

# A Cost Effective Method for Automobile Security Based on Detection and Recognition of Human Face

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**Abstract**—The proposed system for automobile security is a face detection and recognition application that control the automobile to be operated or restricted. This system is established for all types of door locks and particularly for automobiles. By using this methodology, resulted a better quality product with respect to documentation standards, code optimization, user acceptance due to adequately efficient, maintainable, consistence and cheaper software. With the up-to-date and influential technology, the system is not only expected to be workable, but also sufficiently efficient in terms of execution speed and response time. In our work we studied the limitations of the face recognition techniques and try to give the best solution with benefits of both fisherface and eigenface recognition methods at minimum cost. As the main aim of this work is to develop a low cost security system for a common man to keep his automobile save but it does not only protects the automobile but also assist in catching the thief by saving his image. This paper defines an efficient face detection and recognition algorithms using a cross platform of EmguCV as .Net wrapper to the Intel OpenCV library, Visual Studio and C# .Net , with hardware components essentially a Computer Stick and an Arduino uno.

**Keywords**-automobile security; face detection; face recognition; OpenCV (open source computer vision); emgu CV; arduino

## I. INTRODUCTION

With the advancement in information technology face recognition (FR) has become an important research area due to its worth in real world. There are many factors behind the rapid growth of development of face recognition systems like active algorithm development, big database of facial images and a number of evaluation methods for performance measurements of face recognition algorithms are available [1]. Due to these advantages FR has appeared as a striking solution to manage many obligatory requirements needed to give proof of identification and verification [2]. Systems based on face recognition can be deployed to grant or restrict access to certain territory or a device. Now a days due to lot of cases of automobile theft, security is becoming a notable issue and it is strongly needed to pay attention to such criminal acts. As a consequence, it is necessary to develop more reliable security systems. Customary security systems are necessarily should be replaced.

Biometrical expertise are playing considerably a higher level of security than normal methods of security systems [3, 4]. Fingerprint analysis and iris scans are reliable biometric methods of personal identification. But there are some issues associated with fingerprinting like if the owner of the automobile get injured his/her fingers, then he/she will be unable to get access to automobile and in other extreme cases thief cut the fingers of the owner to get access to vehicle. In spite of having many other identification methods e.g. personal identification number, Password token eye retina scanning for a functional identification system to give the proof of identity and verification, FR is progressively acceptable way as it is a deferential and non- invasive way of identification and validation. On the other hand FR is considered to be more secure as no one can embezzle, plagiarize or whipped a face to gain access to an automobile. This is the reason that automobile owners are interested to get benefits of technology for antitheft system.

For the sake of betterment in the effectiveness of face recognition system different researchers have implemented several techniques and algorithms. But the processing speed of languages like java is pretty slow and were not successfully implemented because of their complexity issues. Previous studies have shown that there are lots of automobile security systems, some research studies used holistic based image recognition like eigenfaces and some have used other methods. In our work we have described a novel approach for face recognition using the benefits of both eigenface and fisherface methods [6]. The proposed approach guarantees a prototype of a real expect anti-theft security system which can be implemented by automobile owners all over the world at low cost, without any doubt. In this prototype we have used EmguCV cross platform .Net wrapper to the Intel OpenCV image processing library and C# .Net, with Microsoft visual studio 2015. The standard APIs are delivered while programming by using Open CV library. For this purpose there are various hardware comprehension platforms are available; we are using Arduunio uno board with a computer stick powered by Intel processor. We have selected Arduino because it is user friendly, cheaper, haste free and easy to configure.

The paper can be summarized as below. Section II tells about the motivation for the work, Section III describes related works is followed by Section IV that describes the

proposed system in detail. Finally, Section V consists of discussion and Section VI concludes the paper.

## II. MOTIVATION

Security systems are getting more important in everyday life [7, 8]. As per a crime report (Pakistan 2016 Crime & Safety Report) delivered by the higher authorities of Pakistan, regarding the year 2010 – 2015, a remarkable upsurge has been noticed in crimes. Specifically talking about automobile safety, about 171,713 vehicles, having price Rs. 85 billion, were snatched or stolen in different parts of country in last five years. According to another news (The Nation (Karachi, Pakistan) September 13, 2014), in Punjab only, the rate of stealing is more than 15,500 vehicles during the first half of year 2014, whereas according to another news statement, approximately 50 percent increase has been observed in car robberies. Currently security systems for automobiles dependent on sensors which are even more expensive to afford. Therefore there is a need for a higher level of security to gain a certain level of reliability and safety in cost effective manner.

