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Design Of ARM Based Face Recognition System using Open CV Library

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***Abstract*— Face Recognition is a very active research area specializing on how to recognize faces within images or videos. Face recognition compliments Face Detection. Face Detection is the process of finding a 'face' within images or videos and Face Recognition is the process of matching the detected 'face' to one of many the faces known to the file system. Our goal was to create a portable low cost system using the advanced communication technologies like GPS and GSM. An intelligent portable human recognition and identification system is proposed in this project using an ARM 7 based microcontroller and opencv based machine. The system consists of two parts. Unit 1 consists of portable system with BSD Linux including opencv library, usb and serial port to perform the image processing part . Initially using an usb camera interface continuous images are captured and these images are processed with help of Opencv and compared with existing database. If the current images are matching with any of the existing images the system generates command to the unit 2.The unit 2 will perform the location identification using GPS and forward the necessary information about the identified person using GSM/GPRS to concern authorities.**

***Index terms*—Human face recognition, OpenCV**. ***GPS Module TC35i, GSM Module , ARM embedded system*, LINUX.**

I. INTRODUCTION

Generally this face recognition is a big challenge as there is a chance of high uncertainty due to the external lighting conditions, so we are taking the advantage of gray scale images and PCA (Principle Component Analysis), which are less effected to the external environment changes [1].

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And mainly a prior step of this face recognition involves face detection which is also a big challenge. For this we are taking the help of pre-designed cascades whose detection of objects is satisfactory [5].

With the increasing threat of terrorist, the advanced video surveillance system has to be put into use. The advanced video surveillance system needs to analyze the behaviors of people in order to prevent the occurrence of the potential dangerous case. In recent years, the development of human detection and tracking system has been going forwards for several years, many real time systems have been developed. Face based applications such as face recognition and video surveillance systems have been more popular in computer vision during past several years.

Functions mainly aimed at real time computer vision, developed by Intel in 1999 and now supported by Willow Garage [1]. So, for the easy development of these entire image processing algorithms on a micro-controller, we are taking the help of OpenCV (Open Source Computer Vision Library) which is a library of programming .It is free for use under the open source BSD license [2][5]. 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 very easily. The major applications of this OPENCV include 2D & 3D feature extractions, Ego motion estimation, Facial recognition system, Gesture recognition, Human computer interaction, Mobile robotics [6].

The first part of this project is to use a camera for detecting image or face, face recognisation is the important part of this project will be done using Open CV . The image capture is converted into digital data and transfers to the microcontroller for further process. The image capture will be assigned with a unique ID which will be compared with the IDs predefine in the database, if the ID matches with predefine one then the information such as particular name assigned to the ID, location of the person and time when the person is detected is send as a SMS to the predefine number in the code. If not matches then it will give “INVALID ID”.

This paper has 6 sections with introduction & conclusion. part II of this work describes literature

survey, partIII describes Methodology of work partIV hardware implementation partV software implementation partVI implementation of human face recognition.

II. LITERATURE SURVEY

The research proposes the design of human recognition system that improves speed of the theft identification by OpenCV library and GPS and GSM and LPC2148. Inigo R.M., Application of machine vision to traffic monitoring andControl[1], Wang Lei, Jiang Bing, Chen Wenjian, Design of onboard navigation system based on ARM platform, Microprocessors[2] The main advantage of this kind architecture is its detection speed a cascade detector can detect faces almost in real time. Every node is a classifier which determines one image block contains faces or by several "features". So, how to choose those features is the key point. XIE Yonghua, LIU Chuancai, YANG Jinyu(2008). "The algorithm based on DDCT and TCSVD of human-face feature extraction and recognition[3].

To speed up the system to meet the real-time ability, we choose the cascade detector method to be part of work bases, which has been proved to be the nearly fastest method of all. A cascade face detector uses a sequence of node classifiers to distinguish faces from non-faces. The proposed face detection method is based on a cascade of simple classifiers to handle each part of one integral image. Xusheng Tang, Zongying Ou, Tieming Su,Pengfei Zhao, "Cascade AdaBoost Classifiers with StagFeaturesOptimization for Cellular Phone Embedded Face Detection System[10] Zhu Yu Lian Fuzzy Within-Class matrix Principal Component Analysis And Its Application To Face Recognition[13]. The first alpha version of OpenCV was released to the public at the IEEE Conference on Computer Vision and Pattern Recognition in 2000, and five betas were released between 2001 and 2005. The first 1.0 version was released in 2006. In mid 2008, OpenCV obtained corporate support from Willow Garage, and is now again under active development. A version 1.1 "pre-release" was released in October 2008.

