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Finger Vein Recognition Based Driver Authentication and Alertness System Using GSM

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Abstract
This paper outlines the real time embedded system application for driver authentication and alertness. Biometric systems are the best authentication systems that are used to identify a person. Finger vein authentication is the anti-forgeable. When a person wants to drive, will just press their finger in the biometric system. When the finger vein are match automobile get ignited, this will be keyless authentication system. If the matching fails GSM get triggered on and transmits warming message. Same automobile has the facility todetect fatigue and intake of alcohol by the diver. GSM, camera and buzzers are interfaced with Raspberry pi. Raspbian OS is loaded with python and open CV. Arduino is interfaced with alcohol gas sensor. This two embedded boards are bridged by I2C bus. Arduino will turn off the relay to ignition system.

Keywords: Finger vein authentication, KNN classifier, GSM, Fatigue, alcohol gas sensor, I2C, python, open CV, Raspberry pi, Arduino UNO.

I INTRODUCTION

Road accidents are a tragedy which is caused due many factor, some of the major issues are unlicensed driving, fatigue state and alcoholic consumption of the divers. Road accident involve huge amount of suffering and instantaneous deaths, injuries and etc. Although there are many initiatives are implemented by various road safety improvement programs. The overall situation as revealed by data is far from satisfactory. During the calendar year 2012, there are nearly to 7 lakh road accidents in India, which resulted in more than 3.5 lakh death. According to the static report for every four minutes there is one road accident death in India. Road traffic accidents are easily persuaded to remedial action. Many other countries have tried to control the threatof road accidents by adopting a multipronged approach to road safety that is helpful to control road accident.Some of approaches are traffic management, high quality of infrastructure road, implementing intelligent transport system[9].Driver distraction can be defined as any type of event that takes away attention from the drivingtask by affecting driver's visual, manual and cognitive attention.To reduce the number of road accidentsthat takes places due to driver distraction, new design and a system is implemented that monitors and controls driver distraction, this designis cost-effective and very accurate in the real application. This system is implemented using sensor based data collection and transmission scheme. Tocollectthe dataa user-friendly environment interface is implemented. There are many researches has been performedclaiming antiforger finger vein authentication [1-7]driver drowsiness detection [8-18]. [19-20] shows different methods of measurement for alcohol quantity. Thework that have been done over here is different from [1-18], and provides a very efficient design and algorithm is more practical implementable, which can be easily implemented as a prototype.The software's that are used for developing this project are open source.Two open source development board Raspberry pi [21] and Arduino Uno [22] are used for creating the proposed design of embedded system. Real time application of the embedded system is speed up by using this open source board. Raspberry pi system board is interfaced with GSM, color camera with 5 megapixels which is used for capturing video in real time. Raspberry pi processes the captured video frames. Finger vein authentication is implemented using KKN classifier and GSM is used for transmitting the message when there is an authentication failure. Python programming language [25] is used for authentication and drowsiness detection with open source computer vision extension Open CV[23]. The Arduino module interfaced with MQ-303A [19] alcohol sensor and relay. I2C serial bus is used for interfacing Raspberry pi and Arduino, in this interface Raspberry pi acts as the master and control the Arduino to turn off a relay to the car ignition system, this task is performed by receiving a warming message from I2C or alcohol sensor.

II METHODOLOGY

This section shows the steps towards achieving theObjective of Finger vein authentication and alertness system.To overcome the forger problem

