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Accurate Face Recognition System Based On ARM9 Processor Using Haar Wavelets

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Abstract: A hardware based on the ARM9 processor, using principal component analysis (PCA) of face recognition systems achieved recognition from the PC machine. System uses the common USB camera for image acquisition, Linux-based operating system software, and ARM9 S3C2440. To develop a low-cost, small face recognition face recognition system which has important practical significance the system uses ARM9 as the system control chip, the system achieved low cost, portability, miniaturization requirements. Different from the run on PC machine face recognition algorithm, the system identification algorithm must take into account the computing capacity and ARM-speed, so that recognition accuracy and recognition time is an acceptable range.
Keywords: PCA, Linux software, ARM speed, Miniaturization.

I. Introduction

The history of face recognition dates back to the 1960's semi-automated method was used to compare facial features. Now a day's security plays a vital role in the daily lives of people starting from the common people to officials like VIPs, VVIPs. The existing security systems are having biometric systems as their core part. They are using biometric systems like FPRS (Finger Print Recognition System) and EIRS (Eye Iris Recognition System).

There is a possibility to fraud these types of biometric based security systems. Lots and lots of criminals are present on this earth but all the people are not having their criminal records in the police stations. The identification of those peoples who are not having their criminal records is not an easy task.

In such cases it is very easy to cheat the biometric based security systems. The above problem can be solved by using the latest and very useful technology called as FRS (Facial Recognition System).It is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and facial database. The traditional algorithms identify faces by extracting land marks, or features from an image of the subject's face. For example the algorithm may analyze the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw.

These features are then used to search for other images with matching features. Some algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face detection. Recognition algorithms are divided into two types. First type is geometric which looks at distinguishing features and second type is photometric which distill an image into values and comparing the values with the templates to eliminate variances. Most popular recognition algorithms include PCA (Principal Component Analysis) using Eigen faces, LDA (Linear Discriminate Analysis), Elastic Bunch Graph Matching using the Fisher Face algorithm, the Hidden Markov Model, and neuronal motivated dynamic link matching.

The latest technology that is emerged into facial recognition system is three- dimensional face recognition. This technique makes use of 3D sensors to capture information about the shape of a face. This information is later used to identify the distinctive features of the surface of a face such as contour of the eyes sockets, nose, and chin. One of the advantage of 3D face recognition is this is not affected by changes in lighting like other techniques. It can also identify a face from a range of viewing angles, including a profile view.

The FRS (Facial Recognition System) is having their major application as security systems. The other applications include to searching for potential criminals and terrorists in attendance at the event. Other application is to prevent the voter fraud in elections. Some people will try to vote under several names in an attempt to place multiple votes. By comparing new facial image with those already there in the data base authorities can easily reduce the duplicate registrations. Similar techniques can be used to prevent the people from obtaining fake identification cards and driving licenses.

II. Implementation of System

The system is based on MagicARM2440 board, which is designed by the Guangzhou Zhiyuan Electronics Co., Ltd. It expands enough storage resources and adequate typical interfaces of embedded system. Based on this hardware platform, Embedded Linux operating system and drivers are developed firstly, and then face recognition system is achieved on the operating system.

A. Transplantation of Linux Kernel

The systems choose is special for the embedded systems: Linux Kernel v2.4.18, in the kernel System Software primarily by the underlying operating system, driver and application form. Linux 2.4 kernel system used. Cutting through the appropriate kernel, the system does not delete the system services and drivers. The main drivers of the system used to drive the camera, buttons and lights. This three drivers in the operating system starts, using Linux-specific modules are loaded dynamically loaded to the system kernel. Camera in the Linux kernel driver that comes with OV 51l driver based on the changes to make it compatible with OV 511 + chips. LED driver is mainly used to prompt the current program working condition. Because the program runs on Linux operating systems, applications can not directly control the hardware I / O port, you need to go through the driver the

address of physical address mapping, only the virtual address by mapping I / O operations. Key driver collecting user input, and transmitted through the Linux kernel space hardware interrupt, and then by the dri1.1 ARM9 processor .The system uses Samsung S3C2440 ARM9 family as processor, operating frequency up to 400 MHz, meet the system requirements for computing speed. This processor built-in two USB HOST, the system can be used to mount the USB camera, LCD screen Camera to display a preview of the current acquisition image, the system uses Samsungs 320 × 240 pixel LCD screen, the size of 106.68 cm. The depth of each pixel LCD screen is 2 bit, using RGB565 color space.

