INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN: 2278 – 0211 (Online)

Car Theft Detection And Prevention System

Mr. Vishal P. Patil
Department of Electronics and Telecommunication Engineering,
S. S. G. M. College of Engineering, Shegaon, India

Prof. Dr. K.B. Khanchandani
Head of Department of Electronics and Telecommunication Engineering,
S. S. G. M. College of Engineering, Shegaon, India

Abstract:

In this paper, we present an immobilizer automotive security system using face detection and recognition. The Principal Component Analysis (PCA) algorithm is used to recognize a specific face, and to find and compare the principal components of the current face to those of the known users in a database built in advance. The system automatically takes photos of driver and compares his or her face with database to check whether he is an authenticated driver or not. He can have access to the car only if he is an authenticated driver. If he is not an authenticated driver access to the car will not be provided. Also, the owner of the car gets an image of the theft via MMS (Multimedia Messaging Service), send by GSM modem which is an additional feature of the given system. It hence deters thieves from committing the theft.

Key words: *Face Recognition, PCA, GSM, MMS*

1.Introduction

Car theft has been a persisting problem around the world and greater challenge comes from professional thieves. Currently, automobile manufacturers use computer chips and other common security methods to ensure that even complete copy of the original car mechanical keys, can only open the door, but cannot start the car. However, there is variety of vehicles decoder on the market, and the thieves can use the decoder to replicate the electronic chip keys, which can start the car, in just a few minutes. Such as the decoder, which used the latest intelligence decoder chip developed by the United States, can unlock the most electronic locks of Mercedes Benz, BMW, Audi, Ferrari and other high-end models. Thus, modern security can be deceived by professional thieves therefore a need of biometric authentication technology arises in automotive vehicles.

There are different biometric technologies which are unique and invariant for a very long time, such as fingerprint, iris, palm print, palm vein, hand vein, finger vein, face, knuckle creases, hand-type and so on, which all can be used as the basis of authentication and the various biological characteristic have their own advantages and disadvantages. Compared to other biometric techniques advantages of face recognition includes

- It doesn't require physical interaction.
- It allows passive identification.
- It doesn't require expert to interpret the comparison.

Hence, we have chosen Face Recognition as a biometric technology for security purpose.

2.System Overview

A webcam is placed in front of the driver seat. When the driver inserts key into the lock, signal is generated by the Electronic Lock System. This signal starts the image processing application on PC. After a fixed time interval, the web camera will take the photo and that photo gets processed in the application. Finally, the application will detect whether the driver is authorized or not. If he is not authorized, access to vehicle is disabled by disconnecting the battery connections and ignition unit. Also, the GSM modem will send the snap of theft to the owner's registered mobile.

