Implementation of Improved Face Recognition Technique for Car Ignition Access Control Using Raspberry Pi Microcontroller

V. Ramanath

Abstract- This paper focuses on the use of face recognition technique for Car ignition, as opposed to the natural method of using keys. Face recognition is a fast increasing, interesting area in real time applications .The face recognition methodology enables face recognition of valid users of the vehicle to be enrolled in a database. Before any user can access the car, the image of his face is matched against the faces in the database. The users with no match in the database are prevented from accessing the vehicle. Haar features are used for object detection and Principal Component Analysis is used for face recognition. This work is implemented on Raspberry Pi microcontroller and this is very low cost system.

Keywords: Raspberry Pi, GSM Module, Open CV, QT creator, Haar Features and Principal Component Analysis.

I. INTRODUCTION

The role of electronic gadgets in the daily activities of human beings is exponentially increasing day by day. This type of electronic transactions have resulted in a greater demand for fast and accurate user identification and authentication for establishing proper communication, and access codes for buildings, vehicles , bank accounts and computer systems and PINs for identification and security. The unauthorized use of other's bank accounts, stealing of vehicles, house thefts have become a very common practice now days, which are popular under cyber crimes. Even police have become helpless with such crimes. So, there is a need of some techniques which can prevent this type of crimes. Biometric technology solves this problem to a maximum extent [1]. Biometric features that can be used for identification include fingerprints, handwriting, facial characteristics, face, and some other methods such as voice pattern etc [2]. In this paper, we propose an embedded system that performs the Face Recognition using ARM1176JZF-S (Raspberry Pi) processor. This embedded system using Raspberry Pi has the feature of image or video processing. So, our embedded system that detects the image with high speed. This system takes the captured image by means of USB camera, connected to ARM 11 (Raspberry pi) processor. The image is processed by using the image processing techniques. OpenCV (Open Source Computer Vision Library) which is a library of programming .It is free for use under the open source BSD license [3][4]. It focuses mainly on real-time image processing. As OPENCV can support all the Image and Signal processing algorithms and which can be ported onto the Linux platform easily.

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The major applications of this OPENCV include 2D & 3D feature extractions, Ego motion estimation, Facial recognition system, Gesture recognition, Human computer interaction, Mobile robotics [5]. Qt is a cross-platform application frame work that is widely used for developing application software with graphical user interface and also used for developing non-GUI program such as command-line tools consoles for servers. Qt uses standard C++ but makes extensive use of a special code generator together with several macros to enrich the language and which can be ported onto the Linux platform. The block diagram of the present design is shown in figure 1

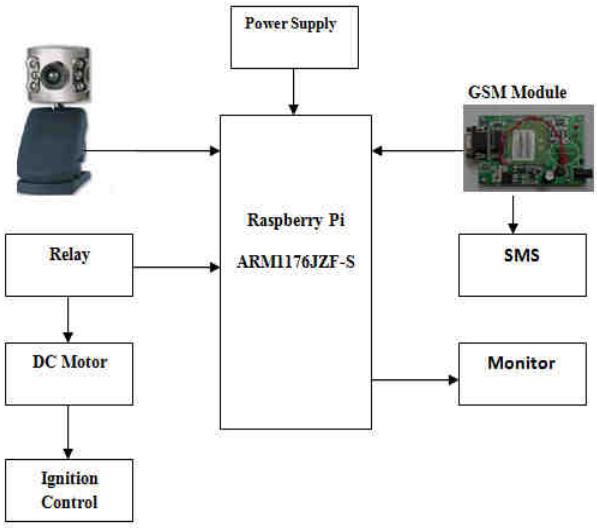

Figure (1). Block diagram of the present design.

