Journal of Information Assurance and Security.
ISSN 1554-1010 Volume 9 (2014) pp. 138-147

Wireless Fingerprint Attendance Management System

Maddu Kamaraju[1], Penta Anil Kumar[2]

[1]E.C.E Department, Gudlavalleru Engineering College, Gudlavalleru, India
[1]*madduraju@yahoo.com*,

[2]*E*.C.E Department, Gudlavalleru Engineering College, Gudlavalleru, India
[2]anilmtechh@gmail.com

***Abstract*— in this paper provides the design method of wireless fingerprint attendance system based on Zigbee technology. The system includes terminal fingerprint acquisition module and attendance management module through computer. It can realize automatically such functions as information acquisition of fingerprint, processing, wireless transmission, fingerprint matching, and attendance management. This attendance management system aims at providing an easy and time saving attendance system that verifies the employee's attendance system at an organization using their fingerprint during the attendance time. When a employee is first enrolled in a fingerprint-based biometric attendance system, the software records a pattern of the employee's fingerprint using a scanner and associates that pattern with the employee's identification number. This template measures the connection between various points in the fingerprint. At the time of attendance, the system verifies that the newly scanned fingerprint matches the pattern originally stored for that identification number. If there is a equal, the knock is recorded. The system will eliminate buddy punch. It will efficiently replace the manually maintained records and the conventional time consuming way of marking attendance. The system may also record the employee's outgoing and incoming time during the days, thus facilitating organizations. In order to achieve the simple and high real-time system, it realized low-cost and high-performance wireless fingerprint attendance function, which provided a new wireless fingerprint attendance system for enterprises and institutions. The earlier fingerprint image enhancement methods are FFT based and has a drawback of poor image quality which results in unreliable minutiae extraction and thereby reduces the accuracy of recognition result. In this paper, at the algorithm level a new approach for fingerprint image enhancement based on the Gabor filter is introduced. Comparatively this algorithm produced the good results in the view of image quality and accuracy.**

Keywords- Attendance; Zigbee; Fingerprint; Gabor filter; Image enhancement;

I. INTRODUCTION

Normally, The Attendance management can reflect truly staff attendance, which provides references for competent authorities. Attendance management is one of the most basic and important management links. Currently, the magnetic card attendance system is widely used. This pattern is Flexible and practical. But it has some disadvantages. For example, the card is easy to lost and damage. The fingerprint has a lot of advantages, such as unique, permanent, good anti-fake and easy to use. So it is recognized increasingly by people. Zigbee technology is an emerging technology developed in recent years. Comparing with some existing wireless communication technologies, Zigbee has advantages in low-power and low cost. It is very suitable for application to wireless sensor networks. Aiming at the disadvantages of traditional wire attendance system, a design method of wireless fingerprint attendance system based on Zigbee technology is proposed. It achieves attendance management by fingerprint identification. At the same time, the system combines Zigbee wireless technology and attendance management. It realized low-cost, low-power and high-performance fingerprint information acquisition, transmission and recognition function, which provided a new attendance way for enterprises and institutions.

For the development of this attendance management system biometric fingerprint sensor is used as data acquisition module. The Biometrics are automated methods of recognizing an individual based on their physiological (e.g., fingerprints, face, retina, iris) or behavioural characteristics (e.g., gait, signature). Each biometric has its strengths and weaknesses and the choice typically depends on the application. There are a number of desirable properties for any chosen biometric characteristic. These include Universality, Uniqueness, Permanence, Measurability, Performance and Acceptability. For any particular application, no single biometric characteristic is expected to effectively meet all these properties. Various biometric technologies are fingerprint, face, iris, hand geometry, voice and signature recognition. Among all those, fingerprint technology is the oldest biometric technology, but still it is most widely used because it provides good levels of accuracy and simplicity. This technology is highly reliable for the recognition purpose because of their uniqueness and consistency over the time. Also, the fingerprint is fast biometric technique for more reliable and secure system.

