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Design and Implementation of Automotive Security System by ARM Processor using Gabor Wavelet Filter

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Abstract

Automotive theft has been persisting problem around the world and greater challenge comes from professional thieves. Modern security can be deceived by professional thieves therefore a need of biometric authentication technology arises in automotive vehicles. Traditional automotive security systems rely on many sensors and cost a lot. When one vehicle is really lost, no more feedback could be valid to help people to find it back. In this paper, we present an immobilizer automotive security system that disables an automobile when lost. 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 vehicle only if he is an authenticated driver access to the vehicle will not be provided. Also the owner of the vehicle gets an image of the theft via E-mail which is an additional feature of the given system. It hence deters thieves from committing the theft.

Keywords: Face recognition, Average Gabor-Wavelet Filter ,ARM,GPS,GSM,MMS

1. INTRODUCTION

With the development of automobile industry, motor vehicle theft has increasingly become prominent issues. According to National Insurance Crime Bureau (NCIB), National wide in 2010,there were an estimated 1.2 million motor vehicle thefts, or approximately 416.7 motor vehicles stolen for every 100,000 inhabitants. Property losses due to motor vehicle theft in 2010 were estimated $ 7.6 billion [1].

Currently, automobile manufactures use computer chips and other common security methods to ensure that even complete copy of the original vehicle mechanical keys, can only open the door, but cannot start the vehicle. However, there is a variety of vehicles decoder on the market, and the thieves can use the decoder to replicate the electronic chip keys, which can start the vehicle, 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 high-end models. Thus, it will be the sticking point of vehicle alarm to lock or unlock engine through authenticating the identity legality.

There are different biometric technologies which are unique and invariant for a very long time , such as fingerprint, iris, palm print vein, hand vein, finger vein, 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

1) It doesn't require physical interaction.
2) It allows passive identification.
3) It doesn't require expert to interpret the comparison.

Thus, we have chosen face recognition as a biometric technology for security purpose.

2. SYSTEM OVERVIEW

The hardware implementation of automotive security system was done by making use of ARM 7.The block diagram for the hardware is shown in figure1.

A webcam will be placed in front of the driver seat. when the driver inserts key into the lock, the ARM 7 generates an interrupt signal which starts the image processing application on PC. After a fixed time interval, the web camera will take the photo and that photo will get processed in the application. Finally, the application will detect whether the driver is authorized or not. If he is not authorized, the ARM 7 will disable the access to vehicle by disconnecting the battery connections and ignition unit. The GPS module finds the exact location of the vehicle. Also, the MMS modem will send the snap of theft and the location co-ordinates to the owner's registered mobile.

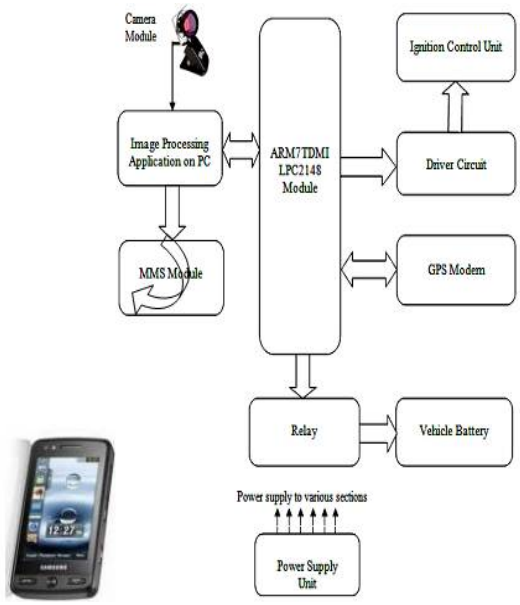

Fig 1: Block Diagram of Automotive Security System

3. IMPLEMENTATION

3.1.Face Detection Subsystem

The Face Detection Subsystem (FDS) involves,

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 vehicle, 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, a moving vehicle 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.

3.1.1.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 to the spatial relationships between eye pair and face.

3.1.2.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 a 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 detection methods development in recent years. These methods include Support vector Machines (SVM), Neural Networks (NN) , Principal Component Analysis (PCA) and Average Gabor-Wavelet Filter. We give a comparison over the above methods in the Table 1

Table1. Comparison of different Face Recognition approaches [5][6].

