International Journal of Engineering Research and Science & Technology

ISSN : 2319-5991
Vol. 4, No. 2
May 2015

www.ijerst.com

Email: editorijerst@gmail.com or editor@ijerst.com

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Vol. 4, No. 2, May 2015

Research Paper

FACE RECOGNITION BASED ATTENDANCE MANAGEMENT SYSTEM BY USING EMBEDDED LINUX

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Students attendance in the classroom is very important task and if taken manually wastes a lot of time. There are many automatic methods available for this purpose, i.e., biometric attendance. All these methods also waste time because students have to make a queue to touch their thumb on the scanning device. This work describes the efficient algorithm that automatically marks the attendance without human intervention based on Embedded Linux. This attendance is recorded by using a camera attached in front of classroom that is continuously capturing images of students, detect the faces in images and compare the detected faces with the database and mark the attendance. The paper review the related work in the field of attendance system then describes the system architecture, software algorithm and results.

Keywords: S3C2440, USB camera, NAND flash, Attendance, Face Detection, Face Recognition, Image Enhancement, Enrollment, Verification, Embedded Linux

INTRODUCTION

Maintaining the attendance is very important in all the institutes for checking the performance of students. Every institute has its own method in this regard. Some are taking attendance manually using the old paper or file based approach and some have adopted methods of automatic attendance using some biometric techniques. But in these methods students have to wait for long time in making a queue at time they enter the classroom. Many biometric systems are available but the key authentication are same is all the techniques . Every biometric system consists of enrolment process in which unique features of a person is stored in the database and then there are processes of identification and verification. These two processes compare the biometric feature of a person with previously stored template captured at the time of enrollment. Biometric templates can be of many types like Fingerprints, Eye Iris, Face, Hand Geometry, Signature, Gait and voice. Our system uses the face recognition approach for the automatic attendance of students in the classroom environment without students' intervention. Face Recognition consists of two steps, in first step

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faces are detected in the image and then these detected faces are compared with the database for verification. A number of methods have been proposed for face detection i.e. AdaBoost algorithm, the FloatBoost algorithm, Neural Networks, the S-AdaBoost algorithm , Support Vector Machines (SVM) , and the Bayes classifier. The efficiency of face recognition algorithm can be increased with the fast face detection algorithm. In all the above methods Voila and Jones is most efficient. Our system utilized this algorithm for the detection of faces in the classroom image by using Embedded Linux.

Linux has been available for the ARM architecture for many years now. The original port was done by Russell King, and he is still the maintainer through whom all ARM kernel patches generally must pass. GNU/Linux is fast becoming the operating system for embedded devices - mainly due to the efficient and portable design of the Linux kernel. The ARM Linux port effort, headed by Russell M. King, also makes life a bit easier for people who run (or want to run) Linux on their embedded devices.

Face recognition techniques can be divided into two types Appearance based which use texture features that is applied to whole face or some specific regions, other is Feature based which uses geometric features like mouth, nose, eyes, eye brows, cheeks and relation between them. Statistical tools such as Linear Discriminant Analysis (LDA), Principal Component Analysis (PCA), Kernel Methods , and Neural Networks, Eigen-faces have been used for construction of face templates. Illumination invariant algorithm is utilized for removing the lighting effect inside the classroom.

IMPLEMENTATION OF SYSTEM

The system is based on the ARM9 processor, using Voila and Jones 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. 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. 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.

Transplantation of Embedded Linux Kernel

The Linux kernel version that the system choose is special for the embedded systems: Linux Kernel v2.4.18, in the kernel source code directory by typing “make menuconfig” command can configure the kernel. After entering the main interface the kernel can be configured in many aspects. Generally the commands, which are used to compile the kernel, are as follow:

root# make dep

root# make zImage

Kernel C source code files have a certain dependency relationship with header files; Makefile has to know this relationship in order to determine which parts of source codes are needed to be compiled. But using “make menuconfig” command to configure the kernel, the command will automatically generate the required header files for compiling kernel.

Therefore, after we change the configuration of the kernel and input the command, the correct dependency relationship should be reestablished. But this step in the kernel2.6 version is no longer required.