A fingerprint, as the name suggests is the print or the impression made by our finger because of the patterns formed on the skin of our palms and fingers since birth. With time, these marks get prominent but the pattern and the structures present in those fine lines do not undergo any change. Because of their permanence and unique nature,

they have been used in criminal and forensic cases for a long time [1].

Every fingerprint consists of ridges and furrows. Literature survey [1] [2] confirms that fingerprints are not distinguished by ridges and furrows but by Minutia. Minutia refers to some abnormality in a ridge. There can be various such Minutia but the two most important and useful minutia types are Termination and Bifurcation. A ridge Termination is defined as a point on the ridge where a ridge ends abruptly or suddenly. On the other hand Bifurcation is defined as point on the ridge where a ridge is divided into two separate ridges. These minutiae points are treated as the features of fingerprint image.

II. STRUCTURAL VIEW OF WIRELESS FINGERPRINT ATTENDANCE MANAGEMENT SYSTEM

The system consists of transmission and receiving module, and attendance Management workstation. The transmitter module consists of fingerprint acquisition module, fingerprint processing module (DSP), Zigbee transmitter module. Fingerprint acquisition module is used to realize fingerprint collecting process. The DSP fingerprint processing is used to realize fingerprint extraction and matching in order to realize attendance management operation. The Zigbee transmitting module is used to send the finger print image related information to the computer. Similarly Zigbee receiving module is used to receive the fingerprint information that is ID from the transmitter section. Attendance management workstation is used to maintain the database related to employees.

III. HARDWARE DESIGN OF WIRELESS FINGERPRINT ATTENDANCE MANAGEMENT SYSTEM

This system can realize automatically such functions as information acquisition of fingerprint, processing, wireless transmission, fingerprint matching, and attendance management. This attendance system can be designed using two sub modules namely transmitter module and receiver module. The two modules are designed using embedded system technology.

The literature survey [5] has confirmed that a number of embedded hardware platforms exist to implement the real time signal processing solutions. Each platform has its strengths and weaknesses. A number of design criteria determine the best hardware platform for signal processing applications. The criteria include performance, ease of development, power consumption, feature flexibility, economy, etc. These parameters help to make the right choice. The hardware platforms available for implementing the real time signal processing applications; are Application-Specific Integrated Circuit (ASIC), DSP (Digital Signal Processor), FPGA (Field Programmable Gate Array), MCU (Micro Controller Unit) and RISC (Reduced Instruction Set Computer).

Among the above mentioned hardware platforms, FPGAs and DSPs offer unique and different options for signal processing. The DSPs will continue to be used for many of today's challenging signal processing applications. The reasons for this are stated below.

The DSPs are especially designed for signal processing applications. They provide good flexibility in real time environment. But FPGAs are not as much flexible as DSPs in real time aspect. So finally, DSP is selected for the implementation of the transmitter and receiver modules of this attendance management system.

A. Transmitter Module Block Diagram

This block consists of a finger print module that captures the data which is a person's fingerprint. The image that is captured by the fingerprint module is given to DSP for the further processing of the image. During the fingerprint registration phase, the DSP process the image, extract the features from the image and then from the template related to current input user's fingerprint. Finally the DSP store the template along one unique ID in the SDRAM database and also send the ID information to the receiver module with the help of Zigbee transmitter and Zigbee transmission channel. During the fingerprint matching phase, the DSP process the image, extract the features from the image and then from the template related to current input user's fingerprint. In this case, DSP compares the current template with the templates that already exist in the SDRAM database. If the finger prints feature and some sample in the database matches, access is permitted. The unique id of the captured data is sent to receiver module through the Zigbee transmitter and Zigbee wireless channel for further processing like attendance management.

The DSP is the nucleus of this transmitter module. The system can run independently without Personal Computer (PC). At the same time, combined the external circuit, the system can achieve fingerprint collection, processing, identification, output and display. The transmitter module block diagram is shown in Fig. 1. The block diagram includes ADSP - BF532, fingerprint sensor, Zigbee transmitter, SDRAM, 2x16 LCD, MAX232, and clock generation circuit. The purpose of each hardware module is clearly explained below.