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

We can conclude from it that the Average Gabor –Wavelet Filter can give a high accuracy and speed that is important in real time embedded applications. Average Gabor-Wavelet Filter is a excellent technique for facial expression recognition.

3.2.MMS Module

An MMS message can contain any combination of graphics, photographic imagery and audio. MMS makes it possible for mobile users to send these multimedia messages from MMS-enabled handsets or modems to other mobile users and to e-mail users. It also makes it possible for mobile users to receive multimedia messages from other mobile users, e-mail users and from multimedia enabled applications. The WAVECOM's Fastrack M1306B MMS Module 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.

3.3.Embedded Module

The embedded module is the heart of this system. All the process is controlled by the embedded control central module ARM 9; include initiating the Face Detection System, achieving GPS information sending E-mail and communicating with Engine Control Unit (ECU).

The advanced RISC machines(ARM) LPC 2148 is used in this system.It is a general purpose 32 bit microcontroller which offers high performance for very low power and consumption and cost.This has made them dominant in the mobile and electronics market as relatively low cost and small size.

3.4.GPS Module

The Global Positioning System (GPS) modem is the receiver that collects data from the satellites and computes its location anywhere in the world based on information it gets from the satellites. It provides reliable positioning, navigation and timing services to worldwide users on a continuous basis in all weather, day and night. We have chosen MT3318 GPS Module to offer the location of the

vehicle in time. It has UART (Universal Asynchronous Receiver/Transmitter), which is used to communicate with many other embedded devices.

3.5.ENGINE Control Unit

An Engine Control Unit (ECU) is a type of electronic control unit that controls a series of actuators on an internal combustion engine to ensure the optimum running. The embedded module ARM 7 is responsible for switching ON/OFF the ECU.

4. Average Gabor- Wavelet Filter

Facial expressions have been studied by cognitive psychologists, social psychologist , neurophysiologists, cognitive scientist and computer scientists [1]. Facial expression recognition also follows the research framework of the traditional pattern recognition, which is composed of three main aspects : facial expression acquisition, feature extraction, and expression classification. Among them, feature extraction is the most critical, which can transform the original space as a smaller dimension space, translate the lattice into images expression in the higher level and finish data mapping [2]. Feature selection (FS) is a global optimization problem in machine learning, which reduces the number of features, removes irrelevant, noisy and redundant data, and results in acceptable recognition accuracy [3]. To detect the facial feature there are three different types of approaches which help in the analysis process [4]: Geometric or Local feature –based approach, Non-Geometric or Appearance or holistic feature based approach and Hybrid approach. In hybrid approach, different feature analysis methods such as Geometric, Non-Geometric are combined and may thus give better recognition results than the individual methods [5].

5. RELATED WORK

Gabor Filter Feature Extraction Technique

Gabor filters can be applied to images to extract features aligned at particular angles. The most considerable parameters of a Gabor filter are angle or frequency can be chosen and used to individualize between different facial emotions depicted in images.

Proposed algorithms is implemented in MaTLaB and JAFEE dataset are used for experiment with ratio 70/30 of training/testing with adaboost classifiers for seven different facial expressions: Anger, Disgust, fear, happy, natural, sad, surprise. A Gabor filter can be represented by the following equation [6].

(x,y), the pixel position in the spatial domain.

λ, Wavelength or a Reciprocal of frequency of pixels.

θ, Orientation of a gabor filter.

S_x S_y, Standard deviation of the x & y directions.

The parameters x' and y' are given as equation

$X'=x\cos\theta + y\sin\theta \quad y'=-x\cos\theta + y\sin\theta$ (2)

The amplitude and phases of Gabor filter bank both contribute valuable cues about specific pattern present in images. The amplitude consists of directional frequency spectrum information and a phase contains information about the location of edges and image details. The feature extraction method converts the pixel and data into a higher-level representation of structure, movement, intensity, characteristic of surface, and spatial configuration of the face or its components. The Gabor features are computed by convolution of input image with Gabor filter bank. I(x,y) is a gray-scale face image of size M*N pixels. The feature extraction method can then be defined as a filtering operation of the given face image I(x, y) with the Gabor filter u, v(x, y) of size u and angle v are given as equation [7].

