ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645
Indian Journal of Science and Technology, *Vol 11(20), DOI: 10.17485/ijst/2018/v11i20/123347, May 2018*

Driver Face Recognition: Anti-Theft System

Kirbana Jai Raman, Afizan Azman*, Wong Kit Wen, Siti Zainab Ibrahim, Sumendra Yogarayan, Mohd Fikri Azli Abdullah, Siti Fatimah Abdul Razak, Anang Hudaya Muhamad Amin and Kalaiarasi Sonai Muthu

Department of Information Science and Technology, Multimedia University, Malacca, Malaysia; jpk_kirbz@hotmail.com, afizan.azman@mmu.edu.my, edmond.wkw91@outlook.com, sitizainab.ibrahim@mmu.edu.my, mastersumen@gmail.com, mfikriazli.abdullah@mmu.edu.my, fatimah.razak@mmu.edu.my, anang.amin@mmu.edu.my, kalaiarasi@mmu.edu.my

Abstract

At the present, vehicles security is now a concern for the owner because there is getting more and more vehicles being stolen or compromise by theft. Nowadays, security of the vehicles is not secure enough to withstand the compromise techniques that the theft have. In this project, a security method to implement in the driving environment, it is called the Driver Face Recognition-Anti Theft System. It involves face enrolment of the driver as the initial stage followed by facial recognition. This is a system is to assist current vehicles security to become better to prevent the vehicles being steal by the theft.

Keywords: Anti-theft, Face Enrolment, Face Recognition, Security

1. Introduction

Lately, technology has been growing rapidly and it will continue. However, there is some concern of the technology growth, which is security. The more advanced technology grows, the more difficult to secure the security concern. As time goes by, security is one of the biggest threats to technology. It is very common that everyone owns a vehicle nowadays. Car technology is getting more and more advanced such as speech recognition and other but it has not done anything on the security part. With the technology growth, we can see cases as car being stolen is occurring everywhere almost every day. Due to this, many people are installing an additional lock on their car to improve the security or to prevent car picking. Biometric is one of the authentication method that is secure and stable that is widely being used on vulnerable area. Biometric authentication methods inclusive of fingerprint, palm print, finger vein, voice, and face recognition. In driving environment, the user is going to use facial as the biometric authentication method because it is a type of authentication that need the less cooperation from the user.

*Author for correspondence

2. Literature Review

As technology advance, security is one of the major issue encounters by much different area. Increasing security is one of a must in world today. One of the common security authentication methods are biometric authentication method.

2.1 Face Recognition

Face Recognition for human is considered easy because we can easily differentiate between the faces. But what about computer program or system how can it differentiate the human faces. The computer differentiates human faces by using statistical measurement that can be analysis and extract from human geometric features. There are two type of facial extraction technique the Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA)[1].

2.1.1 Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is one of the techniques that created before the Second World War. However, the wider application of this method

only occurred in the 1960s, during the "Quantitative Revolution" in the Natural and Social Sciences. In pattern recognition is hard to perform in high-dimensional space it is basically the curse of dimensionality. The goal of principal component analysis is to reduce the dimensionality of the data while retaining as much as possible the variation that present the original dataset[2].

2.1.2 Linear Discriminant Analysis (LDA)

The key for facial recognition are features extraction. As for pattern classification task - the goal of features extraction is to reduces the dimensionality of face images so that features that been extracted is being represented as possible. There is a method call Principal Component Analysis (PCA) is one of the method used in Eigen faces recognition that reduce the dimensionality of the dataset. However, the physical similarity of the representing images is not giving the best measure of useful information to distinguish the faces from one another. This is the time when fisher faces method is proposed that are using Linear Discriminate Analysis (LDA)[3]. This method is insensitive on variation such as lighting direction and facial expression[4].

2.2 Eigenfaces

Eigenfaces is a method that is using principal component analysis (PCA) it first reduces the high-dimensionality of the dataset to covariance matrix where an image with *N* pixels is defined as point or vector in the *N*-dimensional space. This idea or principal components to represent human faces was used by Turk and Pentland[5] for face detection and recognition.

2.2.1 Eigenfaces Concept

Images are loaded into a computer to obtain matrix of different intensities. The images a converted into gray scale so that the operation is done on one layer of the image instead of three (3) layers of image in RGB format. A vector whose direction is unchanged when multiplied by the matrix is referred to as the eigenvector of that matrix. Eigenvector of the covariance matrix associated with a large set of faces are called eigenfaces. The eigenfaces can be thought of as a basis for the set of faces. Just as any vector space is composed of the linear combination of the basis vectors, each face in the set can be expressed as a linear combination of the eigenfaces[5].

