International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Anti-Theft Car Tracking and Controlling Security System based on Face Recognition

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Abstract: ***This paper proposes an intelligent anti-theft car security system, which uses biometric application like Face Recognition to identify thief along with GPS module which tracks and locates the car. The proposed system consists of embedded control ARM processor platform, face recognition system, GPS (Global Positioning System) and MMS (Multimedia Messaging Service) modules used for preventing loss of vehicle. The Face recognition system based on Weber Law Descriptor (WLD) divides image into number of blocks, then WLD is calculated for each block in different neighborhoods and WLD histograms are obtained from blocks of an image to preserve spatial information. WLD histogram from different blocks is concatenated to produce the final feature set of a face image. This extracted feature set of face image is compared with feature set of database image and real time user authentication is performed, if unauthorized entry is detected the unauthorized image of person is sent to owner of the car in the form of MMS using MMS module and seeing the image owner takes action of stopping the car by sending SMS to MMS module which further triggers interrupt to stop the car. Also by using GPS module exact location of car can be tracked and car can be prevented from theft***

Keywords: Face Recognition system, Embedded Control Platform, ARM processor, GPS (Global Positioning System), MMS(Multimedia Messaging Service),Weber Law Descriptor**.**

1. Introduction

As the demand for the cars is increasing day by day there has also been increased in the car theft cases. According to National Crime Records Bureau(NCRB) auto theft in the country accounted for 44.4% of the total thefts ,which accounted for an increase of 2.5% in 2012 as compared to 2010.Theft other than automobile has shown a declining trend of 0.7% from 182837 in 2010 to 181600 in 2011. As per NCRB report only 20% cars are recovered. Because of these circumstances automobile manufacturers are more focusing on anti theft technologies which could prevent loss of car and identify the victim responsible for theft. Earlier central lock system with RFID tag , shock or vibration sensors were used, but major limitations of systems were it could not measure the intensity of shock or jolt which would result in a false alarm, Also the car was not been able to prevent from loss or theft[3]. The most obvious benefit of proposed system is it prevents car from loss and in case of theft car can be located along with the victim responsible for theft. Proposed anti-theft smart car security system that prevents car from loss uses Biometric application like Face Recognition, GPS module for tracking the location of car and MMS module for user identification. A webcam is placed in the car, in which the video frames will be recoded and face of the person trying to enter the car will be recognized using face recognition system. If the person is not the user, the image of unauthorized person along with GPS co-ordinates would be sent to owner of the car through MMS module placed in the car. After receiving MMS on

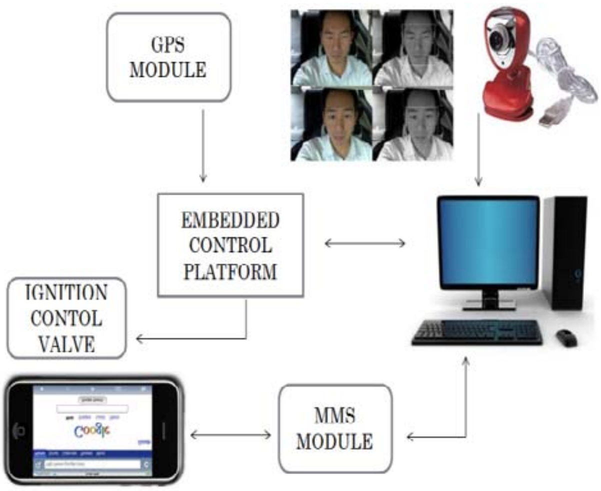

Figure 1: Block diagram of Proposed System

Mobile owner can stop the car by sending SMS to MMS module which then triggers interrupt controller of ARM processor generating interrupt to stop car's ignition unit. Depending on GPS coordinates car can be tracked and recovered and person responsible for theft can be identified.

2. Methodology

A. Face Recognition system

A face recognition system has two main components: feature extraction and matching. Depending on the feature extraction method, previous studies on face recognition fall into two main categories: holistic-based and local feature based. Holistic based methods describe face based on the whole image rather than local features of face, such as Eigen face [5]. On the other hand, local feature-based methods use features extracted from local regions of the image, such as local binary pattern (LBP) [6] and Gabor filters [7].In this system we introduce a novel technique for face recognition using the textural properties of the faces. chen et. al. [6] has demonstrated that WLD outperforms in texture recognition than stat-of-the-art best descriptors like LBP, Gabor, and SIFT. The basic WLD descriptor is a histogram where differential excitation values are integrated according their gradient orientations. The differential excitation values are concatenated irrespective of their spatial location and so WLD behaves like a holistic descriptor.