III. METHODOLOGY OF WORK

This embedded system is based on human-face recognition system. The S3C3400 chip is used as the core of this embedded system which is combined with the technologies of human-face recognition and GSM wireless communication. The new system contained the function of human-face recognition and take advantage of the present one. Face detection is to find faces in one image by the trained cascade classifiers [14]. Every node determines whether there are faces in the image according the data in classifiers" data file which is the outcome of training process. As a result, face detection process is a pure calculation process, and most of the results of face detection research papers are obtained by detecting images on personal computer platform.The main functions are shown as follows:

A. Human-face recognition: The owners' face information is used as the standards recognition. It must verify the feature of the human face before using vehicle.

B. Message alarming: When someone try to thieve the vehicle, the message can be send to the owners' mobile phone as soon as possible without any noise.

C. GPS: The GPS system is designed such that at any point, a GPS module on earth has a clear view of at least four satellites.

D. GSM: GSM digitizes and compress data then sends it down a channel with two other streams of our user data,each in its own time slot.

IV. IMPLEMENTATION

The design of whole system shown in Fig.1 consisted of two part which are hardware and software. The hardware are Designed by the rules of embedded system, and the steps of software consisted of three parts.

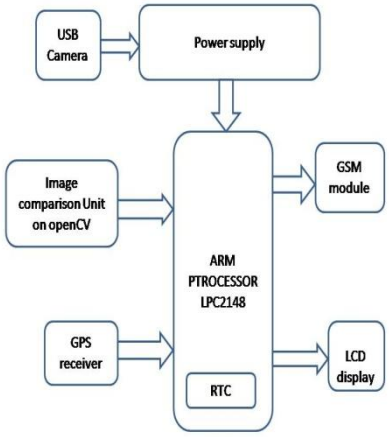

Figure1. Block diagram

A. DESIGN OF HARDWARE:

The LPC2148 chip is used as the core of whole hardware which operates around 1.2V internal, 1.8V/2.5V/3.3V memory, 3.3V external I/O microprocessor with 512KB of flash memory and 40KB of SRAM. Furthermore, the modules of LCD, USB camera, GPS, GSM are connected with the LPC2148 main chip. There are several modules consisted of the system as follows:

LPC2148:

Based on ARM7TDMI CPU with Real-time emulation.LPC2148 is developed by the PHILIPS, is designed to provide hand-held devices and general applications with low-power, and high-performance microcontroller solution. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems

.

Hex Keyboard module: It can be used for controlling recognition method and inputting passwords.

Alarming module: SIM300 alarming module is based on GSM technology implement which can call the police without any sound and send message to owner.

USB module: The function of ZCD301P USB acquires the human-face information.

SRAM and FLASH: The 16-bit 29LV160BB-7OREC of FLASH chip and the 32-bit HY57V561620CT-6 of SRAM chip are connected with the main chip. Their functions are storing the running code, the information of human-face and the algorithm.

Embedded control platform should control those Processes below:

1) Obtain images from camera by USB;
2) Detect faces in images;
3) Get and handle the data from GPS module;
4) Send messages by GSM module;
5) Control IIC interface;

GPS MODULE:

Nowadays the most widely used positioning system is the Global Positioning System of America (GPS), which is a system consisting 24 satellites whose searching area embrace the globe [1]. It can ensure that more than 4satellites will be observed at one time, no matter what time it is or where you are, thus making sure that they can collect the longitude and latitude of the view point, and furthermore realizing the function of navigation, Positioning and time service [1].

GPS technique has been widely used both in military equipments and civil devices in recent years [1]. We choose Jupiter TU30 GPS module to offer the location of the system in time. TU30 has a UART (Universal Asynchronous Receiver/Transmitter), which can be used to communicate with many other embedded devices. It is easy to get a serial of char from TU30 at 9600 bps**.** GPS modules have to evaluate weak antenna signals from at least four satellites, in order to determine a correct three-dimensional position. A time signal is also often emitted in addition to longitude, latitude and height.

Figure2. GPS Satellite system

28 satellites inclined at 55° to the equator orbit the Earth every 11 hours and 58 minutes at a height of 20,180 km on 6 different orbital planes as shown in Fig.2. Each one of these satellites has up to four atomic clocks on board.

GSM MODULE:

GSM is the most widely used mobile technology Using a simple Subscriber Identity Module (SIM) it has taken the world of mobile communication to new Heights[1]. To achieve important information of system, one GSM module is added in to the system [1].