## III. RELATED WORK

For security purpose it has become important to have in place efficient threat detection systems that can automatically detect and recognize the authorized person, and restrict the unauthorized person. Belhumeur et al. used the pattern classification approach to develop a face recognition algorithm that was not sensitive to high deviation in trajectory of light and face countenance [6]. Bozkurt applied optical flow method and differential motion analysis for human tracking [9]. Mazanec et al. worked on human face biometric. They used different algorithms like PCA, LDA and SVM [10]. Hendriks et al., employed flame recognition method for fire detection, by using video and application of Open Source Computer Vision (OpenCV) Library. They use the Graphical User Interface (GUI) based software. In his article he described the control of servo motors through ActiveX entering from the serial port and revealed that the detection can be triggered in real time [11].

Shingne and Krishnamurthy developed human face detection and recognition to restrict access to a door. They used ARM11 based development board and JAVA in eclipse IDE to develop application [12] but was not adequately efficient. Shardool Patil and Sardeshmukh [13] and Bhaghvati et al. [14] proposed an anti-theft system for automobile security based on face recognition and used ARM processor. The problem with all above stated techniques is that some are complex and others are too expensive to be implemented by a common man.

## IV. PROPOSED SYSTEM

The proposed security system construction is shown in Fig. 1. The system consist of (i) The most recent version of the Compute Stick is powered by an Intel Atom Z8300 processor, 4GB of RAM, with 32 or 64GB of eMMC storage (ii) An Arduino Uno (iii) USB hub, as the Arduino board

supports USB connectivity. (iv) USB based camera is used as image sensor.

Our program is written in c#.net using .net framework 4.5 and compiled in Microsoft visual studio 2015 IDE. The image processing C# code samples and Emgu CV 3.1.0.2504 (openCV) library and optimized code with and added parallel communications used to send X, Y values to Arduino.

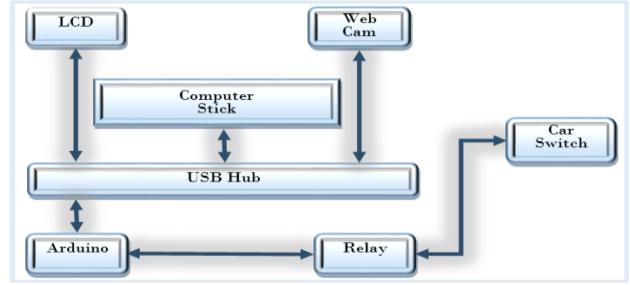


Figure 1. Block diagram of the proposed system.

### A. Structural Analysis of Proposed System

The proposed system is designed under careful consideration of requirements in term of cost and use. To make it inexpensive and extremely usable we had considered the following factors.

#### a. Less critical factors

- Speed of image processing, systems like Traffic control on Image Recognition missiles require high speed processing that is accomplished by using speedy processors, Faster GPU/CPU combination and faster Image recognition APIs, because some millisecond delay may result in missing the target. While car ignition itself takes some seconds to happen, so if software can recognize the image in some milliseconds it will be adequate and almost all APIs can accomplish this. So EmguCV wrapper around OpenCV is more than sufficient.
- High Control of Hardware: If we require more hardware control more switches etc. we have to concentrate on better embedded system. In our case high end hardware is not required because we just need one or two switches to switch on / off the lock.

#### b. More critical factors

- It should be robust.
- It should be within the purchase reach of most of automobile users.
- Its interface should be user friendly. Because most of automobile users are laymen.

So we here just needed the things to response to different sensor readings and manual input so used Arduino, a web cam, .net framework and windows based system, Emgu CV Wrapper, free API that is Open CV. That makes the Interface easy and economical and for adequate and sufficient speed and hardware, a relatively cheaper option for processor and computer that Intel stick computer and embedded hardware control Arduino (Fig. 2) is considered.

### B. Significance of Arduino

In our project our moto is to provide advance automobile security at minimum cost and cheaper switching option with USB control is Arduino. Even other controllers are cheaper but we have to install many peripherals for USB etc. and it becomes many times expensive. But in case of Arduino it has hardware platform set up already, especially the fact that it allows programming and serial communication over USB. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a reset button, a power jack and more. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The key benefit is faster code so result into a more efficient system.



