectangles containing Harr-like features are applied from the first few results it decides whether a face is present or not instead of wasting time, then cascading is performed to minimize the time further.

C. BODY MASS INDEX COMPARISION

In this technique we developed an algorithm in which two images are processed at two different distances say 5m and 2m from the restricted area but the distance from the person entering and camera's is maintained constant in this case. First the image is converted into a grey scaled image followed by edge detection and thresholding now from the threshold image the band width of the no of white pixels are found thus resulting the values for area and height of the pixels these results are used to find the body mass index through the formula shown below. The first BMI value is found at 5m distance from the restricted area and stored in the database which is further compared with the BMI value calculated at 2m distance from the restricted area. These two BMI values are compared and if they match the person is allowed to pass through the security or else he will be restricted from entering.

D. FACE RECOGNITION

In Fig. 2, the stage we used PCA which is most common for face recognition and here we fused this with a Geometric Approach while creating the data set for face recognition, all the frontal faces in the dataset are considered as vectors and a normalized vector is obtained for these images.

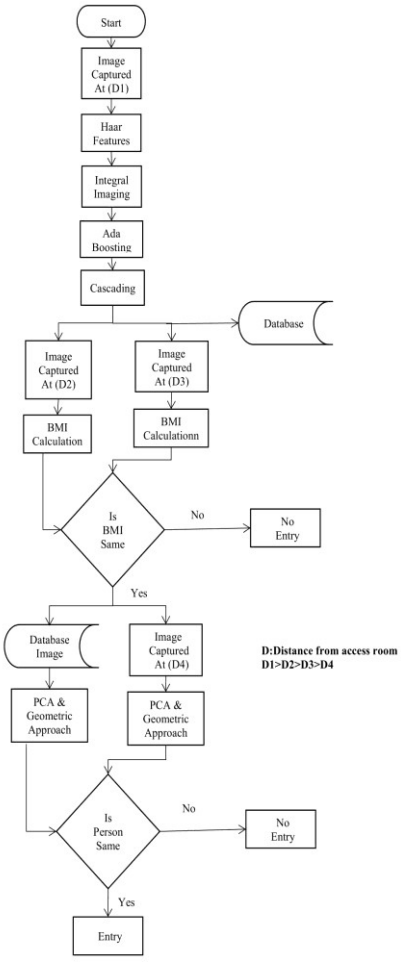

Fig. 2. Flow Chart

Then the obtained normalized vector is subtracted from the other vectors and thus generating a co-variance matrix. From this co-variance matrix, the Eigen vectors are computed. The most significant of these vectors are stored as a feature vector. Then in geometric approach the features we used are geometric measurements on face such as

mouth, nose, and eyes then variance of these features are calculated by mean and standard deviation. These calculated features are then fused with the features already obtained from PCA. The obtained feature vector is then further processed to improve the overall performance of face recognition. The recognition process calculates the minimum distance between the features of test image and features of all images available in the dataset. The image with minimum distance and has maximum proximity will be considered as the recognised image.

IV. Experimentation And Results

The experimental result is provided in detail in this section. We considered a sample size of 50 images by changing the lighting conditions and also included frontal images and sideway images. In the first stage we performed the process of image detection of a person such that there is no wastage of time in calculating the BMI of each and every object present in-front of camera. The facial detection, no tailgating, tailgating scenario and face recognition are shown in Fig. 3, Fig. 4, Fig. 5 and Fig. 6 respectively.

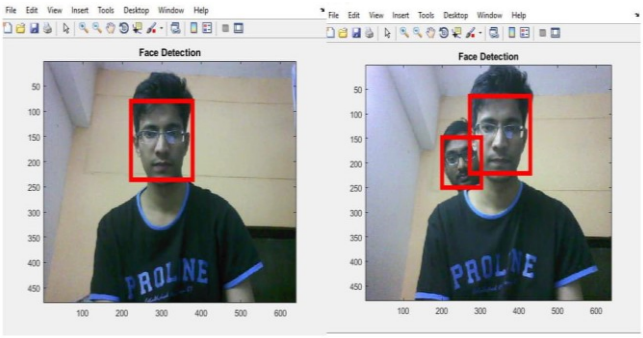

Fig. 3. Facial Detection

The most important part of this image detection is to prevent false detection and for future reference. Here we took 10 voluntaries and found the Success Rate (SR) through the formula mentioned below.

$$SR = \frac{\text{correctly detected faces}}{\text{Total Number of faces}} \times 100\%$$

In the next stage we chose a total of 10 sets of images with tailgater and without tailgater and performed the Body Mass Index comparison technique using the formula show below.

$$BMI = \frac{\text{Weight of pixels}}{(\text{Height of pixels})^2}$$

These are then compared to check if there is any tailgater entering without any authentication. The images attached show how the tailgating is prevented to ensure security through image processing techniques.

The final stage of the security, processes image of the person entering the restricted area is captured and which is then matched/recognised with already existing image of the authenticated person in the database provided or recognized earlier. As the database provided only contains authorised person details only, this is to add an additional layer of security. Here we have used both Olivetti Research Laboratory faces and few real time faces, which includes 50 face images of 5 different persons. The images captured has various postures but with small rotation, orientation less than 10% and in ambient light conditions. The photo's captured are 92 X 112 pixels, quantized to 256 grey levels. The images in the database are pre-processed before applying the feature extraction and recognition algorithms. Certain steps like scaling, intensity adjustment, and removing blur-ness are also performed on images.