Siemens TC35I GSM modem can quickly send SMS messages to appointed mobile phone or SMS server. So the owner and the police can be informed at the first time. The GSM and GPS modules can be serially interfaced to the microcontroller which has UART. Both the modules are connected to MAX232 through a relay for switching alternatively. Initially the GPS continuously takes the data from the satellite and stores the latitude and longitudinal positions in microcontroller's buffer. Fully digital system using 900,1800 MHz frequency band, it Support of Short Message Service (SMS). The system shall provide service portability, i.e., mobile stations or mobile phones can be used in all participating countries. The system shall offer services that exist in the wire line network as well as services specific to mobile communications. In addition to vehicle-mounted stations, the system shall provide service to Mss used by pedestrians and /or on board ships.GSM subscriber unit as shown in Fig3.

Figure3. GSM MODEM

B. DESIGN OF SOFTWARE:

The design of software is so vital for the whole system. The design was consisted of three parts included the design of main program flow chart, the Initializing ones, and the algorithm of human face recognition flow chart. This system of software is implemented by the steps as follows:

At first, Linux kernel and the File system are loaded into the main chip [5]. Secondly, the system is initialized to implement some tasks, such as vehicle, GSM communication, GPS and so on, and then each module reset for ready to run commands. What's more, whether starting the vehicle by the method of human-face recognition or the method of inputting passwords, is judged by system[4].If the former method was adapted, the inputting human face is judged, which would be compared with the information of vehicle database[2].The human face recognition and dection is based on openCV.

OPENCV:

We propose a new approach for detecting human faces from color images under complex conditions such as non-uniform illumination, arbitrary image background. In face recognition Image processing algorithms (Eigen values) is used [13] In the process of inputting human face, the USB camera, which could fix on to the PC, will used for acquiring the image of human face. Next step is that the image of human face would be processed by the main chip. The system will call the police and send the message to the owner; and also send the position of the vehicle by GPS.

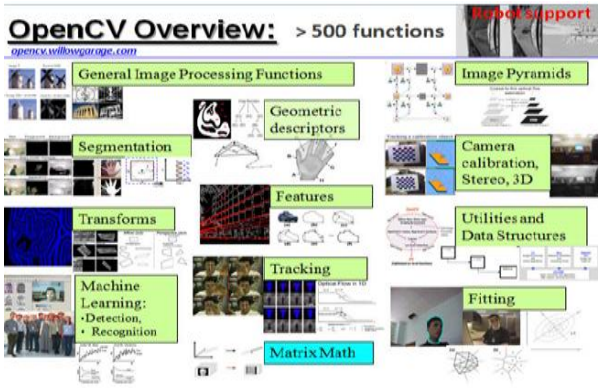

Figure4. OpenCV functions

The initializing process means that initializing the system to set the hardware and software, and then the multiple mission modules is started. To co-ordinate appliances and other devices through Short Message Service (SMS). To effectively receive and transmit data via SMS. To eliminate the need of being physically present in any location for tasks involving the operation of appliances within a household/office. Minimize power and time wastage. OpenCV perform more than 500 functions, some of the functions as shown in the Fig.4

OpenCV 2.1 has several modules:

Cxcore: core libraries. Basic structures, algebra and other math.Drawing functions. CV: computer vision.

Processing functions. cvaux: auxiliary functionality (some experimental).

HighGUI: image and video I/O. Image displaying, and basicGUI.

ML: machine learning. Learning and classification algorithms.

Lots of functionality: Basic algebra operations, Image/matrix manipulation, Dynamic data structures.

Image processing: filtering, edge/corner detection, histogram analysis, morphological operations.

Structural analysis: connected components, contours, distance transform, template correlations, Hough transform, shape fitting,Motion analysis and tracking: optical flow, movement segmentation, tracking,Object recognition: PCA, SVM, .Basic GUI: I/O handling, image loading and saving.

CvSize

Pixel-accurate size of a rectangle.

```
typedef struct CvSize
{
int width;
int height;
}
CvSize;
```

width Width of the rectangle

height Height of the rectangle

```
/* Constructor */
inline CvSize cvSize( int width, int height )
```

All the functions include the parameter color that uses a rgb value (that may be constructed with CV RGB macro or the cv function) for color images and brightness for grayscale images. For color images the order channel is normally Blue, Green, Red, this is what cv, cv and cv expect , so if you form a color using cv, it should look like:

cvScalar(blue component; green component; red component[; alpha component])If you are using your own image rendering and I/O functions, you can use any channel ordering, The drawing functions process each channel independently and do not depend on the channel Order or even on the color space used. The whole image can be converted from BGR to RGB or to a different color space using cv.If a drawn figure is partially or completely outside the image, the drawing functions clip it. Also, many drawing functions can handle pixel coordinates specified with sub-pixel accuracy, that is, the coordinates can be passed as fixed-point numbers, encoded as integers.