in the previous work, here non forger finger vein is used as a biometric authentication. Finger vein is proved as an antiforger biometric authentication and it will be a secured key system. Finger vein authentication has less than 0.001% for false rejection rate and 0.0001% for false acceptance, this make the finger authentication high accuracy than all other authentication. The following system uses vein as a biometric key and also it adds more feature for driving safety like drowsiness detection, Alcohol sensor and car theft security using GSM. The proposed system consists of two modules namely (i) ignition module, (ii) security module. Authentication of the system can be done in several ways using different type of finger vein recognition algorithm. In this proposed system the combination of face detection, eye region detection and eye closing rate detection in real time environment is used to detection of drowsiness. Making a real time application with computer vision is very effective and efficient challenging task that needs processing powerful system. OpenCV is open source software, which is used for creating computer vision. OpenCV is available in C, C++, Python and Java programming languages extension. Raspberry-pi is controller small sized ARM 11 open source controller with the GPU provides up to 1.5Gpixels of graphics processingand processing CPU speed 700 MHz.It can be over clocked maximum 1500MHz Raspberry-pi can work with Raspbian operating system,which is a light weight Linux.Raspbian OS is loaded with Python-IDLE programming software and OpenCV.The family members or authorized members finger vein is stored as the data base by using the vein reader. Among the persons, one of the people is fixed as an authority, In case of third person, the message will be sent by using GSM and the car will not ignite. Buzzer will be turned on till the GSM receives positive message from authority. In this case GSM is used only for transmitting and receiving the message to the authorized person. Here KNN classifier is used as the finger vein recognition algorithm.Haar Featurebased Cascade Classifier technique,it is a machine learning based approach where a cascade function is trained from a lot of positive and negative images, this positive image is used for detecting face region and eye region with the update of region of interest ROI. Open CV is packed with a trainer as well as detector. The open CV is used for creating user defined an objectclassifier.The object classifier that has been created is stored in.xml file extension.This object classifier can be used in the later stages of programming. Arduino is used for delectation of the alcohol consumption by the person, for this an alcoholgas sensor or breathalyzer MQ-303A is interfaced. Arduino will detect if the person who is driving drunk or not. Based on the Authentication scheme, an alarm will be turnedon with GSM and the car's power source can be cut down through arelay to stop the car or preventing the driver to start the car. If authentication grand is there then only, detection of drowsiness or alcoholic intoxication will takes place and same measure will be taken as in authentication scheme. Fig. 1 shows the basic block diagram of the system.

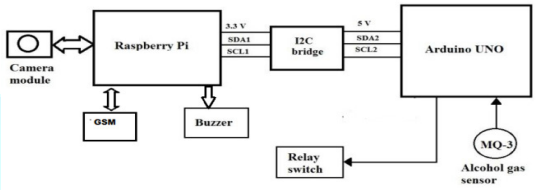

FIG.1. BLOCK DIAGRAM OF THE PROPOSED EMBEDDED SYSTEM

III FINGER VEIN RECOGNITION ALORITHM

Finger vein recognition is a newly found physiological and biometric behavioral technology that is used as an individual identic. A finger vein is a network of small vessels that located under the finger skin that it is invisible to naked human eyes. Finger vein can be viewed through an image sensor sensitive to near-infrared light with wavelengths between 700 and 1000 nanometers. Finger vein recognition algorithm is show in fig 2.finger vein recognition have three general stage image acquisition, image pre-processing(cropping, resizing and enhancement) and identification process. Enhancement is used to reduce the noise that are present and it act as matched filter.

A.FEATURE EXTRACTION

The feature extraction stage that is useful to find the minutiae. The minutiae are operated on thinned image and these are straightforward to detect. Finger vein image are thinned with image processing like resizing, cropping.PCA(principal component analysis) is one of the fundamental and very effective methods in terms of dimensional reduction. PCA is sensitive to the relative scaling of the original variables.

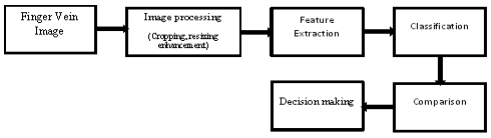

FIG.2. FINGER VEIN RECOGNITION ALGORITHM

B.CLASSIFICATION

The K-nearest-neighbor (KNN) algorithm is an instance based learning method, fig,3.shows the KNN as classifier in vein recognition ,KNN measures the distance between a query scenario and a set of scenarios in the data set. Each sample in our data set has n scenarios of attributes which we combine to form an n-dimensional vector $x=\{x_1,x_2,\ldots,x_n\}$,$y=\{y_1,y_2,\ldots,y_n\}$. Data set as a matrix G = N X R containing R scenario $s^1,\ldots,s^R$where each scenario s^ihave N scenario features $s^i=\{s_1^i,s_2^i,\ldots,s_n^i\}$. A vector c with length R of output values $c = \{c^1,c^2,\ldots,c^R\}$ accompanies this matrix, listing value of outputs for each scenario. It should be noted that the vector c can also be seen as a column matrix. The width of the matrix may be expanded, if the output is multiple for desired values.