Figure 2. Arduino uno.

### C. Working of the Proposed System

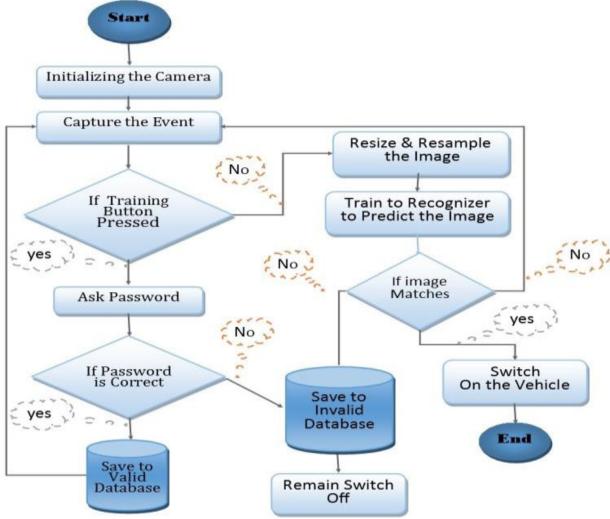


Figure 3. Work flow of the proposed system.

When a person open the door of the automobile, it will turn on the web camera that is installed in the automobile and is capable of capturing live video feed. The face detection system will detect the face of the person who try to run the automobile and matches his face with the authorized

face images saved in the database using face recognition system. For this, enhanced algorithm of face detection and recognition system are used for verification and validation. If the image get a matching image then it will grant the access to run the automobile otherwise will save the image to assist the owner in catching the thief. Our proposed approach consists of four phases: capturing, training, detection and recognition. Training is seldom needed when a new person with the permission of the owner sits into the automobile then it will need to train the system to detect and recognize his/her image to allow him/her access to run the vehicle. The flow of the phases in form of sequential steps is shown in Fig. 3.

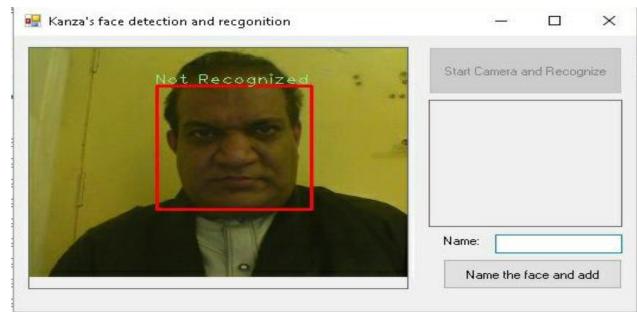


Figure 4. Face capturing.

#### a. Capture the image



Figure 5. Training image database of authorized person.

Whenever a person (owner or any other person) open the door of the vehicle, it will cause to activate the camera and when he starts the automobile it will initialize the camera and video stream is detected, if proper human face is detected

then system capture the image and stops taking video streams (Fig. 4).

#### b. Images training

The training phase consists of saving images into database by giving a value. Face recognition is done by using these values. During training an image is Transformed the original images of the training set into a set of eigenfaces [15] or fisherfaces depending on the size of database. Our defined algorithm counts the samples, if samples are fewer then it uses Fisher face recognizer and if samples are a lot like more than 100 then it uses Eigen face recognizer (showed in image training pseudo code). Then the weights for each image for the training set are calculated and stored. When an unknown or new image is captured, the weights are calculated and stored for this new image. In EmguCV the model state is saved in the form of YAML file. At least 10 to 20 images of one person are saved for training, an example of training set is given in Fig 5.

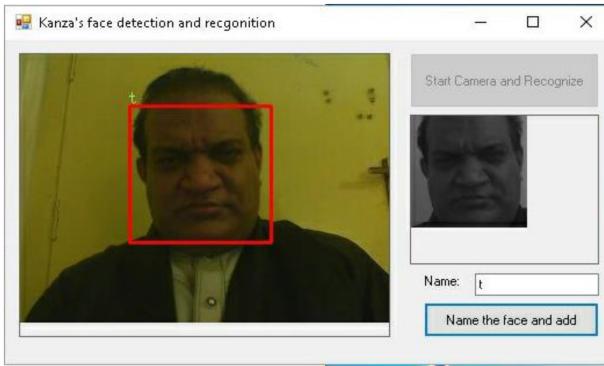


Figure 6. Face Recognition.