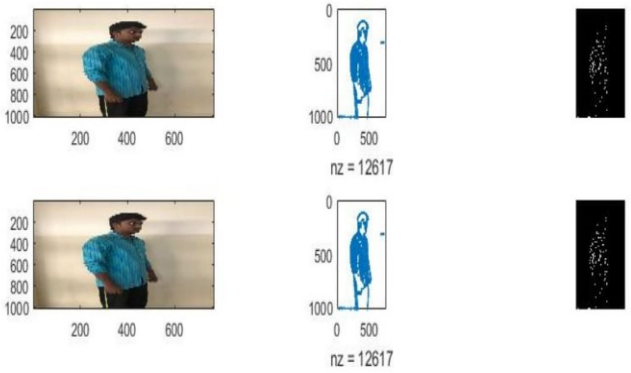

Fig. 4. No Tailgating

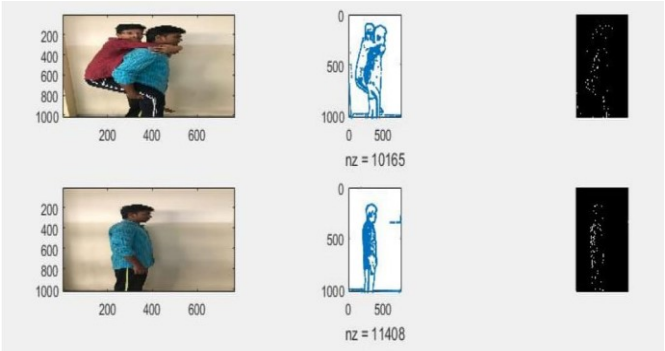

Fig. 5. Tailgating scenario

Fig. 6. Face Recognition

The main objective of the experiment is to prevent tailgating by image processing techniques by performing image detection, BMI comparison and image recognition. This technology can reduce the work load of a human operator and at the same time minimize room for errors by assisting human to take decisions. Fig. 7 shows the average computational time in each stage.

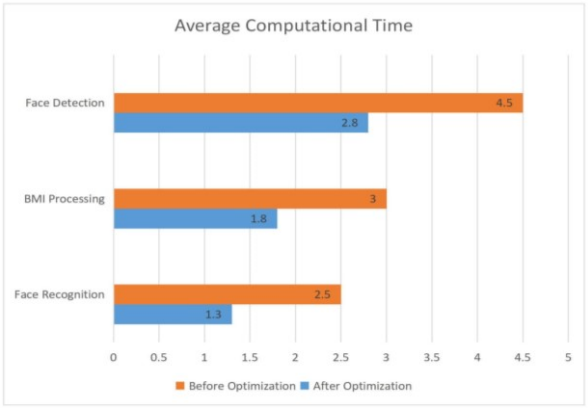

Fig. 7. Average computational time in each stage

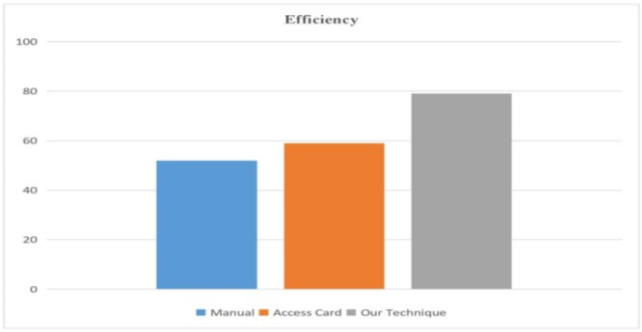

Fig. 8. Comparison with various methods

The comparison with various methods are shown in Fig. 8. Most of the disadvantages of the traditional solution to prevent tailgating/piggybacking violation has been eliminated by using image processing through our proposed tailgating/piggybacking detecting security algorithms.

V. Conclusion

From this research done, 'a tailgating/piggybacking detecting security system', capable of analysing various situations were successfully developed. The research utilizes four inexpensive cameras with an affordable low cost embedded based control unit combining with Matlab software. There are several benefits for implementing the detection system on embedded system. The affordability of embedded based control unit can lower down the cost for the whole security system. In addition, operating cost can also be reduced due to processor low power consumption. Besides that, in embedded system the probability of failure is very low. This will also ensure continuous operation of the security system with a minimum downtime. The developed system can achieve an accuracy of 90.7% with the three stage comparing algorithm, this system is even able to outperform the already existing algorithm such as motion templates. A few advantages like low cost and the ease of deployment of this system. This research is in its preliminary stage and in later stages it can be developed in a sophisticated system to effectively tackle tailgating/piggybacking security issue compared to various existing solutions available in the market. This system can also be integrated with existing video surveillance system in a target area to identify the intruders. The future scope of this research is to implement this system in pitch dark conditions by using infrared camera and sensors and to further improve the process to work under various posture conditions and real time scenarios.

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