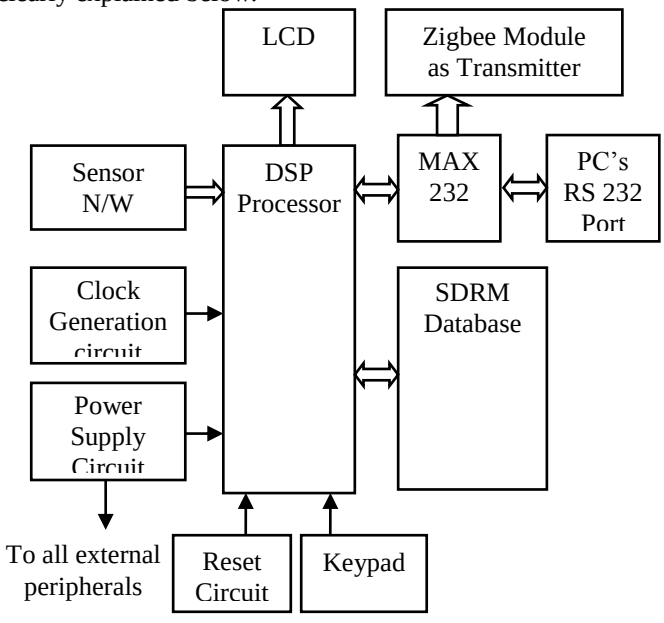

Figure 1. Transmitter module block diagram

ADSP - BF532 is the core of the transmitter module. BF532 produced by Analog Devices (AD) is a high performance and low power DSP. DSP-BF532 has plentiful on-chip peripheral interfaces included External Memory Interface (EMIF), a UART port, an SPI port, two serial ports (SPORTs), four general-purpose timers (three with PWM capability), a real-time clock, a watchdog timer, and a parallel peripheral interface (PPI).

The fingerprint sensor first illuminates the print with a laser or LED light and then captures the image. Resolution, dynamic range and pixel density are factors that contribute to the image quality and influence the accuracy of the sensor. Here Tooan OP-100N optical sensor is used for the implementation of transmitter module because it provides high resolution.

The transmitter module's application software is developed on the PC using Visual DSP++ project management tool. After development, this program needs to be dumped into DSP processor to achieve recognition task. So a communication path is required between PC and DSP. Generally the voltage levels supported by DSP are incompatible with PC's RS232 voltage levels. So a voltage convertor is required for communication between PC and DSP. Here MAX232 is used as the voltage level convertor.

This transmitter module requires 3 different voltages. These voltages are 5V, 12Vand 3.3V. The 3.3V is generated with the help of LM117 variable voltage regulator and is used to power up the BF532. The LCD, MAX232, keypad operates from a single 5-V power supply, and this supply is acquired by using a bridge rectifier and 7805 voltage regulator. The fingerprint sensor requires 12V power supply for its satisfactory operation and it is obtained with the aid of bridge rectifier and 7812 voltage regulator.

The Reset circuit resets the DSP device by assigning the internal registers and memory with default values.

This transmitter module is a user friendly design because it is designed to operate in 4 flexible user modes. The user can easily select any specific mode with the assist of portable common cathode configuration keyboard attached to the DSP.

A 2x16 LCD is connected to DSP device to display the result of various modes. The LCD can add a lot to our application in terms of providing useful interface to the user. The DSP is interfaced to LCD with the aid of port F.

B. Receiver Module Block Diagram

The receiver module receives the unique code i.e. ID from the transmitter and then give it to work station (PC) to register or update information related to the employee of the institution. The block diagram of the Receiver module is shown in Fig. 2.