II. HARDWARE DETAILS

(i) Raspberry pi: Raspberry pi is a micro-controller development platform with in-built ARM11 processor provided with internet/Ethernet connectivity, 4 USB ports, 512MB memory and works in Linux operating system. The main use of raspberry pi is to convert conventional television to smart tv. The board provides both the audio and video outputs as well the onboard storage of the micro-controller kit supports SD card slot. Raspberry pi can be used for several applications including image capturing, media streaming, home automation, to control robots, internet radios etc. The major requirements of raspberry pi are a bootable SD card with Linux, USB power adapter with support for 700 mA and USB Wi-Fi adapter for internet connectivity. The main signal processing chip used in our system is a Broadcom 2835 700MHz Chip in which CPU core is a 32 bit ARM1176JZF-S RISC processor designed by Advanced RISC Machines, Ltd. It has very rich peripheral. The design does not include a built in hard disk or solid state drive, instead relying on an SD card for

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booting and long term storage. This board is intended to run Linux kernel based operating systems. Plenty of interfaces are contained on the Raspberry Pi board, including 4 USB ports through which a Keyboard, mouse and USB web camera can be connected. Ethernet port is used for networking even though it is optional, although it makes updating and getting new software for Raspberry Pi board much easier.

(ii) Power supply: The power supply is via the micro USB connector. The Samsung mobile charger is used to connect with a micro USB connector will do, it can supply at least 700mA at +5Vdc.

(iii) USB Camera: USB Camera is a digital camera designed to take an image and it is connected to Raspberry Pi microcontroller and it take a necessary action to take an image. The images are taken in the RGB format. These images are store in (.png) format and sent to Raspberry Pi microcontroller.

(iv) Global system for mobile communication (GSM) Module: The model of GSM is SIM-300. GSM modem consists of a SIM (Subscriber Identity Module) card slot to send the SMS (short message service) to owner's mobile number. Baud rate for it 9600 bits per second is set here. The power supply for this module is 12V. USB to TTL connector is used to connect to the Raspberry Pi. The connector has 4 pin out of these 4 pins 2 pins are connected to Raspberry PI power supply and ground and reaming 2 pins are Tx and Rx. The Tx and Rx pin are connected to GPIO 14 pin and GPIO 15 pins of the Raspberry Pi.

(v) Monitor: By using HDMI (High Definition Multimedia Interface) connector is used connect the monitor, the HDMI port provides a high-speed digital connection for pixel-perfect images on computer monitors. Using the HDMI port, a Pi can display images at the Full HD 1920x1080 resolution of most modern HDTV sets.
Relay: the Relay pin is connected to the GPIO 17 pin of the Raspberry Pi and the relay pis are connected to the DC-Motor.

(vi) Face Recognition system:

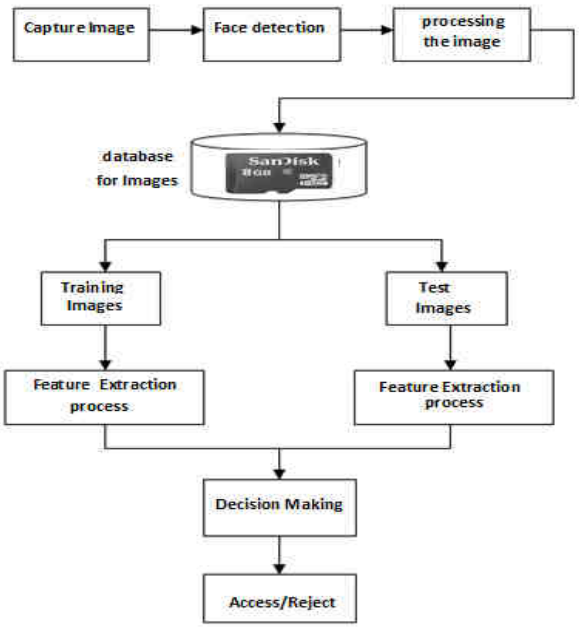

Figure (2): Face recognition System

All identification or authentication technologies operate using the following these stages.

