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Real Time Vehicle Security System through Face Recognition

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Abstract

In this modern age there is rapid increase in number of vehicles and so is the number of car theft attempts, locally and internationally. With the invention of strong stealing techniques, owners are in fear of having their vehicles being stolen from common parking lot or from outside their home. Thus the protection of vehicles from theft becomes important due to insecure environment. Real time vehicle security system based on computer vision provides a solution to this problem. The proposed vehicle security system performs image processing based real time user authentication using face detection and recognition techniques and microprocessor based control system fixed on board with the vehicle. As the person enters the parked car overcoming the existing security features, the infrared sensor attached to the driver's seat of the vehicle activates the hidden camera fixed in appropriate position inside the vehicle. As soon as the image is acquired from the activated camera, face of the person is detected using Viola Jones algorithm. The extracted face is recognized using the enhanced Linear Discriminant Analysis (LDA) algorithm which discriminates much of the features rather than looking for exact pattern based on Euclidean distance and also reliable to be used with large samples of data. Performing authorization involves setting the threshold value and comparing with that of Euclidean distance above which the person is not authenticated. The face of the person which is classified as unknown is sent to the mobile of the owner as a MMS through the operating GSM modem. The owner upon receiving the information commands the system and the fuel is regulated using the relay in accordance with the command of the owner. This would be

effective to authenticate the person under different environment and to have an efficient way of vehicle security.

Keywords: Vehicle security, Face detection, Face recognition, Multimedia Messaging Service (MMS), Authorization.

1. Introduction

The use of vehicle becomes important everywhere in the world and also preventing it from theft is required. Vehicle manufacturers are attaining the security features of their products by introducing advanced automated technologies to avoid the thefts particularly in case of cars. Biometric and non-biometric methods usually provide such security features. Sometimes these systems fail due to hacked password and encryption of decrypted data, but it is almost impossible to make replica of distinctive characteristics. Biometric systems are modern and use techniques like fingerprint recognition, iris recognition and face recognition. Of these face recognition and detection systems are more sophisticated, easy to deploy and people can be identified without their knowledge. Some advantages of facial recognition method for vehicle security application are:-

1. More convenient, sensed as soon as one is seated in position.
2. Low cost and a better approach to be used with existing methods.
3. Requires no active part of the user.

In vehicle security system, the objective is to prevent the theft of vehicle and ensure safety of vehicle by avoiding the means of theft. One level of ensuring authentication of driving is through face recognition system that authenticates a user being an authorized person to have access to the ignition system. The microprocessor based control system fixed inside the vehicle uses GPS receiver, GSM modem and captures image from the camera on detection of person in the parked vehicle. Face is detected and recognized using algorithm overcoming the pose and illumination constraints. The recognized image is compared with the authorized image of users in the database. If matched, the system allows operating the vehicle. If not matched, it sends MMS of face and GPS values to the owner. Shihab A Hameed et al, (2011) in their work focused on the MMS and database technology with good response time. This helps the owner in making decision about the control of vehicle. The owner decides and commands the system to prevent the access of the vehicle or to allow the person to operate the vehicle.

2. Computer Vision Based Security System

In recent years, computer vision has played a significant role in biometric identification and user recognition. Biometric identification based security systems are considered to be the most secure especially due to their ability to identify people with minimal ambiguity. It uses a face detection and recognition system that identifies and

verifies a person automatically by extracting unique features of face from an image or video captured by the camera. Implementation of biometric authorization emerged successful when employed in the vehicles as machine vision technology provides a new level of theft detection and extra security by monitoring the presence of intruders inside the vehicle.

3. Methodology

The real time extendable emergency system with microcomputer comprises image processing control unit and microprocessor to prevent the parked vehicle from theft. Face detection and recognition system use enhanced algorithm for authentication. The entire security system comprising each component is shown in Fig. 1. Bagavathy et al, (2011) realized the importance of using ARM processor in real time applications. Hence ARM 7 microprocessor is used as the control unit in the system. The passive infrared sensor attached to the seat of the driver activates the hidden camera fixed inside the vehicle through the ARM 7 microprocessor control of the microcomputer once the intruder enters the car. The camera acquires the image of the person inside the car fixed in an appropriate position in front of the driver seat. Once the image of the person is acquired, the system now tries to detect the face.