Webcams typically include a lens, an image sensor, support electronics, and may also include a microphone for sound. Various lenses are available, the most common in consumer-grade webcams being a plastic lens that can be screwed in and out to focus the camera. Fixed focus lenses, which have no provision for adjustment, are also available. As a camera system's depth of field is greater for small image formats and is greater for lenses with a large f-number (small aperture), the systems used in webcams have a sufficiently large depth of field that the use of a fixed focus lens does not impact image sharpness to a great extent.

Image sensors can be CMOS or CCD, the former being dominant for low-cost cameras, but CCD cameras do not necessarily outperform CMOS-based cameras in the low cost price range. Most consumer webcams are capable of providing VGA resolution video at a frame rate of 30 frames per second. Many newer devices can produce video in multi-megapixel resolutions, and a few can run at high frame rates such as the PlayStation Eye, which can produce 320×240 video at 120 frames per second. Support electronics read the image from the sensor and transmit it to the host computer. The camera pictured to the right, for example, uses a Sonix SN9C101 to transmit its image over USB. Typically, each frame is transmitted uncompressed in RGB or YUV or compressed as JPEG. Some cameras, such as mobile phone cameras, use a CMOS sensor with supporting electronics "on die", i.e. the sensor and the support electronics are built on a single silicon chip to save space and manufacturing costs. Most webcams feature built-in microphones to make video calling and videoconferencing more convenient.

The USB video device class (UVC) specification allows for interconnectivity of webcams to computers without the need for proprietary device drivers. Microsoft Windows , Linux [12] and Mac OS X (since October 2005) have UVC support built in and do not require extra device drivers, although they are often installed to add additional features.

B. Interfacing Webcam with ARM9:

The Webcam is interfaced to communicate with the ARM9 processor through USB protocol. The camera output format is yuv, before the output to the screen, the data format to be converted to RGB565 format.

Memory

System uses 64 MB of SDRAM, the two K4S561632 chips, working in 32 bit mode. Another 64 MB of NAND Flash, using K9F1208 chip through the Linux inter-process communication, one of the signal communication, spread torun in Linux user space applications.

III. Embedded Human Face Recognition System

Traditional face recognition system includes five parts: (1) inputting image from camera, (2) face detection, (3) preprocessing, (4) feature extraction, (5) feature matching. The Figure 1 is the work flow chart of embedded face recognition system in my project.

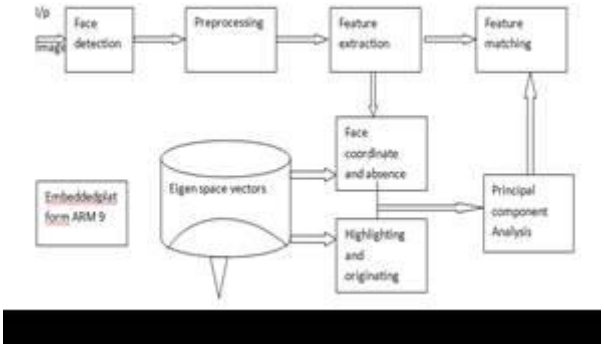

Fig 1 shows the Block diagram of Human Face recognition system

IV. Recognition Algorithms:

Face recognition involves two stages

- Face Detection
- Face Recognition

Face Detection:

Face detection is the stage where a photo is searched to find any face (shown here as a green rectangle), then image processing cleans up the facial image for easier recognition.

Face recognition is the stage where that detected and processed face is compared to a database of known faces, to decide who that person is (shown here as red text). It can also be very difficult to detect a person's face if the photo is not very bright or if part of the face is brighter than another or has shadows or is blurry or wearing glasses, etc.