USB WEBCAM: This usb webcam is used to take an input image during the enrolment and identification process.

Face detection: Face detection is a computer technology that determines the locations and sizes of the input image. Face detection can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces (usually one). In face detection, face is processed and matched bitwise with the underlying face image in the database. Any slight change in facial expression, e.g. smile, lip movement, will not match the face [6].For our purpose, face detection is actually a face localization problem in which the image position of single face has to be determined [7]. The goal of our facial feature detection is to detect the presence of features, such as eyes, nose, nostrils, eyebrow, mouth, lips, ears, etc. With the assumption that there is only one face in an image [8].

Processing: The input of a face recognition system is always an image or video stream from the camera captured images are passes through the Preprocessing the image unit. The preprocessing the image unit performs image like RGB color to gray color scale conversion, resizing and illumination and background removal in order to normalize the input image. Then the template is created and extraction the unique data is extracted from the input image and template is created.

Decision making: These templates images are stored to the face database for images. Some of the databases are taken as training images database and one of the face databases is taken as test image database. The template is then compared with new input image.
Access/not access: the system decides if the features extracted from new image are a access or not-access.

III. HAAR FEATURE FOR FACE DETECTION

Haar features are digital image feature used for object detection but here we used it for face detection. The biggest advantage of it over most other features is its calculation speed. Figure 3 shows the types of Haar like feature. Generally eye region is darker than other region from the face. Figure 3 shows how Haar like feature is used for face detection purpose. Figure 4 gives the complete preprocessing steps, which includes binary to gray scale image conversion, Histogram Equalization method, Laplacian of Gaussian filter and final step is contrast adjustment. Preprocessing is done because we have to remove influence cause by illumination variation for accurate face recognition.

- Edge feature
- Line feature
- Center-surround feature

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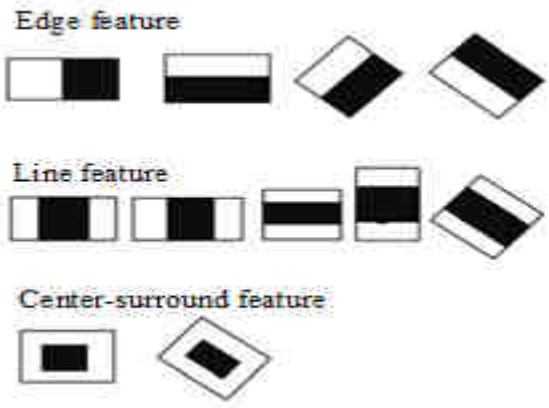

Figure (3) Haar feature

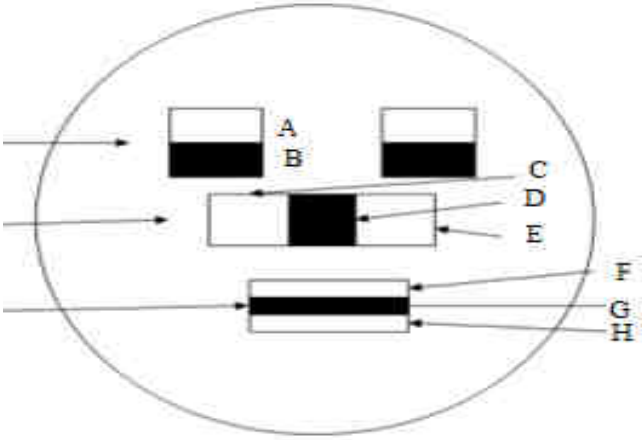

Figure (4): Example of Face Features

Face consists of many features, different sizes, polarity and aspect ratios (see Figure 4). These features could be considered as rectangular face features.
Two eyes= (Area_A - Area_B)
Nose = (Area_C+ Area_E- Area_D)
Mouth = (Area_F+ Area_H -Area_G)
The eye-area (shaded area) is dark; the nose-area (white area) is bright. So f is large, hence it is face [10].