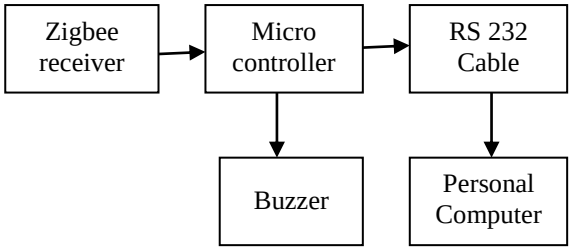

Figure 2. Receiver module block diagram

The unique id of the captured data is received by the Zigbee receiver module and is forwarded to microcontroller. The database of the person's that has been stored in microcontroller is compared with the unique id. If they match then a signal is indicated using the light and the buzzer. The microcontroller then sends the data to PC through RS232. The data is sent to PC for a specified time interval. The PC thus updates the information in the database.

IV. SOFTWARE IMPLEMENTATION OF WIRELESS FINGERPRINT ATTENDANCE MANAGEMENT SYSTEM

The transmitter module's application software is developed on the Visual DSP++ project management tool using C language. This C code is translated into assembly level language with aid of Visual DSP++ project management compiler. Finally the assembly level program is dumped into BF532 DSP. System application software mainly includes whole system initialization program, program of fingerprint feature extraction and matching, and computer communication program. This transmitter module application software mainly performs following tasks:

1. Initialize the ports of BF532 DSP.
2. Initialize the program memory and program memory pointer; pointer value indicates memory location where the processor starts program execution.
3. Initialize the stack memory and stack memory pointer.
4. Initialize the external SDRAM where the database is maintained and also initialize the I/O peripherals.
5. After the initialization process, the processor switch to user mode i.e., the processor checks the status of keyboard.
6. The processor changes its program sequence to one of the six subroutines. The six subroutines are new user enrolment, matching, delete, all delete increment and decrement. Each key in the keyboard is associated with one subroutine.
7. After the execution of a particular subroutine specified by the user through keyboard, processor switches to normal program flow.
8. Now the processor sends the data to LCD that displays the result corresponding to mode selected by the user. Suppose if the use select the matching mode, then LCD displays either *matching success* or *matching fail*.

This transmitter module is a *user friendly* design because it is designed to operate in 4 flexible user modes. The can easily select any specific mode with the assist of portable

keyboard. Each user defined mode can be clearly explained below.

A. New User Enrollment Mode

The new user can be registered into transmitter module by means of *New Enrollment* key on the keyboard. During the enrollment mode, a fingerprint sensor scans the person's fingerprint to create a digital representation. The pre-processing algorithm and feature extraction algorithm processes the digital representation to generate a more compact and expressive representation called a template. The template for each user is stored in a recognition system database (SDRAM) for the purpose of future comparison. The *New User Enrollment mode* is supported by the enrollment algorithm comprises of pre-processing algorithm feature extraction algorithm [6] [7] [8]. After extracting the minutia points, form the template corresponding to new input user and then stored in a specific memory location. The desired memory location can be selected with the help of increment and decrement keys on the keyboard. Enrollment algorithm steps are briefly furnished below. Enrollment algorithm flow is shown in Fig. 3.

1) Noise Removal and Image Segmentation

The image acquired from the fingerprint sensor is temporarily stored in the SDRAM. The noises introduced into the image during fingerprint acquisition process, so the image is first subjected to noise removal process. After removing the noise, image is segmented. In a fingerprint image there are foreground regions and the background regions. The Segmentation process separates the foreground regions in the image from the background regions. The background regions where the noises introduced into the image during fingerprint enrolment process. When minutiae extraction algorithms are applied to the background regions of an image, it results in the extraction of noisy and false minutiae. Thus, segmentation is employed to discard these background regions, which facilitates the reliable extraction of minutiae [3].

2) Local Normalization

Normalization is performed on the segmented fingerprint image to standardize the grey-level intensity values in an image by adjusting the range of grey-level values so that it lies within a desired range of values.