$Gu, v(x, y)=I(x, y)*\Psi(x, y)$ (3)

2.2 Discrete wavelet transform Feature Selection Technique

In the Wavelet transformation the signal is decomposed into different sub-band which has low frequency coefficient contains dominant information about gesture and detailed coefficient represents disruption and noise in a signal. So we have to extract low frequency coefficient or approximate components from transformed wavelet coefficient matrix [8].

6. PROPOSED WORK

In the Gabor Filter Feature Extraction technique, the dimension and redundancy is too large for performing feature extraction. To overcome this disadvantage of huge feature vector dimension decrease the size of feature vector So that the down sampling is performed without losing any kind of information.This high dimension and redundancy should be reduced by discrete wavelet transformation to obtain optimum features from facial dataset In the Gabor filter feature extraction technique, the problem of feature extraction can be viewed as a dimensionality reduction problem . It refers to transforming the input data into a reduced representation set of features which encode the relevant information from the input dat. In my proposed average Gabor wavelet filtering the wavelet transform is applied on each average Gabor matrix which converts it into four equal sub bands LL, LH, HL and HH in which LL sub band have most prominent information or characteristics features and HH sub band represent most redundancy. Using wavelet transform at one level a filtering of a factor of 4 is carried out on average Gabor feature matrix.

7. EXPERIMENTS & RESULTS

The simulation of proposed work is implemented in MATLAB and JAFFE data set is used for evaluation of proposed algorithm for facial expression recognition.

The JAFFE dataset (Lyons et al., 1998; Zhang et al., 1998) used in experiment contains 213 images posed by 10 female. Among 213 images 150 (70%) are training image and 63 (30%) are testing image. The images were taken from 10 japanese female models. Each image as a resolution of 256 x 256 pixels. The number of images corresponding to each of the 7 categories of expression (neutral, happiness, sadness, surprise, anger, disgust and

fear) is almost the same 3 or 4. The multiclass AdaBoost classifier is applied for classification of facial expressions.

8. Experimental Results and Analysis

In this project the real time face recognition is achieved using Average Gabor-Wavelet Filter.

Figure 5 shows the experimental result of MATLAB, when test image belongs to the database images as shown.

Figure 6 shows the experimental results when the thief tries to start the vehicle

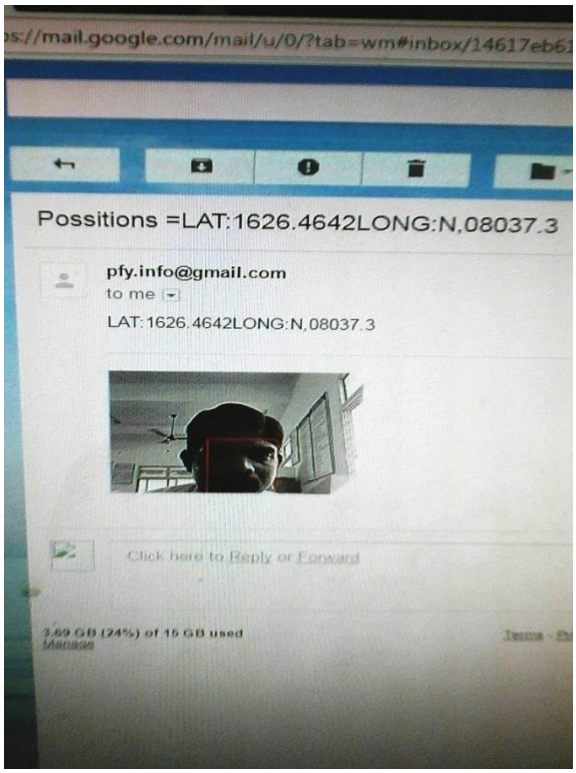

Figure 7 shows the email structure which has been send to the owner's mail.id from the vehicle.

9. CONCLUSION

An embedded automotive 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. Comparing with traditional aautomotive system, this system does not need any sensor, and thus it is highly reliable.

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