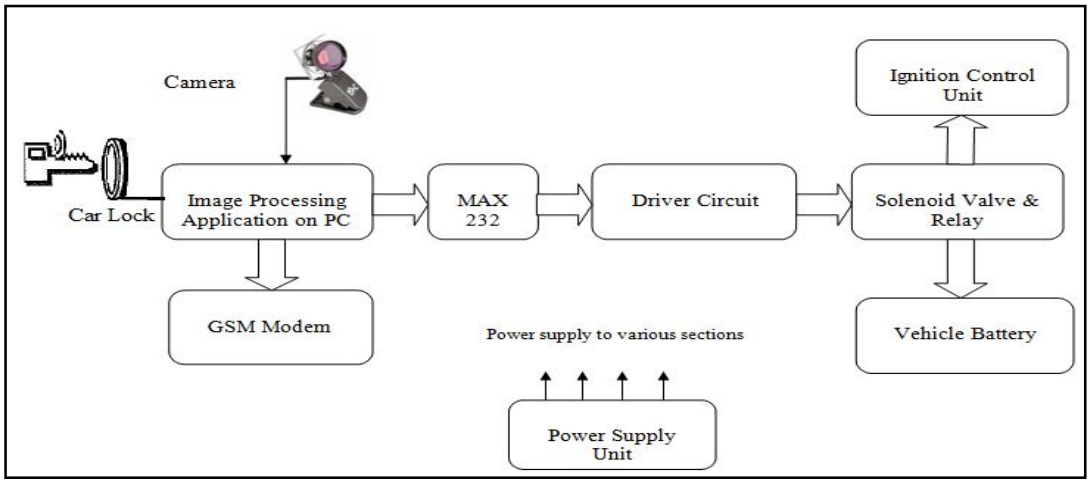

Figure1: Block Diagram of Automotive Security System

3. Implementation

3.1.Face Detection Subsystem

3.1.1.Image Acquisition Subsystem

Image understanding starts with image acquisition. The purpose of image acquisition is to acquire the video images of the driver face in real time. A camera installed in the car, which capture image and sent it to face detection and face recognition stage. The acquired images should have relatively consistent photometric property under different climatic ambient conditions and should produce distinguishable features that can facilitate the subsequent image processing. In real vehicles moving, a moving car presents new challenges like variable lightening, changing background and vibrations that must be haven in mind in real systems. The image data is transmitted to the Face Detection System by USB channel.

3.1.2.Face Detection

The process of face detection used for the system presented in this paper is robust and rapid. Face detection algorithm extracts face portion alone from the photo taken by a webcam. At first, we get the location of the eye pair easily due to brighter pupil effect. After the location of eye pair, we can easily clip the face area from the input image according the spatial relationships between eye pair and face.

3.1.3.Face Recognition

In face recognition, validation of the input image is done .i.e. it involves comparing the input face with the faces in the database. Photos in the database is called training images and the photo taken during authentication phase is called as test image.

Human face recognition belongs to a general classification problem with the characteristics limited spanning space. A lot of different approaches were present in the last years in the field of face recognition methods development in recent years. The state of the art techniques are appearance based methods which includes also a lot of different approaches for face recognition. These methods cover Hidden Markov Models (HMM), Neural Networks (NN), Support Vector Machines (SVM), and Principal Component Analysis (PCA). We give a comparison over the above methods in the table1.

Sr. No.	Technique	Accuracy
1.	HMM	≈ 84.00%
2.	PCA	≈ 98.50%
3.	Neural Networks	≈ 95.60%

Table 1: Comparison of different Face Recognition approaches. [6][7]

We can conclude from it that the PCA Eigen faces algorithm can get a high accuracy. Again it costs less time than the other two algorithms that is very important in real time embedded applications. In our embedded automotive security system, the PCA Eigen faces algorithm is used for driver's real time face recognition.

3.2.GSM Modem

The GSM modem can accept any GSM network SIM card and act just like the mobile phone with its own unique number. The modem is connected to the PC serial port directly. It can be used to send and receive SMS (Short Message Service) or make /receive voice calls.

The WAVECOM's Fastrack M1306B GSM modem is used in this system. This modem is used in the GPRS mode to send images of the driver. So the owner and the police can be informed at the first time.

4. Principal Component Analysis (PCA)

4.1.Algorithm

PCA algorithm is based on an information theory approach that decomposes face images into a small set of characteristic feature images called "Eigen faces," which may be thought of as the principal components of the images in database. Recognition is performed by projecting a new image into the subspace spanned by the Eigen faces ("face space") and then classifying the face by comparing its position in face space with the position in face space with the positions of known individuals.

Each individual face can be represented exactly in terms of a linear combination of the Eigen faces. Each face can also be approximated using only the "best" Eigen faces—those that have largest Eigen values, and which therefore account for the most variance within the set of face images. The best M Eigen faces span an M-dimensional subspace—"Face space"—of all possible images.