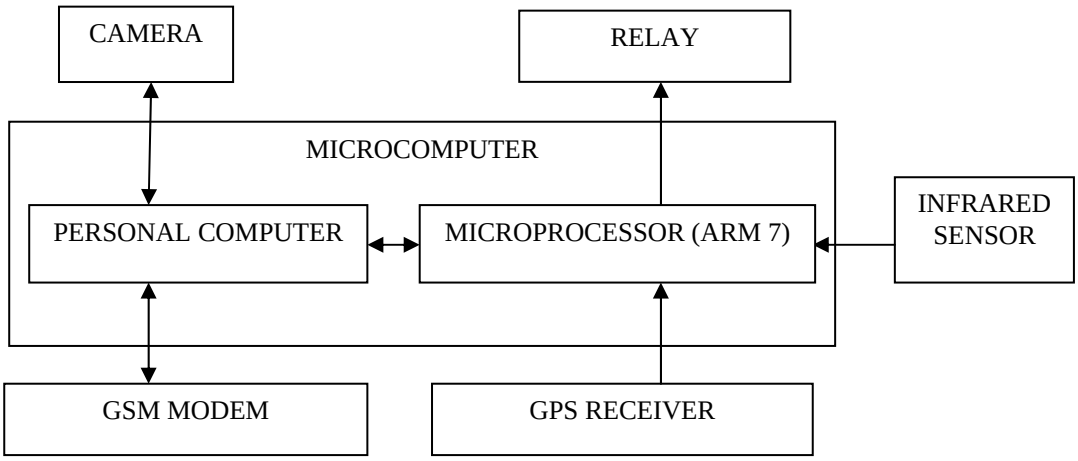

Fig. 1: Block Diagram of Security System.

3.1 Image Processing

The microcomputer which contains the image processing unit embedded within it performs the face detection and authorizes the person. The processing of image involves two parts, face detection and face recognition.

3.1.1 Face Detection

The acquired image is processed to detect the face using the Viola Jones algorithm (Viola and Jones, 2002) which effectively uses the cascade object detection. The

cascade detector detects the face of the acquired image and the face region is extracted. The authentication based security system has the database which stores the face images of the authorized persons under different environments. The face images are enhanced by normalizing them to remove the unwanted information due to illumination constraints while acquiring the image and are stored in the database. Now the task of face recognition must be performed with the detected faces.

3.1.2 Face Recognition

Face recognition can be performed with various algorithms which are feature based or model based. Mostly feature based algorithms are used in the security systems involved in real time. Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) algorithms are efficient in terms of extracting the features to perform recognition. Both algorithms are compared (S K Hese and M R Banwaskar, 2013) and they found to have similar features but Linear Discriminant Analysis (LDA) outperforms Principal Component Analysis (PCA) algorithm when large training sets are involved in recognition. Also, LDA discriminates most of the information present in the image efficiently by computing the intra class and inter class scatter matrices. Using the database which contains normalized face images, the recognition is performed in the vehicle security system through the LDA algorithm. LDA performs the feature extraction of the stored images in the database which are called the training images and the camera acquired face image which is called the test image. The test image is to be compared with the database images and the classifier used in the algorithm decides the image as known or unknown using the Euclidean distance and the threshold value.

The Euclidean distance is calculated between the corresponding weights of features and the image which produces minimum distance is best matched with the test image. The person is classified as known or authorized when the Euclidean distance is smaller than the threshold value and the person is classified as unknown or unauthorized when the distance value exceeds the threshold. The steps performed in the image processing algorithm and authorization is shown in the Fig. 2.