IV. PRINCIPAL COMPONENT ANALYSIS (PCA)

Principal Component Analysis is a suitable strategy for face recognition because it identifies variability between human faces, which may not be immediately obvious. Principal Component Analysis does not attempt to categorize faces using familiar geometrical differences, such as nose length or eyebrow width. Instead, a set of human faces is analyzed using PCA to determine which 'variables' account for the variance of faces. In face recognition, these variables are called eigenfaces.

V. EIGEN VALUES USED FOR FACE RECOGNITION

Any grey scale face image I(x,y) consisting of a NxN array of intensity values may also be consider as a vector of N2. For example, a typical 100x100 image used in this thesis will have to be transformed into a 10000 dimension vector!

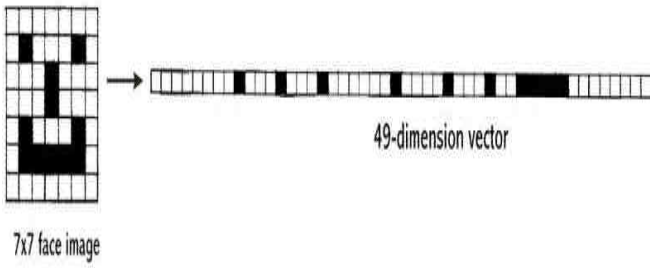

Figure (5): Eigen values understand

This vector can also be regarded as a point in 10000 dimension space. Therefore, all the images of subjects' whose faces are to be recognized can be regarded as points in 10000 dimension space. Face recognition using these images is doomed to failure because all human face images are quite similar to one another so all associated vectors are very close to each other in the 10000-dimension space.

VI. HARDWARE SETUP

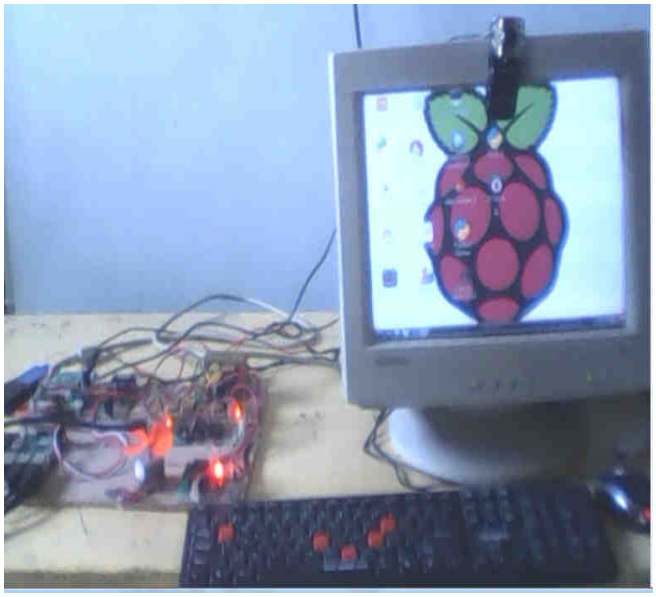

Figure (6): Face Recognition Setup

Face detection will be done using Haar cascade algorithm & Face recognition will be with PCA algorithm. The system uses the USB camera to capture images under the embedded Linux system platform which based on Raspberry Pi ARM 1176JZF-S processor. An application is designed through Qt creator to enable the face detection system to run on the embedded board. Qt will make system interactive to be compatible with real time constraints through GUI on Monitor. When face recognition system is running the USB Camera is ready to capture the image of person. In face recognition system as many as 15 images can be captured per each person and train it and these images are converted into RGB to Gray color as shown figure (7). These 15 gray color images are stored in database in the.png format. (Portable Network Graphic). Open CV provides haar training utility which can be used for training. It generates .XML files from training sample images which further can be used for fast object detection such as .XML file. Open cv package generate the Eigen photos as shown in figure (8).