However, Face Recognition is much less reliable than Face Detection, generally 30-70% accurate. Face Recognition has been a strong field of research since the 1990s, but is still far from reliable, and more techniques are being invented each year such as the ones listed at the bottom of this page (Alternatives to Eigen faces such as 3D face Recognition or recognition from video). To learn the theory of how Eigen face works, you should read Face Recognition with Eigen face from Servo Magazine and perhaps the mathematical algorithm

In the above Figure the first step is to detect human face. Face detection is one of the main technical parts of the automatic face recognition system. Face detection is one of the main technical parts of the automatic face recognition system. Face detection needs to determine whether the given image is a face, if it is someone's face, and then return the position of the face. In order to better recognize all of the faces in the image, the system use face class Haar feature to detect human face. After having gotten all of the faces, the next step is finding the special face. Compared with traditional face recognition system, in this thesis the embedded face recognition system is based on the work carried.

V. Analysis of working algorithm:

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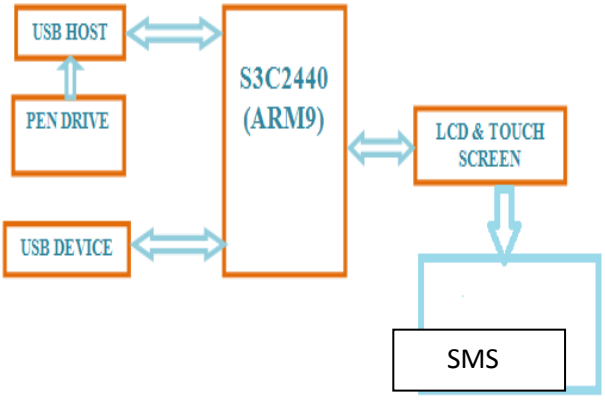


Fig 2 Working flow chart

a) Face Detection Base on Haar Feature

Haar-like features are digital image features used in object recognition. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector. Historically, working with only image intensities (i.e., the RGB pixel values at each and every pixel of image) made the task of feature calculation computationally expensive.

An earlier publication discussed working with an alternate feature set based on Haar wavelets instead of the usual image intensities. Viola and Jones adapted the idea of using Haar wavelets and developed the so called Haar-like features. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image.

For example, let us say we have an image database with human faces. It is a common observation that among all faces the region of the eyes is darker than the region of the cheeks. Therefore a common haar feature for face detection is a set of two adjacent rectangles that lie above the eye and the cheek region. The position of these rectangles is defined relative to a detection window that acts like a bounding box to the target object (the face in this case).

In the detection phase of the Viola–Jones object detection framework, a window of the target size is moved over the input image, and for each subsection of the image the Haar-like feature is calculated.

This difference is then compared to a learned threshold that separates non-objects from objects. Because such a Haar-like feature is only a weak learner or classifier (its detection quality is slightly better than random guessing) a large number of Haar-like features are necessary to describe an object with sufficient accuracy. In the Viola–Jones object detection framework, the Haar-like features are therefore organized in something called a classifier cascade to form a strong learner or classifier.

The key advantage of a Haar-like feature over most other features is its calculation speed. Due to the use of integral images, a Haar-like feature of any size can be calculated in constant time (approximately 60 microprocessor instructions for a 2-rectangle feature). The feature database contains 3 types and 4 different forms of features. The 3 types: 2 rectangles feature, 3 rectangles feature, and 4 rectangles feature.

b) Gabor Filters and Gabor Feature Extraction of Human Face

Human face images are represented by the direct use of pixel gray value. The gray values are affected by face expressions, lighting conditions and various geometric transformations, while the Gabor filter can capture the images which correspond to the local structure information of the spatial location, spatial frequency and direction. It is not sensitive to the brightness of face image and the changes of human face expression, and it is beneficial for multi-gesture face recognition.

Two dimensional Gabor filter is a kind of band-pass filter; in spatial domain and frequency domain Gabor filter has a better distinguish ability, such as direction selectivity in spatial domain and frequency selectivity in frequency domain. The parameters of two dimensional Gabor filters reflect the ways of sampling in spatial domain and frequency domain, and determine the ability of expressing signal.

C)Human Face Image Recognition Based on PCA

PCA method (ie, eigenface method) is M. Turk and A. Pentland proposed in the literature, the basic idea is: the image vector by KL transformation from high-dimensional vector is converted to low-dimensional vector, and the formation of low-dimensional linear vector space, that is, subspace, and then face the projector to the low-dimensional space, with the resulting projection coefficients as the recognition feature vectors. Recognize faces, just the projection coefficient of samples to be identified in the target database sample set of projection coefficients were compared to determine what types of recently.