3) Block Orientation Estimation

The block direction estimation defines the local orientation of the ridges contained in the fingerprint. The least mean square estimation algorithm is used to calculate the block direction

4) Image Enhancement using Gabor filter

The Gabor filter is applied to the fingerprint image by spatially convolving the image with the filter. The convolution of a pixel (i, j) in the image requires the corresponding orientation value $O(i,j)$ and ridge frequency value $F(i,j)$ of that pixel. Hence, the application of the Gabor filter G to normalized image provides the enhanced image.

5) Image Binarization

The original image is an 8-bit grayscale image. The binarization process converts a grey-scale image into binary image by assigning pixel values ‘1’ for furrows and ‘0’ for ridges.

6) Minutia Extraction and False Minutia Removal

After the ridge thinning process, the next step is to extract the minutiae from the thinned fingerprint image. The concept of Crossing Number (CN) is most extensively used method for extracting the minutiae from fingerprint image. Along with genuine minutia points some false minutia points are also present in the fingerprint image. So identify where these points are located and remove those points.

After extracting the minutia points, form the template corresponding to new input user fingerprint and then stored in a specific memory location of SDRAM.

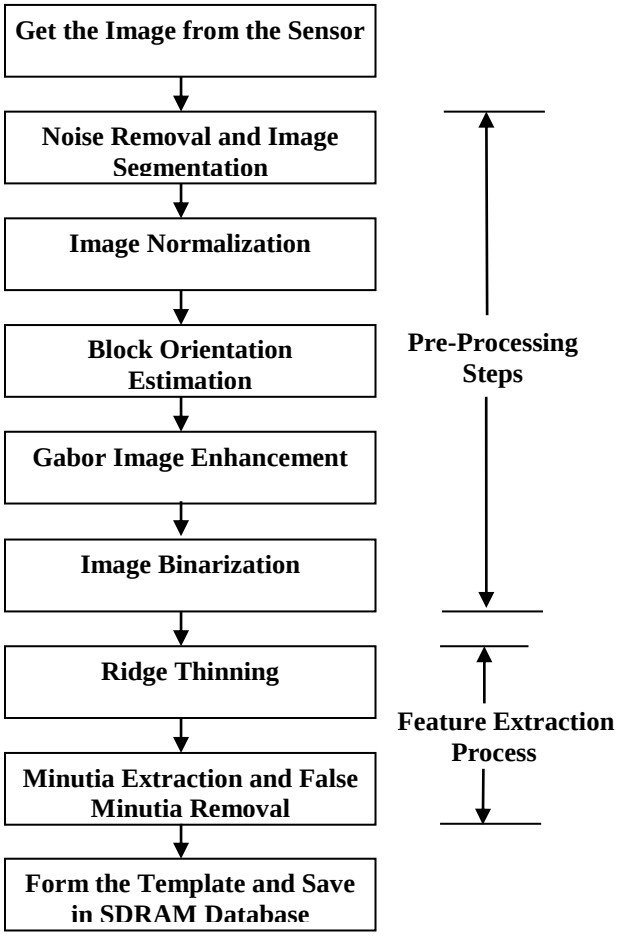

Figure 3. Enrollment algorithm flow

7) Image Binarization

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B. Matching Mode

The matching mode is responsible for identifying individuals at the point of access. Matching Process is shown in Fig. 4.