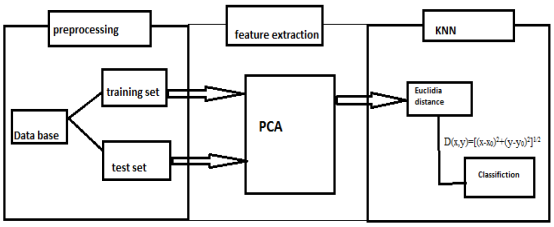

FIG.3. BLOCK DIAGRAM OF KNN AS CLASSIFIER IN VEIN RECOGNITION

KNN can be run in these steps:

1. Store the output values of the M nearest neighbors to query scenario q in vector $r=\{r^1,r^2,\ldots,r^M\}$ by repeating the following loop M times:

a. Go to the next scenario s^i in the data set, where the current iteration*I*is within the domain {1,…,R}

b. If q is not set or $q<g(q,s^i):q\leftarrow d(q,s^i),t\leftarrow o^i$**(1)**

c. Loop until we reach the end of the data set

d. Store q into vector c and into t vector

2. Calculate the arithmetic mean output across p as follows:

$r=\frac{1}{M}\sum_{r=1}^{M} r^i$**(2)**

3. Return r as the output value for the query q scenario.

IV ALCOHOL SENSOR

The MQ303A is a heater-driven alcohol gas sensor, its output is an analog signal which measures alcoholcontent [24].It has fast response to alcohol detection, suitable for portable alcohol detector. It is used measure the present of alcohol in the volume of breath in mg/L (milligrams per liter). These are also known as Breathalyzer or breathe air content (BrAC). To find out whether a person is consumption alcohol or not the most proper and strand method to measure the blood alcohol content (BAC) in person, which is the calculating the amount of alcohol content present in the blood volume. Observing the calculated the % BAC value, we can determine the diver consumed alcohol or not by the percent of BAC in blood of driver. There is direct relationship between BrAC and BAC(i.e. 2100:1 ratio). MQ-303A measured BrAC values can be converted to BAC.

0.1% BAC = 1000 mg/L

Therefore final computation formula for convention is % BAC = BrAC mg/L * 0.2**(3)**

V PROGRAMMING SOFTWARE ALGORITHM

Python and Open CV is used to implement the system in Raspberry pi. Functional module of Raspberry pi is shown in fig.5installing OpenCV (2.4.2) on the Raspberry Pi is pretty easy using the base Debian Squeeze image if any error occurs type sudo apt-get update. Import the libraries functions like timer, I2C, numpy, Open CV, camera and GSM [6] .the finger vein is extracted and processed by various processing methods. Processed finger vein image is stored in SD card, this SD card act as a data base. When a person wants to use the car his or her finger is extracted and processed. This image is matched for authentication. Authentication scheme is interrupt to raspberry pi this activates GMS for non-authentication or camera for grand. GMS is used for transmitting of messages to a person or group as per specification. When camera is initialized video are processed as a frames. These frames are created as a user defined requirement and stored as a XML file format. This user defined object contains the information that as to classified or stored and used for processing in later stages. These images are in gray scale images. Now computer visionwill find the faces in the gray scale image. If the faces is detected, it returns the positive value to the classifier and positions of detected area i.e face as Rect(x,y,w,h)[23]. Once we get these positive values, classifier will create a ROI for the face areaand classifier will update the ROI and apply eye area ROI (since eyes are always on the face). When the eye gets detected and classifier will receive positive values. Once again the ROI is update to detect the closed or opened eye.