4.2.Flowchart

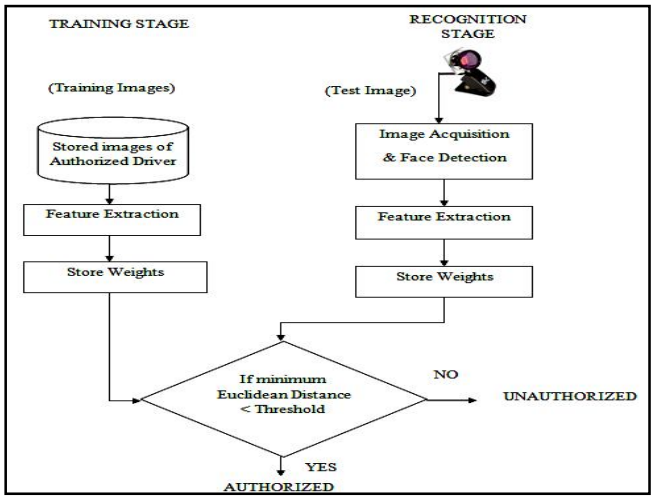

Figure2: Flowchart of PCA Algorithm

4.3.Steps for PCA Algorithm

1. Acquire an initial set of face images (the training set).

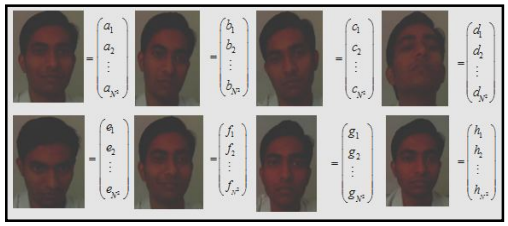

Figure3: Database images

2. Compute the average face.

$$\vec{m} = \frac{1}{M}\begin{pmatrix} a_1 + b_1 + \cdots + h_1 \\ a_2 + b_2 + \cdots + h_2 \\ \vdots \quad \vdots \quad \vdots \\ a_{N^2} + b_{N^2} + \cdots + h_{N^2} \end{pmatrix}, \quad Here, M = 8 \qquad (1)$$

Where, M = Number of images in the database.

N = Size of image.

3. Subtract the average face from training faces.

$$\vec{a}_m = \begin{pmatrix} a_1 - m_1 \\ a_2 - m_2 \\ \vdots \quad \vdots \\ a_{N^2} - m_{N^2} \end{pmatrix}, \quad \vec{b}_m = \begin{pmatrix} b_1 - m_1 \\ b_2 - m_2 \\ \vdots \quad \vdots \\ b_{N^2} - m_{N^2} \end{pmatrix}, \quad \vec{c}_m = \begin{pmatrix} c_1 - m_1 \\ c_2 - m_2 \\ \vdots \quad \vdots \\ c_{N^2} - m_{N^2} \end{pmatrix}, \quad \vec{d}_m = \begin{pmatrix} d_1 - m_1 \\ d_2 - m_2 \\ \vdots \quad \vdots \\ d_{N^2} - m_{N^2} \end{pmatrix},$$

$$\vec{e}_m = \begin{pmatrix} e_1 - m_1 \\ e_2 - m_2 \\ \vdots \quad \vdots \\ e_{N^2} - m_{N^2} \end{pmatrix}, \quad \vec{f}_m = \begin{pmatrix} f_1 - m_1 \\ f_2 - m_2 \\ \vdots \quad \vdots \\ f_{N^2} - m_{N^2} \end{pmatrix}, \quad \vec{g}_m = \begin{pmatrix} g_1 - m_1 \\ g_2 - m_2 \\ \vdots \quad \vdots \\ g_{N^2} - m_{N^2} \end{pmatrix}, \quad \vec{h}_m = \begin{pmatrix} h_1 - m_1 \\ h_2 - m_2 \\ \vdots \quad \vdots \\ h_{N^2} - m_{N^2} \end{pmatrix}, \qquad (2)$$

4. Construct the matrix,

$$A = \left[\vec{a}_m \; \vec{b}_m \; \vec{c}_m \; \vec{d}_m \; \vec{e}_m \; \vec{f}_m \; \vec{g}_m \; \vec{h}_m \right] \qquad (3)$$

Size of matrix A is N^2 x M.