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Figure (7): RGB to Gray Color photos

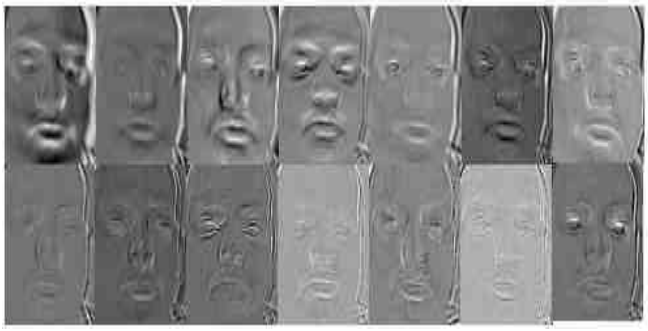
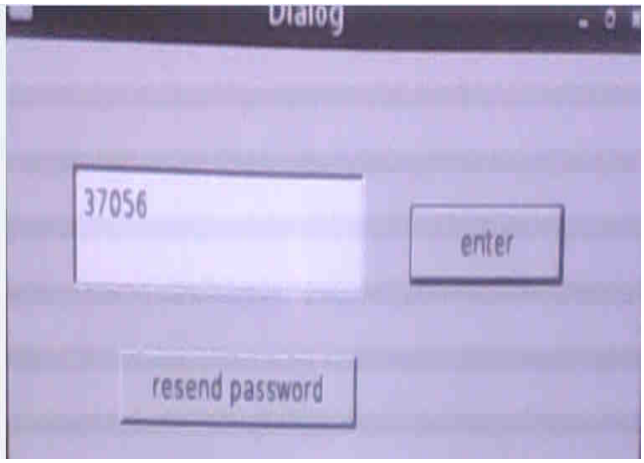


Figure (8): Eigen Faces

When Rec (Recognition) button is pressed the camera is used to search for face the raspberry Pi receive this images it detect face as shown in figure(9) and then its takes a action to compare the database images and captured images. When both images are matched and SMS is send to the user mobile. This SMS has password numbers which enters into the dialog box as shown in figure (10). For new password next time user can press the resend button and the user get the new password. This number is entered into the dialog box. At each and every time the user mobile receive different (Random) password numbers not same password numbers .The Dc motor will be rotating continuously ,to stop the rotating Fan press the OFF button in the dialog box as shown below figure. Finally the car ignition control is ON.

Figure (9): Face Detection Photo



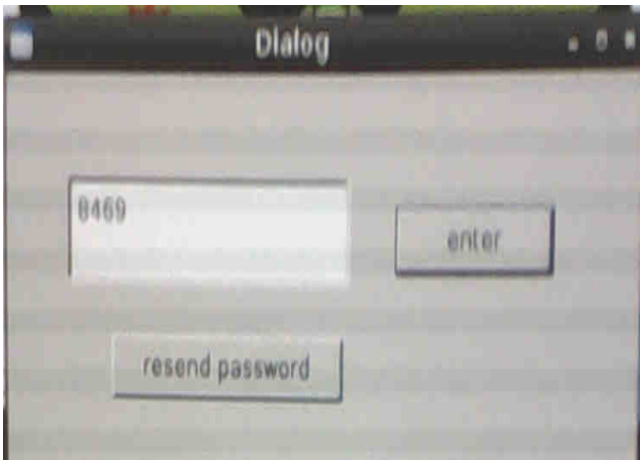


Figure (10): Entering Password is not same at each time is different password.

VII. RESULTS AND CONCLUSION

Automatic car locking system based on Principal Component Analysis is designed and implemented on the Raspberry Pi ARM microcontroller .The performance of the developed embedded system is verified under different test conditions and it is found to be working with higher accuracy when compared to crude Principal Component Analysis .The present system could overcome various inherent problems like low resolution of images, skin color variations and different lighting conditions etc.

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