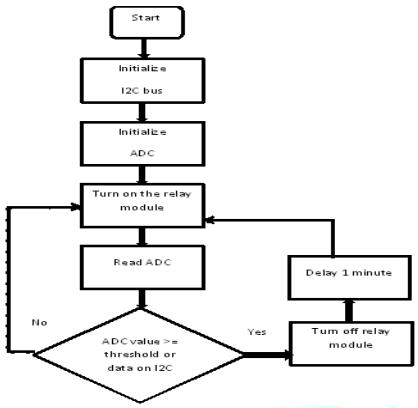

FIG.4. ALGORITHM OF ARDUINO

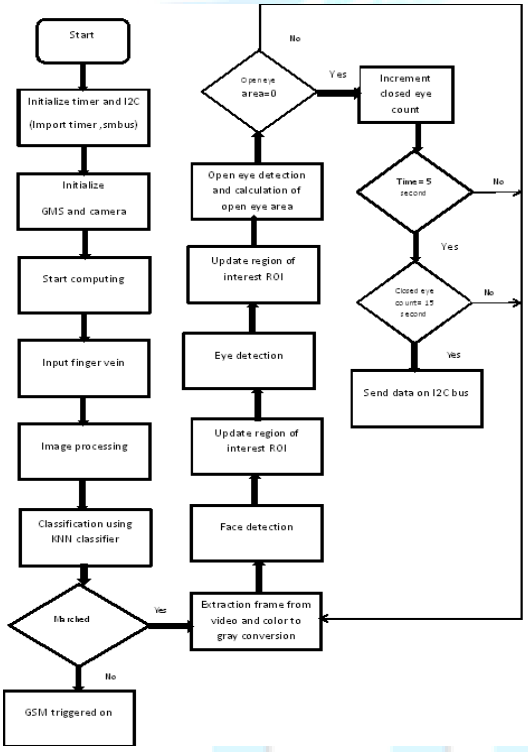

FIG.5. PROGRAMMING ALGORITHM OF RASPBERRY PI

```
Face =face_cascade.detectMultiscale(gray, 1.3, 5)
For(x,y,w,h) in face:
cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)
roi_gray = gray[y:y+h, x:x+w]
roi_color = img[y:y+h, x:x+w]
eyes = eye _cascade.detectMultiScale(roi_gray)
for (ex,ey,ew,eh) in eyes:
cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,0)
2)
cv2.imshow('img',img)
cv2.waitKey(0) cv2.
destroy.AllWindows() [23]
```

There is condition 5second of closed eyes, as per research blink of an eye last maximum for 5 second only. If the closed area threshold is more than user defined value,message is transmitted on I2C bus by raspberry pi to Arduino to turn off the relay.
Arduino module is programmed with Arduino IDE. Programming algorithm for Arduino is simple when compared with raspberry pi module. Programming module is show in fig.4. Arduino is configured as salve device to the raspberry pi. Whenever Arduino receives themessage data by I2Cfrom Raspberry pi. Arduino will turn off the relay to ignition module. When there is no message from Raspberry pi, Arduino is programed to detect the alcohol. Pin A is connected to 100KΩ potentiometer and pin B to ground as shown on the fig 6.[24]In the same pin where you are connecting the pin A, you need to connect a wire to the AD convert Arduino that is where you are going to read the Alcohol information.

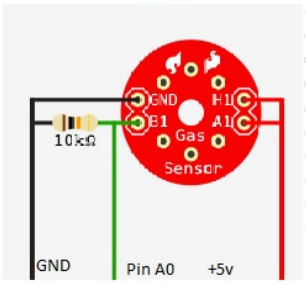

FIG.6. MQ3 INTERFACE WITH ARDUINO

VI EXPERIMENTAL RESULTS

Proposed system is still in research level, this prototype have not yet implemented in any real car environments. Few functional moduleslike keyless authentication, drowsiness and alcohol detection are programmed and there are working as expected. Finger vein is collected from different person and extracted from finger vein reader. This finger vein images resulted from different image processing techniques as mentioned early in this paper.