Transformations within RGB space like adding/removing the alpha channel, reversing the Channel order, conversion to/from 16-bit RGB color (R5:G6:B5 or R5:G5:B5), as well as Conversion to/from grayscale using:

RGB[A] to Gray:Y ←0:299 . R + 0:587 .G + 0:114 .B

And Gray to RGB[A]:R ← Y;G ← Y;B ← Y;A ← 0

The conversion from a RGB image to gray is done with cvCvtColor(src ,bwsrc, CV_RGB2GRAY) .Flowchart of is shown in Fig5.

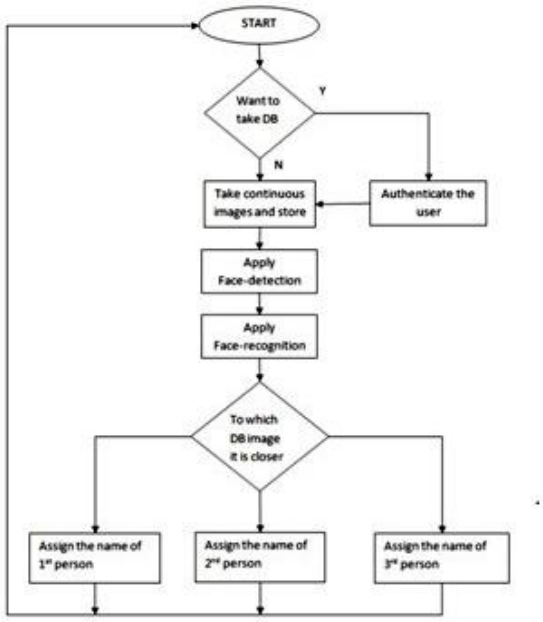

Figure5. Overall flow chart of the software

V. REALIZATION OF HUMAN-FACE RECOGNITION:

The design of algorithm based on human-face recognition was very important for this embedded system. Basically, the process of face recognition follows the face detection first [7]. So as we are designing a basic prototype of human face detection and recognition system, we are taken the cascade classifiers which are already available in the Open CV library for the face detection and the concept of Eigen values in order to recognition[13][7].So at first from the data base images of vehicle drivers, the Eigen values at each and every pixel point is measured and stored in memory [13]. Secondly, from the real time camera the images are taken within short span of time, and the Eigen values at each and every point for these real time images are also found using the same method [12]. At last these two Eigen values are compared with respect threshold level, and the further action will be taken [13].The task of facial recognition is discriminating input signals (image data) into several classes (persons). The input signals are highly noisy (e.g. the noise is caused by differ-ing lighting conditions, pose etc.), yet the input images are not completely random and in spite of their differences

there are patterns which occur in any input signal. Such patterns, which can be observed in all signals, could be in the domain of facial recognition the presence of some objects (eyes, nose, mouth) in any face as well as relative distances between these objects[14].

These characteristic features are called eigenfaces in the facial recognition domain (or principal components generally). They can be ex-tracted out of original image data by means of a mathematical tool called Principal Component Analysis (PCA).By means of PCA one can transform each original image of the training set into a corresponding eigenface[14]. An important feature of PCA is that one can reconstruct recon-struct any original image from the training set by combining the eigenfaces. Remember that eigenfaces are nothing less than characteristic features of the faces. Therefore one could say that the original face image can be reconstructed from eigenfaces if one adds up all the eigenfaces (features) in the right proportion.

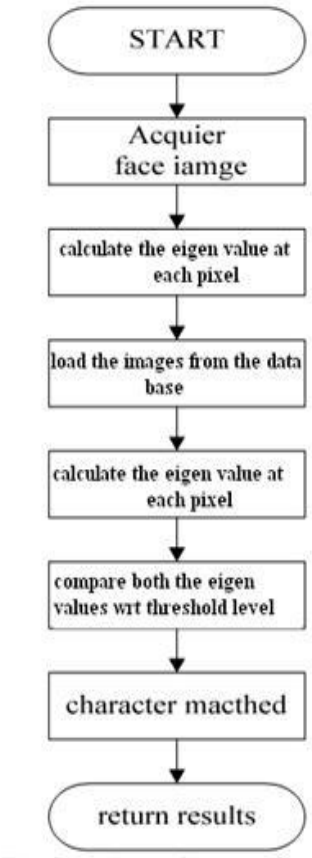

Figure6. flowchart of FRS

Each eigenface represents only certain features of the face, which may or may not be present in the original Image. The detected human face will be compressed by the image compression unit using cascaded classifier[15]. The image software execution is based on the Linux operating system by using native complier.