Let $X = \{x_1, x_2, ..., x_n\}$ be a random vector with observations $x_i \in R^d$

1. Compute the mean μ

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i$$

2. Compute the the Covariance Matrix S

$$S = \frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)(x_i - \mu)^T$$

3. Compute the eigenvalues λ_i and eigenvectors ν_i of S

$$Sv_i = \lambda_i v_i, \; i = 1, 2, ..., n$$

4. Order the eigenvectors descending by their eigenvalue. The k principal components are the eigenvectors corresponding to the k largest eigenvalues.
The k principal components of the observed vector k are then given by:

$$y = W^T(x - \mu)$$

Where, $W = (\nu_1, \nu_2, ..., \nu_k)$
The reconstruction from the PCA basis is given by:

$$x = Wy + \mu$$

where $W = (\nu_1, \nu_2, ..., \nu_k)$
The Eigenfaces method then performs face recognition by:

- Projecting all training samples into the PCA subspace,
- Projecting the query image into the PCA subspace, and
- Finding the nearest neighbor between the projected training images and the projected query image.

2.3 Fisherfaces

Fisherfaces is enhanced versions of eigenfaces algorithm it have solve the problem of covariance matrix using linear discriminant analysis. This algorithm are powerful way to represent the data because it ensures the data that is extract from the image so call data variance is maintained while excluding the unnecessary existing correlations among the original features or dimensions in the sample vectors or data[6]. But when the objective is classification rather than representation, the Least-Squares (LS) solution may not be produces the most desirable results. In such cases, one desired to find a subspace that maps the

sample vectors of the same class in a single spot of the features representation and those of different classes as far apart from each other as possible. To achieve this objective there are a techniques call Discriminant Analysis (DA) algorithm. The most known DA is Linear Discrimination Analysis (LDA)[6].

Let X be a random vector with samples drawn from C classes:

$$X = \{x_1, x_2, ..., x_c\}$$

$$X_i = \{x_1, x_2, ..., x_n\}$$

The scatter matrices S_B and $S\_\{W\}$ are calculated as:

$$S_B = \sum_{i=1}^{c} N_i (\mu_i - \mu)(\mu_i - \mu)^T$$

$$S_W = \sum_{i=1}^{c} \sum_{x_j \in X_i} (x_j - \mu_i)(x_j - \mu_i)^T$$

where μ is the total mean:

$$\mu\iota = \frac{1}{N} \sum_{i=1}^{N} x_i$$

And μ_i is the mean of class $i \in \{1, ..., c\}$:

$$\mu_i = \frac{1}{|X_i|} \sum_{x_j \in X_i} x_j$$

Fisher's classic algorithm now looks for a projection W that maximizes the class reparability criterion:

$$W_{opt} = \arg \max_W \frac{|W^T S_B W|}{|W^T S_W W|}$$

Following, a solution for this optimization problem is given by solving the General Eigenvalue Problem:

$$S_B v_i = \lambda_i S_W v_i$$

$$S_w^{-1} S_B v_i = \lambda_i v_i$$

Table 1 show that the comparison of both of the algorithm. The table stated that the eigenfaces algorithm extract less detail for the facial feature this is the main advantages for the system because the objective of the system are detecting the faces and do face recognition process so it does not need to extract more detail facial features by using the fisherfaces algorithm. By extracting less detail of the facial features it will reduces the burden of the system storage.

Table 1. Comparison of algorithm

	Pros	Cons
Eigenfaces	Extract less detail facial features.	Hard to produces more detail features
Fisherfaces	Extract more detail facial features	More complicated features categorize

2.4 Methodology

In order to complete the project and make the system look clear and precise, there will have few design sketches out of the outline structure of the system to gain more understanding on the system. The outline structure of the system is divided into face enrollment and face recognition.

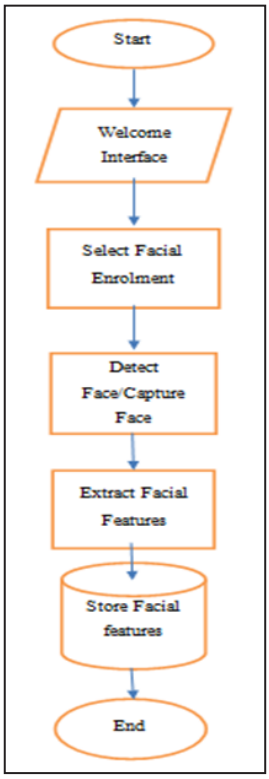

Figure 1. Face enrolment.

Figure 1 show that the facial enrolment flowchart. As the Figure shown the system will start with a welcome screen after than it will go into and option of facial enrolment after the user choose the facial enrolment the facial detection and facial capture will start, after the system capture the facial features it will start the process of facial extraction. After the facial extraction the data will store into the database and end the system.