#### c. Face detection

The Haar like feature based Cascade Classifier algorithm is used for face detection. It is defined by Paul Viola and Michael [16]. Machine learning based approach is used by Paul and lot of positive and negative images are used to train using a cascade function. Cascade object detection is available in open CV library, it catches the image and cascade detector identifies the face of the captured image. A human Face has common features that are extracted to a standard sized rectangle then image preprocessing algorithm will work to process image to grayscale image and histogram equalization. After that other face images are detected.

#### d. Face recognition

The final outcome of the proposed system is to recognize face image, this is done by Principal Component Analysis (PCA) algorithm with improved features. As we discussed above that all images are saved with a numeric values, when a person want to get access to vehicle, his face image will be captured and saved with a numeric value. His image will be predicted by the recognizer to match the detected image in already existing images from authorized person database (see image recognition pseudo code). If face is recognized, it means matches with the images in database then signal

through USB is sent to Arduino and then Arduino controls the lock through Relay/SSR and will grant the access to operate the automobile. Otherwise his image will be saved in unauthorized person database for investigation purpose and does not allowed the person to operate vehicle. Fig.6 shows face recognition window in which detected face is recognized with his name abbreviation 't'.

#### Pseudo Code for Image Training

```

FOR (Each Face found inside the Image)
{
Save the image inside the File having the name of last file name + 1;
Add the Image name inside txt file database and add a delimiter
}

Show a message box confirming how many images got detected and saved.
Clear the Labels array
Get unique names from table in variable hst
Store count of labels in tmp variable

FOR (each label)
{
Assign a number to the label and add it to Label Array
}

IF (number of labels is less than 1000)
{
Assign Recognizer object OF OPEN CV the Recognition method as Fisher
FaceRecognizer Algorithm
}

ELSE
{
Assign Recognizer object OF OPEN CV the Recognition method as Eigen Face
Recognizer Algorithm
}

Train the recognizer Object with Parameters of Training images array and training
labels array.

```

If text box with the name of the person is empty show the message box asking for name input in text box.

#### Pseudo Code for Image Recognition

```

IF (there exit some Images)
{
USE the predict method of OpenCV with the image in Camera as parameter and
get the label of the Image Name;

IF (There is no label)
{
Draw a rectangle around the face and write in the corner of the rectangle Image
not recognized;
Send Data to Usb for lock Control to not to open the door Lock of the Vehicle
}

ELSE
{
Draw a rectangle around the face and write in the corner of the rectangle the
name of the person;
Send Data to Usb for lock Control to open the door Lock of the Vehicle
}
}

```

## V. DISCUSSION

Facial recognition is somewhat is perplexing issue and in this paper we try to make it easy, by employing OpenCV and Emgo CV we built an example application which is capable of recognizing a specific person. When predict method is called, the face recognizer begins recognizing a face. The

predict method takes a frame as input. In this scenario this frame definitely contains a face. For this reason, at first face detection take place to give a face as input to recognizer. Different light directions and presence of shadows on face may cause to an unsatisfactory recognition rate. This situation can be overcome by taking the benefit of fisherface algorithm as fisherface method proves to be the best at extrapolating and interpolating over variation in lighting. This is why the fisherface method offers lower error rate as compare to eigenface method and as well as less calculation time. And other trick to give high precision is to train the recognizer directly from within the situation where the faces are needed to be recognized. It will surely leads to relatively high precision. The choice of hardware and use of free API that is OpenCV has made it inexpensive but most of the practitioners think that Arduino is suitable for prototyping but we say, definitely it has all the appropriate competences like reliability and easy to use that are essential for commercial use applications.

## VI. CONCLUSION

Our proposed application is approachable and more effective than other security systems available in market, as they are too expensive and unaffordable. Using this technique we have minimized requirements for analysis and development. The use of the best suitable face detection and recognition algorithms and optimized code with cheap hardware will surely make it possible to be acceptable all over the world. Experimental results showed that this simple security system is more appropriate for automobile security in both cases from theft and child abuse. Due to the combination of both fisherface and eigenface recognition this technique is pretty fast with high precision. But coming to limitations, the Arduino does not have an operating system of its own. We need to use the Arduino on Windows or Mac OS. In future we shall workout this issue by using Raspberrypi instead of Arduino.

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