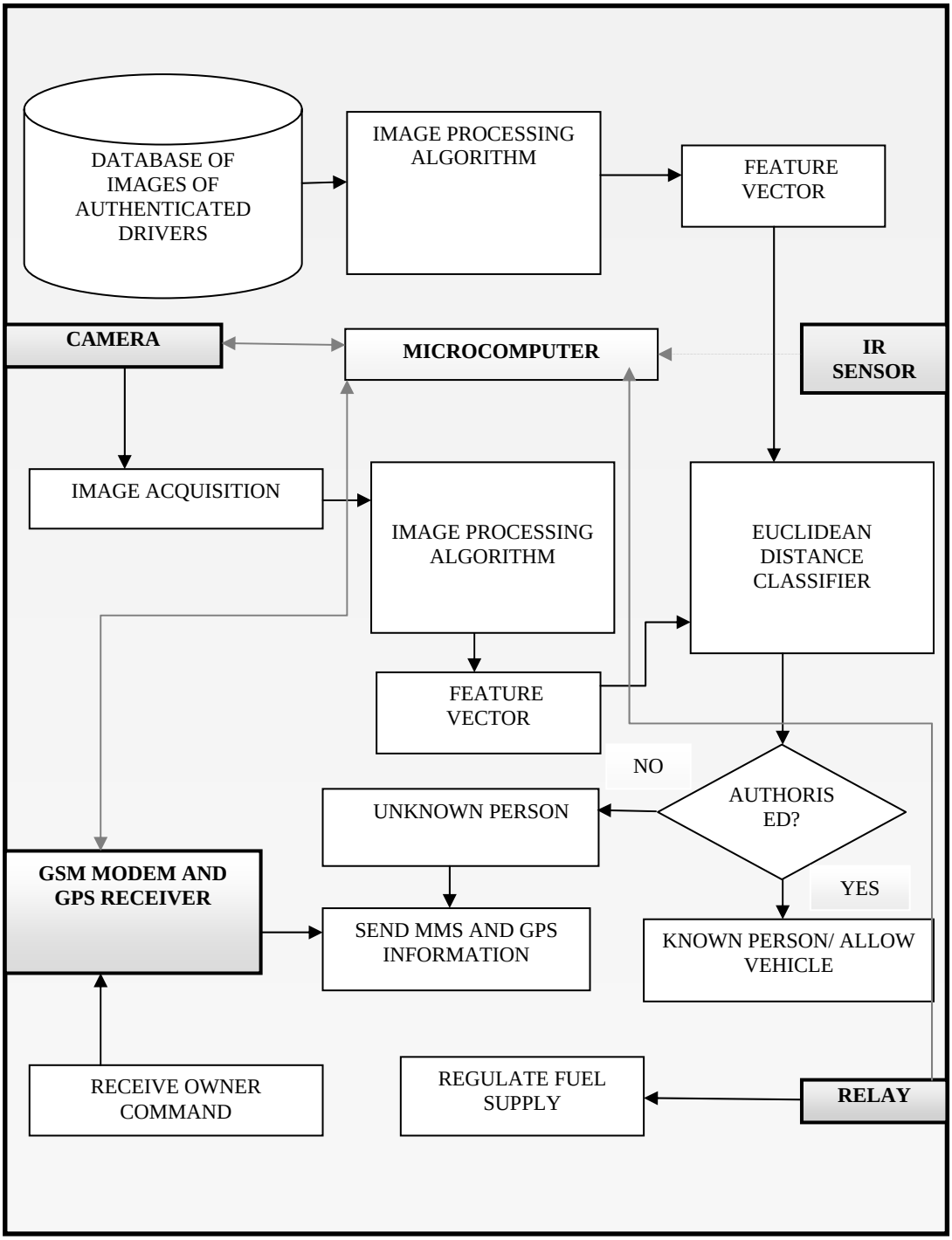

Fig. 2: Image Processing based Authorization.

3.2 Vehicle Control

When the image processing unit classifies the person as unknown, the unauthenticated face image is sent to the owner mobile through Multimedia Messaging Service (MMS) using GSM modem. Also the system updates the GPS information about the location of vehicle to the owner mobile. The owner based on the received information commands the control unit of the system. If the owner commands to stop the vehicle operation, the relay which is in connection with the engine control unit blocks the ignition unit and stops the vehicle in movement. If the owner wants the person to be authorized, he is allowed to operate the vehicle. This provides a level of security in the vehicle which is critical in the modern world of improved techniques of theft.

4. Results

The security system based on computer vision is realized with the microcomputer using MATLAB in the personal computer and ARM 7 microprocessor as the controlling unit. The database is maintained with 5 authorized users under different environments as shown in Fig. 3 and the image is acquired for face detection. The face is detected using the cascade detector in the acquired image and is shown in Fig. 4.

Fig. 3: Database images of Authorized persons.

Fig. 4: Face detected image

4(a). Test Image

4(b). Recognized image

4(c). Authorized

The extracted face from face detection which is the test image is shown in Fig. 4(a) and the Linear Discriminant Analysis (LDA) algorithm is used for face recognition. The authorization involving the recognized image from the database is shown in Fig. 4(b). Hence the test image is authenticated and is classified as known person as shown in Fig. 4(c). The results prove that the computer vision based algorithm is reliable for incorporating in the vehicle security system to recognize faces under different conditions to prevent the theft of the vehicle.

5. Conclusion

In this paper, an embedded automotive security system involving face recognition is presented. The system can be used to reduce the increased vehicle theft and allows the owner to identify the intruder thereby having the vehicle under his/her control. The results obtained through the face recognition shows that it can be relied upon to ensure safety of vehicle. The system is also reliable to be used in other authorization applications involving robotics, border management, banking security involving ATMs etc.

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