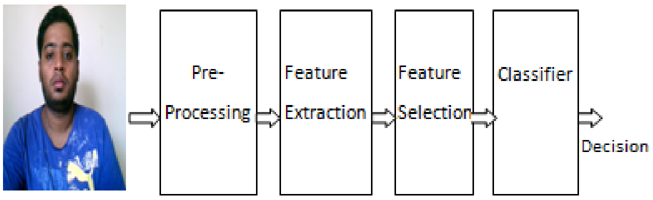

Figure 2: Face Recognition System.

B. Weber Law Descriptor for Face Recognition:

WLD descriptor is based on Weber's Law. Ernst Weber, an experimental psychologist in 19th century, observed that the ratio of the increment threshold to the background intensity is a constant [7]. This relationship, known since as Weber's Law, can be expressed as:

$$\frac{\Delta I}{I} = K.$$

where ΔI represents the increment threshold (just noticeable difference for discrimination); I represents the initial stimulus intensity and k signifies that the proportion on the left side of the equation remains constant despite of variations in the I term. The fraction $\Delta I / I$ is known as the Weber fraction. The computation of WLD descriptor involves three components: calculating differential excitations, gradient orientations and building the histogram.

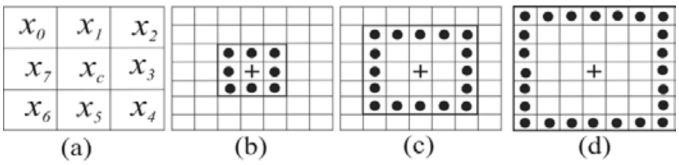

Figure 3: (a) Central pixel and its neighbours in case p = 8.(b) (8, 1) neighbourhood of the central pixel, (c) and (d) (16,2) and (27, 3), respectively, neighbourhoods of the central pixel

Differential Excitation: For calculating differential excitation $\mathcal{E}(X_c)$ of a pixel x, first intensity differences of X_c with its neighbours xi, $i = 0,1,2, \ldots, p-1$ (see Figure 1(a) for the case $p = 8$) are calculated as follows:

$$\Delta I_i = I_i - I_c \qquad (1)$$

Then the ratio of the total intensity difference between X_c and its neighbour's xi to the intensity of X_c is determined as follows:

$$f_{ratio} = \sum_{i=0}^{p-1} \frac{\Delta Ii}{Ic} \qquad (2)$$

Arctangent function is used as a filter on Eq (2). to enhance the robustness of WLD against noise which results in:

$$\epsilon(Xc) = \arctan \sum_{i=0}^{p-1} \epsilon\left(\frac{\Delta Ii}{Ic}\right) \qquad (3)$$

The differential excitation $\mathcal{E}(X_c)$ may be positive or negative. The positive value indicates that the current pixel is darker than its surroundings and negative value means that the current pixel is lighter than the surroundings

Gradient Orientation: Next main component of WLD is gradient orientation. For a pixel X_c the gradient orientation is calculated as follows:

$$\theta(Xc) = \arctan\left[\frac{I_{73}}{I_{51}}\right] \qquad (4)$$

Where $I_{73} = I_7 - I_3$ is the intensity difference of two pixels on the left and right of the current pixel X_c and $I_{51} = I_5 - I_1$ is the intensity difference of two pixels directly below and above the current pixel, see Figure 1(a). Note that $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$. The gradient orientations are quantized into T dominant orientations as

$$\phi_t = \frac{2t}{T}\pi \text{ where } t = \mathrm{mod}\left(\left\lfloor \frac{\theta'}{2\pi/T} + \frac{1}{2} \right\rfloor, T\right) \qquad (5)$$

Where $\theta' \in [0, 2\pi]$ and is defined in terms of gradient orientation computed by Eq.(4) as

$$\theta' = \arctan2(I_{73}, I_{51}) + \pi. \qquad (6)$$

In case T=8, the dominant orientations are $\phi_t = \frac{t\pi}{4}$, t=0,1..........T-1; all orientations located in the interval $[\phi_t - (\frac{t\pi}{4}), \phi_t + (\frac{t\pi}{4})]$ are quantized as ϕ_t.

Basic WLD Descriptor: After calculating differential excitation and dominant orientation, WLD descriptor is build. Corresponding to each dominant orientation: t = 0, 1, 2… T-1 differential excitations are organized as a histogram Ht. Then each histogram Ht: t = 0, 1, 2… T-1 is evenly divided into M sub-histograms $H_{m,t}$: m = 0, 1, 2, …, M-1, each with S bins. These histograms form a histogram matrix, where each column corresponds to a dominant direction Each row of this matrix is concatenated as a histogram H_m = { $H_{m,t}$: t = 0, 1, 2, …, T-1}. Subsequently, histograms H_m: m = 0, 1, 2, …, M-1 are concatenated into a histogram H = { H_m: m = 0, 1, 2, …, M-1}. This histogram is referred to as WLD descriptor. This descriptor involves three free parameters: T, the number of dominant orientations, M the number of segments of each histogram corresponding to a dominant orientation and S, the number of bins in each segment