5. Find the Co-variance matrix.

$$Cov = AA^{\mathrm{T}} \qquad (4)$$

Size of Co-variance matrix is N^2 x N^2.

6. Find the Eigen values of the co-variance matrix.

But, its size is large and hence, the computational efforts will be large.

7. Compute another matrix L,

$$L = A^{\mathrm{T}}A \qquad (5)$$

Size of matrix L is M x M.

8. Find the Eigenvectors of matrix L and build matrix V.
9. These vectors determine the linear combinations of the M training set face images to form the M Eigen faces.

$$U = AV \qquad (6)$$

10. For each face, compute its projection onto the face space.

$$\Omega_1 = U^{\mathrm{T}}\left(\vec{a}_m\right), \quad \Omega_2 = U^{\mathrm{T}}\left(\vec{b}_m\right), \quad \Omega_3 = U^{\mathrm{T}}\left(\vec{c}_m\right), \quad \Omega_4 = U^{\mathrm{T}}\left(\vec{d}_m\right),$$
$$\Omega_5 = U^{\mathrm{T}}\left(\vec{e}_m\right), \quad \Omega_6 = U^{\mathrm{T}}\left(\vec{f}_m\right), \quad \Omega_7 = U^{\mathrm{T}}\left(\vec{g}_m\right), \quad \Omega_8 = U^{\mathrm{T}}\left(\vec{h}_m\right) \qquad (7)$$

11. Compute the threshold θ.

$$\theta = \frac{1}{2}\max\left\{\left\|\Omega_i - \Omega_j\right\|\right\} \quad for\ i, j = 1..M \tag{8}$$

12. Take the test image.

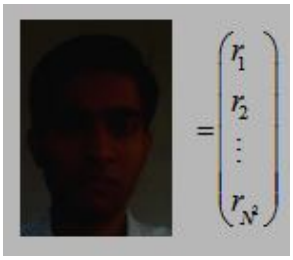

Figure 4: Test Image

13. Subtract the average face from it.

$$\vec{r}_m = \begin{pmatrix} r_1 - m_1 \\ r_2 - m_2 \\ \vdots \quad \vdots \\ r_{N^2} - m_{N^2} \end{pmatrix} \tag{9}$$

14. Compute its projection onto the face space U.

$$\Omega = U^{\mathrm{T}}\left(\vec{r}_m\right) \tag{10}$$

15. Compute the distance in face space between the input face and all the known faces.

$$\varepsilon_i^2 = \left\|\Omega - \Omega_i\right\|^2 \quad for\ i = 1..M \tag{11}$$

16. Reconstruct the input face from the Eigen faces.

$$\vec{s} = U\Omega \tag{12}$$

17. Compute the distance in face space its reconstruction

$$\xi^2 = \left\|\vec{r}_m - \vec{s}\right\|^2 \tag{13}$$

18. The following conditions are checked and the results are derived from it.

Sr. No	Conditions	Results
1.	If, $\xi \geq \theta$	Not a face.
2.	If, $\xi < \theta$ *and* $\min\{\varepsilon_i\} < \theta, (i = 1..M)$	Known face.
3.	If, $\xi < \theta$ *and* $\varepsilon_i \geq \theta, (i = 1..M)$	New face.

Table2: Classification of image

5. Experimental Results

In this project, the real time face recognition is achieved using PCA algorithm.