Implementation of Drivers Development

Linux device driver can be divided into the following parts: Registration and cancellation of the driver;

Opening and releasing the device; Reading and writing the device; Controlling the device; the interrupts of device and the cyclic process. Embedded Linux kernel which already contains many source codes of general purpose hardware device driver for different hardware platforms, they are only needed to be done some simple modifications and then can be used. For some of the more special equipments (such as the camera drive), you need a detailed understanding of the hardware and then finish the driver development. Video4Linux provides a unified programming interface for the USB camera. In this paper, the USB camera device file —— (/dev/video0) is primary to capture and store images for the corresponding programs. Data structures are commonly used in the program as follow:

struct voide_capability grab_cap; video_capability contains the camera's basic information, such as device name, the max and min resolution, and signal source information and so on. Corresponding to member variables: name, maxwidth, maxheight, minwidth, minheight, channels (the number of signal source)type and so on. struct video_picture grab_pic; voide_picture contains a variety of properties of the captured images, such as: brightness, hue, contrast, whiteness, depth and so on. struct video_mmap grab_buf; video_mmap is used to map memory. struct video_mbuf grab_vm; video_mbuf uses mmap to map frames information, which actually is the frames information from the camera buffer memory. Contains: size, frames, offsets and so on.

EMBEDDED LINUX BASED ATTENDANCE SYSTEM

Enrollment

First step in every biometric system is the enrollment of persons using general data and their unique biometric features as templates. This work uses the enrollment algorithm as shown in the Figure 1.

Figure 1: Enrollment Process

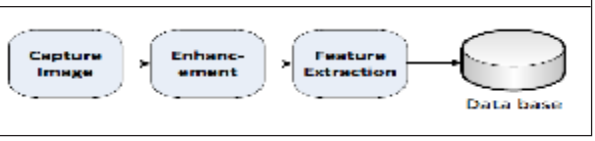
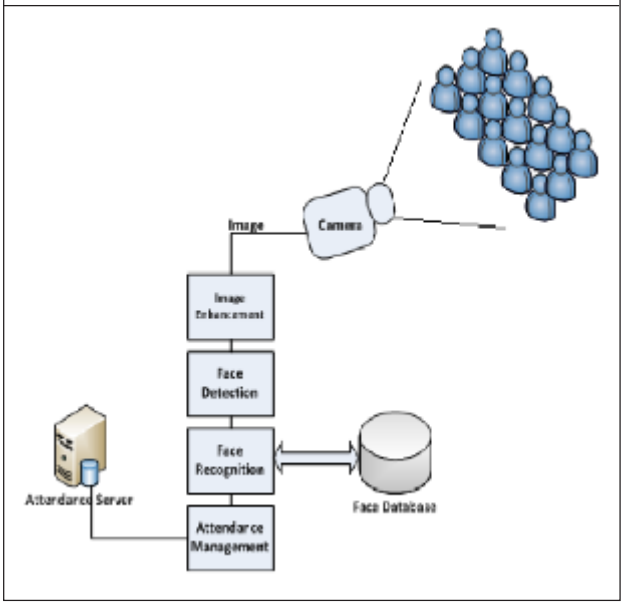


Image is captured from the camera and then it is enhanced using histogram equalization and noise filtering. In the second step face is detected in the image and features are extracted from it. These unique features are then stored in the face database with certain id of that person.

System Description

The system consists of a camera that captures the images of the classroom and sends it to the image enhancement module. After enhancement the image comes in the Face Detection and Recognition modules and then the attendance is marked on the database server. This is shown in the experimental setup in Figure 2. At the time of enrollment templates of face images of individual students are stored in the Face database. Here all the faces are detected from the input image and the algorithm compares them one by one with the face database. If any face is recognized

Figure 2: Experimental Setup



the attendance is marked on the server from where anyone can access and use it for different purposes. This system uses a protocol for attendance. A time table module is also attached with the system which automatically gets the subject, class, date and time. Teachers come in the class and just press a button to start the attendance process and the system automatically gets the attendance without even the intensions of students and teacher. In this way a lot of time is saved and this is highly secure process no one can mark the attendance of other. Attendance is maintained on the server so anyone can access it for it purposes like administration, parents and students themselves.

Camera takes the images continuously to detect and recognize all the students in the classroom. In order to avoid the false detection we are using the skin classification technique. Using this technique enhance the efficiency and accuracy of the detection process. In this process first the skin is classified and then only skin pixels remains and all other pixels in the image are set to black, this greatly enhance the accuracy of face detection process. Two databases are displayed in the experimental setup Figure 2. Face Database is the collection of face images and extracted features at the time of enrollment process and the second attendance database contains the information about the teachers and students and also use to mark attendance.

SYSTEM ALGORITHM

This section describes the software algorithm for the system.

The algorithm consists of the following steps

- Image acquisition
- Histogram normalization
- Noise removal
- Skin classification
- Face detection
- Face recognition
- Attendance

In the first step image is captured from the camera. There are illumination effects in the captured image because of different lighting conditions and some noise which is to be removed before going to the next steps. Histogram normalization is used for contrast enhancement in the spatial domain. Median filter is used for removal of noise in the image. There are other techniques like FFT and low pass filter for noise removal and smoothing of the images but median filter gives good results.