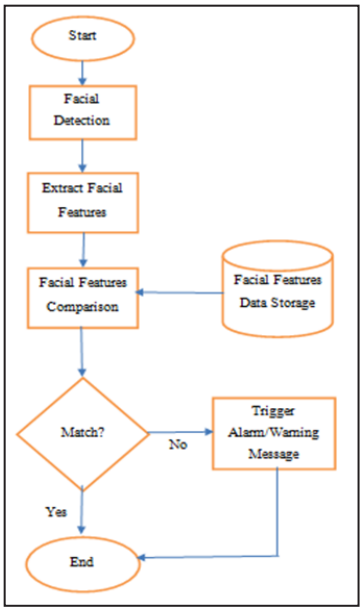

Figure 2. Face recognition.

Figure 2 facial recognition flow chart the flow chart is representing how the system of facial recognition flows. When the system start it will first detect the facial then extract the data then start the facial comparison and retrieve the original user facial features from the database to do comparison if it is match then do nothing else trigger alarm or send message to user.

2.5 Implementation

Figure 3. Main interface.

Figure 3 shown the graphical user interface for the main system that consists of 3 button, facial enrolment program, facial training and face recognition program. Figure 4 shown the GUI interfaces for face enrolment program. It is that shown the yellow rectangle has successfully display around the face, the snap average time has being successful display in the lower bottom left, and the save button is successful display on the mid bottom.

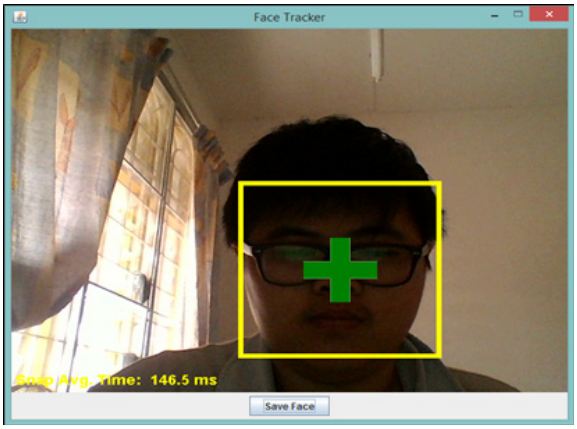

Figure 4. Face enrolment.

Figure 5 shows the column to fill in the name for the image. The image will be then stored in the folder as shown in Figure 6 and ready to be trained as shown in Figure 7.

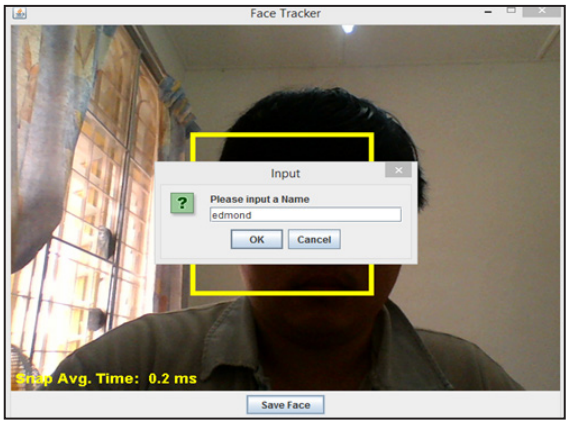

Figure 5. Face enrolment.

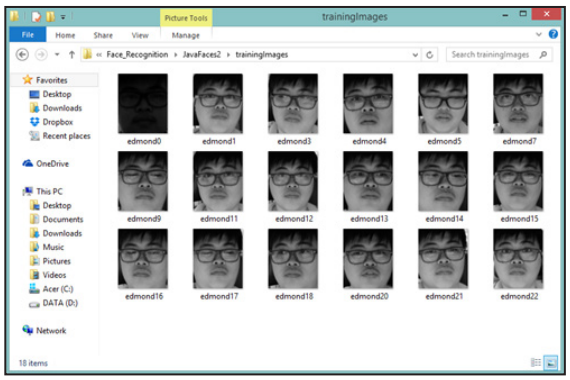

Figure 6. Saving image.

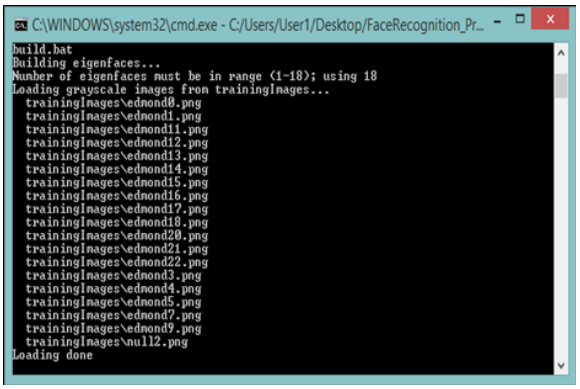

Figure 7. Training file.