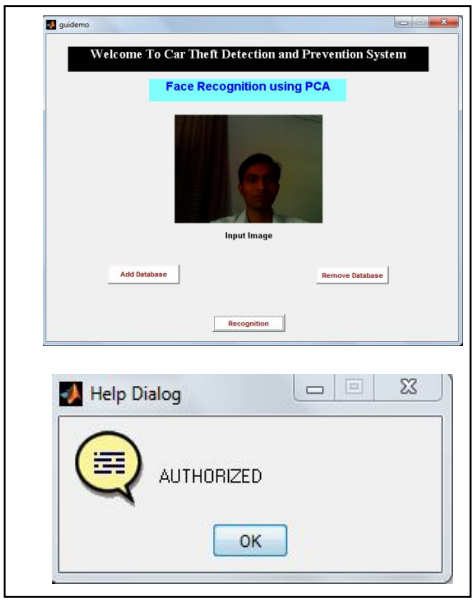

Figure5: Recognition of Authorized Image

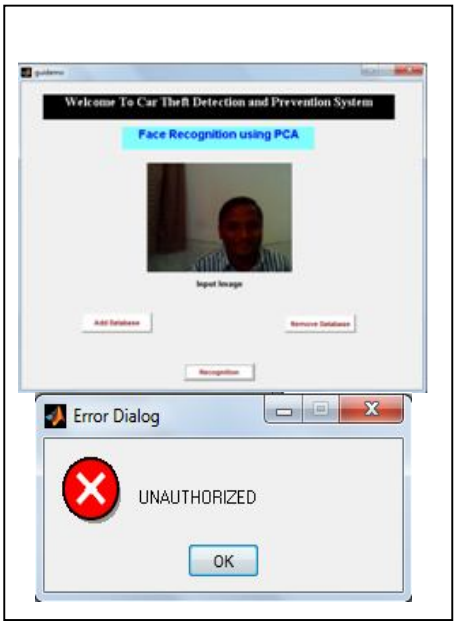

Figure 6: Recognition of Unauthorized Image

Figure5 shows the experimental result of MATLAB 7.10.0®, when the input image belongs to the database images. Figure6 shows the experimental result when the theft tries to start the vehicle.

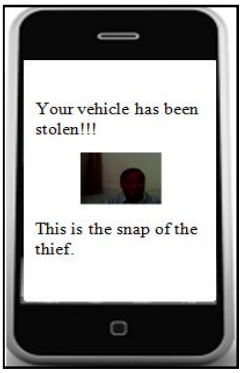

Figure7: MMS Structure

The figure7 shows the MMS structure which has been send to the owner's mobile from the vehicle.

6. Conclusion

An image processing based car security system is presented in this paper. Face recognition is a both challenging and important recognition technique. It has been shown that a proposed system can be implemented at any types of automobiles and can be used at any place where face recognition is needed. This system reduces increased amount of vehicle theft present today.

7.Acknowledgment

I express my thanks to Prof. Dr. K.B. Khanchandani for his esteemed guidance and continuous encouragement, especially through difficult times. His suggestions broaden my vision and guided me to succeed in this work. I am also very grateful for his guidance and constructive comments while designing the project and learnt many things under his leadership.

8.Reference

1. Kerstin Lemke, Christof Paar, Marko Wolf. (2006). Embedded Security in Cars. New York: Springer.
2. Matthew Truk and Alex Pentaland. Eigen faces for Recognition. Journal of Cognitive Neuroscience, 3, Number 1, 1991.
3. Xiaozheng Zhang, Yongsheng Gao. Face recognition across pose: A review. Pattern Recognition,42, ELSEVIER, 2009.
4. Fleming, M, & Cottrell, G. Categorization of faces using feature extraction. Proceedings of IJCNN, 90,2, 1990.
5. Xiaofei Zhou, Yong Shi, Peng Zhang, Guangli Nie, Wenhan Jiang. A New Classification Method for PCA based Face Recognition. International Conference on Business Intelligence and Financial Engineering,2009.
6. T-H. Sun, M. Chen, S. Lo, and F.-C. Tien. Face Recognition using 2D and disparity Eigen faces. Expert System Application,33, 2, 2007.
7. Kohir, V.V; Desai, U.B. Face Recognition using a DCT-HMM approach. WAC'98, Oct. 1998.
8. [7] Oravec, M, Pavlovicova, J. Face recognition methods based on Principal Component Analysis and feed forward neural networks. Neural Networks, July 2004.