This Algorithm is shown in the Figure 3. Next is the description of each step in the above algorithm with effects on the images after each process.

Figure 3: Software Algorithm

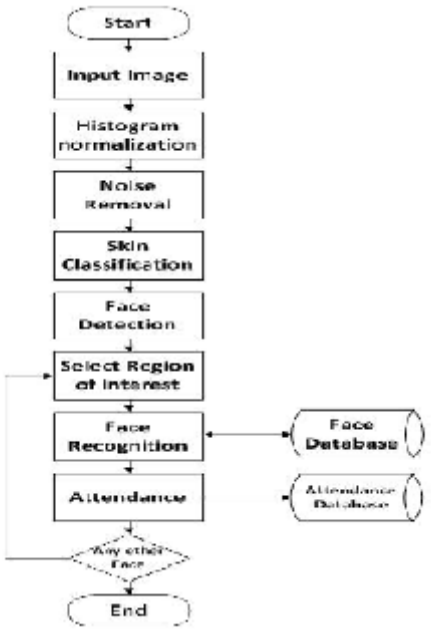


Image Acquisition

Image is acquired from a high definition camera that is connected above the white board.

This camera is connected to the computer. It captures images after every 2 min and sends these images to the computer for processing. Figure 4 shows the input image of classroom captured by the camera.

Figure 4: Input Image

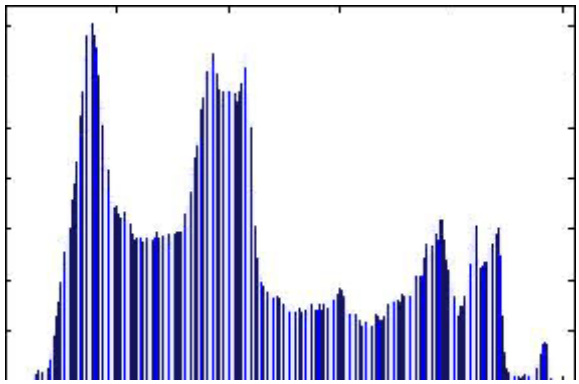
Histogram Normalization

Captured image sometimes have brightness or darkness in it which should be removed for good results. First the RGB image is converted to the gray scale image for enhancement which is shown in the Figure 5 below.

Figure 5: Gray Image of class

Figure 6 shows the histogram of the input gray scale image.

Figure 6: Histogram of Input Image

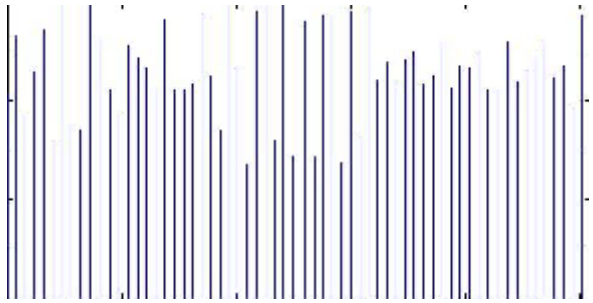


Histogram normalization is good technique for contrast enhancement in the spatial domain. Figure 7 shows the histogram normalized image of the input image.

This can be easily seen that the students sitting on the back rows are now clearly seen and in this way they can be easily recognized. There are other techniques for making an image illumination invariant. Figure 8 shows the histogram after the equalization of input image.

Figure 7: Histogram Equalized Image

Figure 8: Histogram of Equalized Image



Noise Filtering

Many sources of noise may exist in the input image when captured from the camera. There are many techniques for noise removal. Low pass filtering in the frequency domain may be a good choice but this also removes some important information in the image. In our system median filtering in is used for the purpose of noise removal in the histogram normalized image.

Skin Classification

This is used to increase the efficiency of the face detection algorithm. Voila and Jones is used for detection and its accuracy can be increased if the skin is classified before the scanning procedure of faces.

As can be shown in the above Figure 9 pixel those are closely related to the skin becomes white and all other are black. This binary image uses the thresholding of skin colors.

Figure 9: Skin Classification

Face Detection

In this section faces are detected and shown in the Figure 10 by marking circles on the faces of students.

Figure 10: Face Detection

This can be seen from the Figure 7 that after the process of skin classification the detection rate of algorithm improved. Haar classifiers have been used for detection. Initially face detection algorithm was tested on variety of images with different face positions and lighting conditions and then algorithm was applied to detect faces in real time video.

Algorithm is trained for the images of faces and then applied on the class room image for detection of multiple faces in the image. The algorithm can also detect the veil faces as shown in the Figure 11. After the detection of faces from the images next step is cropping of each detected

Figure 11: Face Detection

face. The algorithm uses the technique of threading to enhance the speed of algorithm. Each cropped image is assigned to a separate thread for the recognition purposes.

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