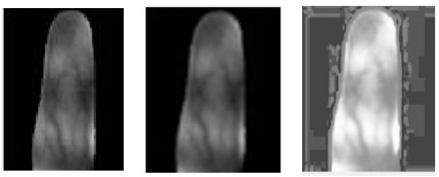

FIG.6. DIFFERENT IMAGE PROCESSING OF FINGER VEIN BY DIFFERENT FILTERS

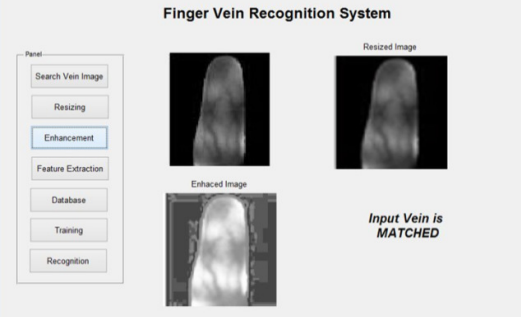

FIG .7.FINGER VEIN AUTHENTICATION MATCHED

Fig.6.Shows the samples of processed by different filters on finger vein images. Processed images are used for training the classifier. KNN classifier has the performances 95.59 % for 5trains and 5test. KNN is very effective for small data base. Samples output of the finger vein authentication is show in the fig 7 and fig 8 showing the matching and miss-matching. When miss match occur GSM get triggered on to transmit message. GSM transmits OPT(one time password) to over reads the system, after the authentication miss match.Blue color rectangle is used to detect the face of the person, green color to detect the eye region and red the open or closed eye.These color rectangles are the

Test no	%BAC	Relay state
1	0.157	ON
2	0.160	ON
3	0.675	OFF
4	0.665	OFF
5	0.642	OFF
6	0.155	ON

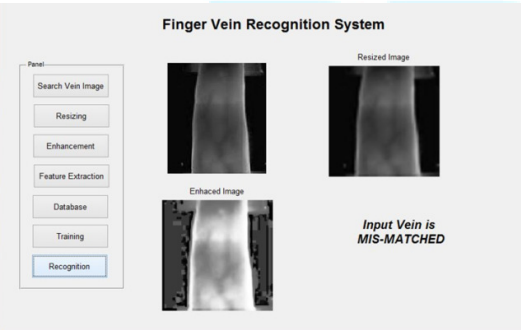

FIG .8.FINGER VEIN AUTHENTICATION MISS-MATCHED

region of interest (ROI) this get update from face to eye for everyframe. Fig 9 show the ROI. When the classifier fails to detected red color rectangle for more than 5 second. In other words eye closed for more than 5 second warning message is transmitted from Raspberry Pi to Arduino via I2C bus. In this work threshold value of 11 second is settled for transmitting the message. This threshold values can be changeable as per the designer. I2C is used bridge to Raspberry Pi and Arduino as both run on 3.5 and 5 volts each. Therefore I2C level shifter created by BS170.The MQ303 is a heater driven alcohol sensor that outputs is an analog signal.

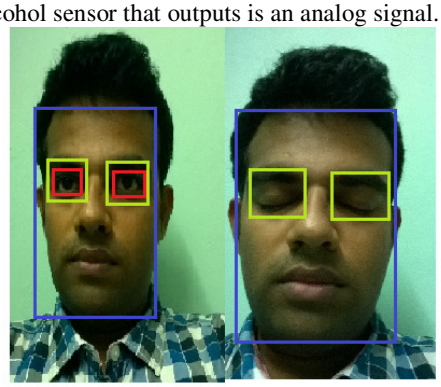

FIG.9. FACE AND CLOSED OPEN EYE DETECTION

TABLE.1. M3 DATA IN ARDUINO TERMINAL

This value can vary from .150 to 1.023, by Arduino code and calibration; can be interpreted for whatever application use we needed.For this project methyl alcohol is used. When sensor is exposure to alcohol ADC reading is 0.63, this value is %BAC.

VII CONCLUSION

As discussed in this paper many technologies exist for biometric authentication, driver alcohol intake and drowsiness detection. This system is created with effective current technologies andsoftware algorithm. There are few higher end cars having this technologies integrated but this is system is coat effective.The research is still in progressing state to develop into infancy mode. There is much to improve and work on in this system with current emerging techniques and use them.

Date base of finger vein image is collected free online data base, Human Identification using Finger Images [4]. Images are collected BMP format, Image 320 x 240 pixel sizes and converted into JPG. 100 finger vein images are collected from 5 persons, each 20 samples. 15 images are used for testing and other remaining images are used as training data base for a single Person.

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