PCA algorithm is divided into two steps: the core face database generation phase, the training phase and identification phase.

(1) The core face database generation phase.

1) Suppose there are K Zhang M × N size of face image. Each image by column into the first (M × N) × 1 column vector, named as xi, i = 1,2, ..., K.

2) calculation of the characteristics of AAT vector μi; calculated that the amount of retained j largest subspace feature vector composition.

3) will each face φ (after subtracting the mean) j expressed as a linear combination of a feature vector, φ is the characteristic face. Standardized training for each face φi with Ω = (ω1i, ω2i, ..., ωji) T, i = 1,2, ..., K said.

(2) identify the stage.

1) set up to identify the unknown faces as T, T by the column first change is a vector xt.

2) xt may find the difference between the average face ψ φ. Then φ to the subspace projection, that is,

3) will be expressed as φ < / P>

4) Finally, calculate the Euclidean distance of two matrices if er <ξ, where ξ is a fixed value, the face to be identified.

radius: r

D) Implementation of final system

The current project face recognition system makes use of latest, less power consumptive, small size and fast working micro controller like S3C2440.It uses an USB camera

to take a snapshot of the users that are present in front of camera. The captured images are stored into NAND flash. The current project utilizes Haar- like features for object recognition. The key advantage of Haar-like features over most other features is it calculation speed. Due to use of integral images, a Haar-like features can be calculated for any size in constant time(approximately 60 microprocessor instructions for a 2-rectanglefeature). By using the Haar-like features the face part of the any user will be detected if next time same user will come then it compares the newly captured image with the image that already existing in the internal database. If any match occurs then face recognition system shows how many times matching is occurred and at what time the matching is occurred. if its matched that image output show in mobile.

Fig.3 The original images

Fig 4 The final images of face detection

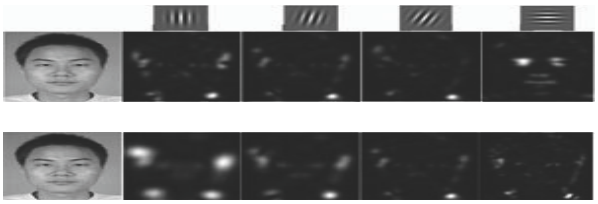
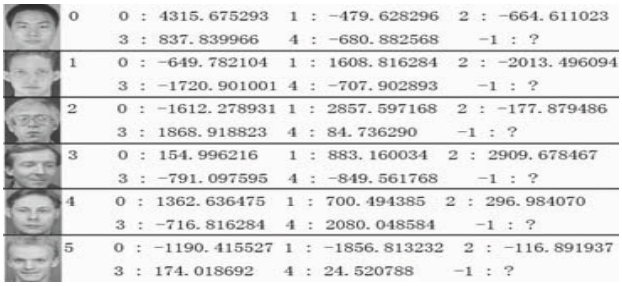


Fig.5 The features of the image edge.



0	0 : 4315.675293	1 : -479.628296 2 : -664.611023
	3 : 837.839966	4 : -680.882568 -1 : ?
1	0 : -649.782104	1 : 1608.816284 2 : -2013.496094
	3 : -1720.901001	4 : -707.902893 -1 : ?
2	0 : -1612.278931	1 : 2857.597168 2 : -177.879486
	3 : 1868.918823	4 : 84.736290 -1 : ?
3	0 : 154.996216	1 : 883.160034 2 : 2909.678467
	3 : -791.097595	4 : -849.561768 -1 : ?
4	0 : 1362.636475	1 : 700.494385 2 : 296.984070
	3 : -716.816284	4 : 2080.048584 -1 : ?
5	0 : -1190.415527	1 : -1856.813232 2 : -116.891937
	3 : 174.018692	4 : 24.520788 -1 : ?

Fig 6 The sample images and the training data of PCA.

VI. Conclusion

In this work, the development process of embedded face recognition system is introduced in detail, including transplantation of Linux operating system, the development of drivers, and the research of the corresponding algorithms of face recognition. By testing the system, it basically achieves the desired result.

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