The detail of flow chart of human-face recognition was shown in Fig.6

VI. RESULTS AND DISCUSSION

The experimental results obtained fulfils with the requirements of the system. The main objective of the implementation is the face recognition using openCV. FRS is used to detect the face of the driver and compare it with the predefined face. For example, in the night when the car's owner is sleeping and someone theft the car then FDS obtains images by one tiny web camera which can be hidden easily in somewhere in the car.FRS compares the obtained image with the predefined images So now owner can obtain the thief in his mobile as well as he can trace the location through GPS. The location of the car displayed to the owner through SMS. So by using this system, owner can identify the thief location of the car. This system prototype is built on the base of one embedded platform in which one ARM7as core. The FRS system using OpenCV library provides users to know more about the visitor besides a notice which usually left from visitor. The system has successfully implemented in the real time environment with capability to capture the object that appears in front of the camera in ten seconds. Software development using µvision Keil IDE as shown in Fig7.

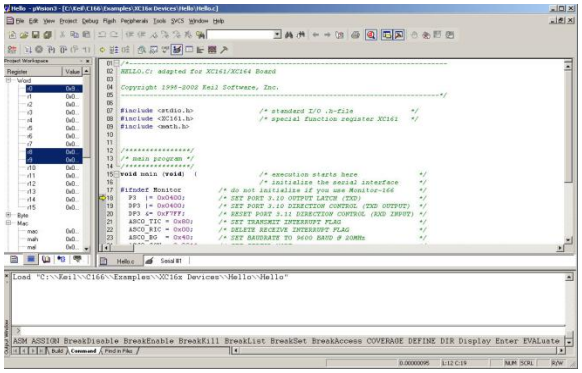

Figure7. Flash magic configuration tool

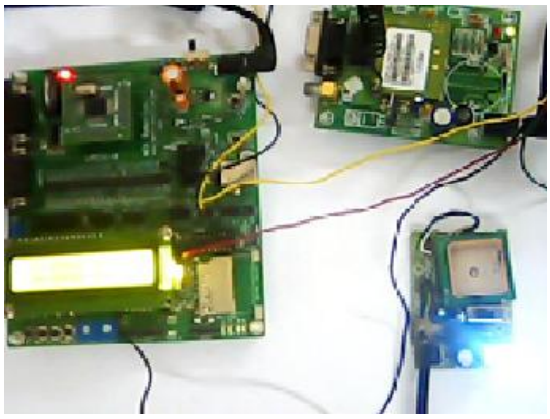

Figure8. Hardware prototype

VII.CONCLUSION:

Generally this face recognition is a big challenge as there is a chance of high uncertainty due to the external lighting conditions, so we are taking the advantage of gray scale images and PCA (Principle Component Analysis), which are less effected to the external environment changes. An intelligent portable human recognition and identification system is proposed in this project using an ARM 7 based microcontroller and opencv based machine. The proposed face detection method is based on a cascade of simple classifiers to handle each part of one integral image. The design of whole system consisted of two part which are hardware and software.

As size and portability are the major unique advantages of this OpenCV, it can replace all other image and signal processing tools like MATLAB which is of very huge size and which can't be ported onto any device. What's more, the system contained the second verifying methods which were inputting owner's password in order to make the other people gain the permission of owner's to use the vehicle. The security features were enhanced largely for the stability and liability of human-face recognition. This technology FRS USING OPEN CV library provides user to know more about the visitor besides a notice which usually left from visitor. The system has successfully implemented in the real time environment with capability to capture the object that appears in front of the camera. If another GPRS module is added in, the image data could also sent to an information server and sends the image through MMS.

APPENDIX

ARM: ADVANCED RISC MACHINE, i.e.advanced reduced instruction set computer machine which acts advanced microcontroller and microprocessor. It consists of microprocessor, memory,I/O devices and Analog to digital, digital to analog converters.

GPS: GLOBAL POSITIONING SYSTEM .Offers the capability to accurately determine location anywhere on earth in addition to speed, altitude, heading, and a host of other critical positioning data. GPS is widely used in military, consumer, and service markets with applications ranging from container shipping to weapons systems and handheld devices.

GSM: GLOBAL SYSTEM FOR MOBILE COMMUNICATION:GSM is Aadigital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a GSM uses a (TDMA).

OPENCV: The library was originally written in C and this C interface makes OpenCV portable to some specific platforms such as digital signal processors.

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