Spatial WLD descriptor: The basic WLD descriptor described in previous subsections represents an image as a histogram of differential excitations organized according to dominant gradient orientations. In this histogram differential excitations are collected according to their values and gradient orientations irrespective of their spatial location. Spatial location is also an important factor for better description. For example, two different regions in an image with similar differential excitations and gradient orientations will contribute to the same bins in the histogram, and will not be discriminated by WLD descriptor. To enhance the discriminatory power of WLD descriptor, we introduce spatial information into the descriptor. We divide each image into a number of blocks, compute WLD histogram for each block and concatenate them to form a Spatial WLD descriptor (SWLD). SWLD involves four parameters: T, M, S and the number blocks. This performs better because it captures the local information in a better way, which is important for recognition purpose. But this approach introduces another parameter: the size of blocks. The optimal value of this parameter can lead to better recognition results.

Multi-scale Spatial WLD Descriptor: Spatial WLD descriptor characterizes both gradient orientation and spatial information at fixed granularity. For better representation of an image, it is important to capture local micro-patterns at varying scales (*P*, *R*). To achieve this end, we introduce Multi-scale Spatial WLD descriptor; in this case for each block of an image, a multi-scale WLD histogram at a particular scale (*P*, *R*) is computed and then these histograms are concatenated. The final histogram is the Multi-scale Spatial WLD descriptor (MSWLD) at scale (*P*, *R*). We represent Multi-scale Spatial WLD operator by *SWLDP,R*(*T*, *M*, *S, n*). We use MSWLD for feature extraction or face recognition by tuning parameters T,M,S and no. of blocks as described above. All the features in MSWLD descriptor are not helpful in recognition some features are redundant, to get rid of redundant features we employ Fisher score method and we use minimum distance classifier with chi square (CS) distance measure.

B. Embedded Control System

Embedded control system is the brain of the proposed Anti-theft system. Interrupt generation and reception operation is performed by embedded control system. In our proposed system we have used LPC-2148 having microcontrollers based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. The LPC-2148 contains two UARTs having fractional baud rate generator enabling the microcontrollers to achieve standard baud rates with any crystal frequency [3]. The LPC2l48 include up to nine edge or level sensitive External Interrupt Inputs.

C.GPS Module

A GPS Module is used for parsing the strings, Latitude and Longitudinal information of the car. In our project GPS is used for navigational purpose which receives all the GPS co-ordinates from GPS satellite to guide the user to track the location of car.

Figure 4: Representation of GPS module.

D .MMS Module

A MMS module is a rugged and versatile modem having USB with RS-232 interface used for SMS/MMS gateways. The MMS module controlled by AT commands operates at 19200 bits is used for transferring captured images and GPS co-ordinates obtained from GPS module to user. The MMS module in the proposed system is used for bi-directional communication. At first instance the captured image and GPS coordinates are transmitted to user and later depending on authorization decision of user in case of unauthorized entry to stop the ignition unit of car is transferred to embedded control unit via MMS module.

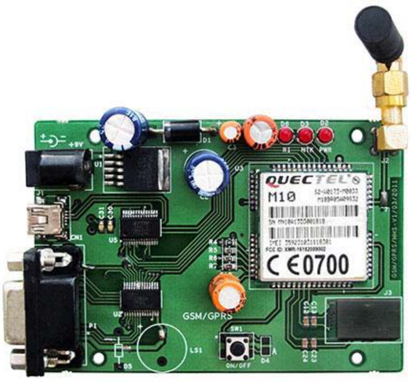

Figure 5: Representation of MMS module

3. Experimental Results

In this proposed system Real time face authentication is performed using Weber Law Descriptor

Figure 6: Database Images

Figure 7: Recognition of Authorized Image

Figure 8: Recognition of Unauthorized Image

Figure 9: (a) Representation of MMS image of thief on Owners Mobile. (b).Owners reply to stop the Car

Figure 10: VB Front End of MMS/GPRS modem

4. Conclusion

In this paper, We propose an flexible real time smart car security system using Face Recognition to prevent car from theft, the proposed smart car security system proves to be reliable and helpful in preventing the car from theft as compared to traditional sensor based car security systems. Also the WLD technique for Face Recognition is more efficient than local feature based methods like LBP (Local Binary Patterns), Gabor Filter and PCA (Principal Component Analysis) methods.

5. Future Scope

The Proposed Anti-theft system can be made more efficient by improving precision of Face Recognition and adding other biometric applications lik finger print recognition along with Face Recognition feature for more secureness also by replacing MMS and GPS modems with higher baud rate MMS and GPS modems the communication problem of the system could be minimized.

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