Figure 8 shows the yellow rectangle and the average snapping time is successfully displayed on the left bottom of the screen, the owner name is successfully display on the right bottom of the screen, the button "Recognize Face" is successful displayed on the bottom left of the screen, and the name and distance is successfully display on the right bottom of the screen. It is also tested using untrained user face as shown in Figure 9 and it displays 'Unknown'.

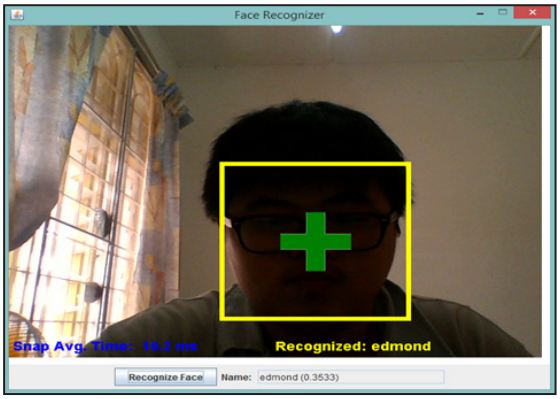

Figure 8. Successfully recognized.

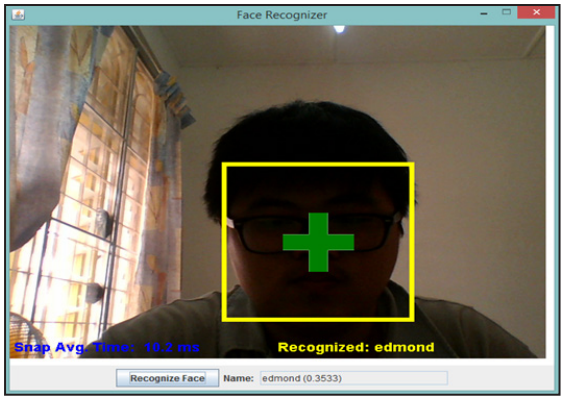

Figure 9. Unknown face recognized.

Figure 10. System tested in driving environment

3. Conclusion

This project is an essential toward a better security environment for car or vehicles. Few aspects that were strengthening in this project are the security features a normal car will have. Normal car will have alarm as and security features that will be trigger when the car is breach without a proper key. This system will enhance the security by add on a security method after the user went into the car or vehicles the system will detect the user face and compare it face features with the data storage to make sure it is the owner or authorized user of the car or vehicles if it does not match any of the authorize user in the data storage it will display unknown in the screen.

Advancement of technology is meant to ease people life but sometime it lack of security concern. This system is purposely to enhance the security environment of a car or vehicles with the use of the advance technology that having today. Using a right system to enhance the security mean by, letting the user to have less worried about their car or vehicles.

In the Driver face Recognition-Anti Theft system, there are limitation because most of the system will have the strong side but it will also have the weak side of the system. For the limitation for the system are commonly occurs in face recognition algorithms such as low lighting will cause the accuracy of the face recognition system drop sometime it may be even undetectable. The similarity of the faces will also affect the current system algorithms. Face similarity such as twins' faces. The accuracy for eigenfaces algorithm is not very high but in certain situation, it is still good. For the system hardware specification the smoother, the system wanted to run the higher the hardware specification needed. Spaces require for the data storage will be more because the more training images is store the more accurate the system will be.

4. Acknowledgement

This research work was ostensibly supported and carried out within the framework of a project entitled "Connected car services - Automatic facial recognition for driver satisfaction detection and for vehicle data analytics" funded by TM R&D between Multi-Media University (MMU), Melaka, Malaysia and Proton, Malaysia.

5. References

1. Open CV. Retrieved from: http://docs.opencv.org/modules/core/doc/operations_on_arrays.html.
2. Steven M. Holland. Principal Components Analysis (PCA), Principal Components Analysis. 2014; 1(1):1-10. Retrieved from: http://strata.uga.edu/software/pdf/pcaTutorial.pdf.
3. LDA. 2014. Retrieved from: http://www.saedsayad.com/lda.html.
4. Raschka S. Linear Discriminant Analysis bit by bit. 2014. Retrieved from: http://sebastianraschka.com/Articles/2014_python_lda.html.
5. Turk Matthew, Pentland Alex. Eigenfaces for Recognition, Journal of Cognitive Neuroscience. 2014; 3(1):71-86. Retrieved from: http://www.face-rec.org/algorithms/PCA/jcn.pdf.
6. Martinez Aleix. Fisherfaces, Scholarpedia. 2011; 6(2):4282. Retrieved from: http://www.scholarpedia.org/article/Fisherfaces.