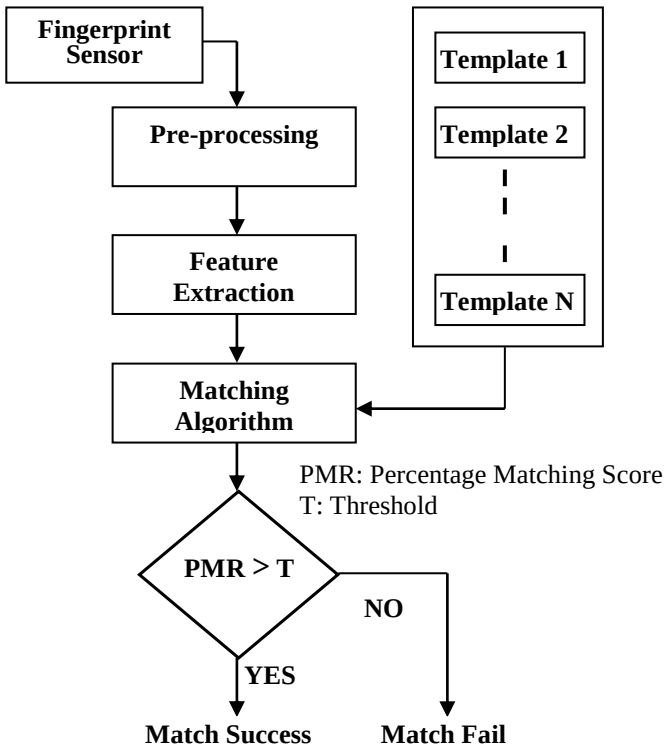


Figure 4. Matching process

During the operation phase, the fingerprint sensor captures the fingerprint of individual to be identified and converts it to a digital format, which is further processed by the pre-processing algorithm and feature extraction algorithm to produce the same representation. The resulting representation is fed to the minutia matching algorithm which compares it against the template(s) stored in the SDRAM database to found the identity. The matching algorithm calculates the Percentage Matching Score (PMR). If the matching score satisfies the specific condition then match is declared as successful match otherwise it is considered as the Failure match [9]. Here the matching algorithm used is elastic match algorithm.

Given two set of minutia of two fingerprint images, the elastic match algorithm determines whether the two minutia sets are from the same finger or not. An alignment-based match algorithm is used. It includes two consecutive stages: one is alignment stage and the second is match stage.

In the Alignment stage, given two fingerprint images to be matched, any one minutia from each image is chosen, and the similarity of the two ridges associated with the two referenced minutia points is calculated. If the similarity is larger than a threshold, each set of minutia is transformed to a new coordination system whose origin is at the referenced point and whose x-axis is coincident with the direction of the referenced point. The new coordinate system is originated at reference minutia M and the new x-axis is coincident with the direction of minutia M. No scaling effect is taken into account by assuming two fingerprints from the same finger have nearly the same size. So we get transformed sets of minutiae I_1' and I_2'.

In the Match stage, after obtaining two set of transformed minutia points, the elastic match algorithm is used to count the matched minutia pairs by assuming two minutia having nearly the same position and direction are identical.

An elastic string (x, y, θ) match algorithm is used to find number of matched minutia pairs among I_1' & I_2'. According to the elastic string match algorithm, minutia mi in I1' and a minutia mj in I_2' are considered "matching," if the spatial distance (sd) between them is smaller than a given tolerance r_0 and the direction difference (dd) between them is smaller than an angular tolerance Θ_0.

Let mm (.) be an indicator function that returns 1 in the case where the minutiae mi and mj match according to above equations.

$$mm(mi, mj) = 1, \quad sd(mi, mj) \le r_0 \text{ and } dd(mi, mj) \le \Theta_0$$
$$= 0, \quad \text{otherwise}$$

Now the total number of matched minutiae pair given by,

$$\text{Num (matched minutiae)} = \sum mm(mi, mj)$$

And final match score is given by,

$$\text{Match Score} = \frac{\text{Num (matched minutiae)}}{\text{Max (num of minutiae in } I_1, I_2)}$$

If the match score is greater than a threshold value which is pre-specified, then the two fingerprints taken are from the same finger.

The complete elastic fingerprint matching process is represented as flowchart in Fig. 5. The various terms mentioned flowchart are illustrated below.

The variables 'i' and 'j' are always compared with NF (I_1) and NF (I_2) respectively.

Where NF (I_1) = Number of features extracted from image 1. NF (I_2) = Number of features extracted from image 2.

Let us consider the two minutia m1 and m2, and these minutia are said to be matched The minutia mi in I_1' and a minutia mj in I_2' are considered "matching," if the spatial distance (sd) between m1 and m2 is smaller than a given tolerance r_0 and the direction difference (dd) between them is smaller than an angular tolerance Θ_0.

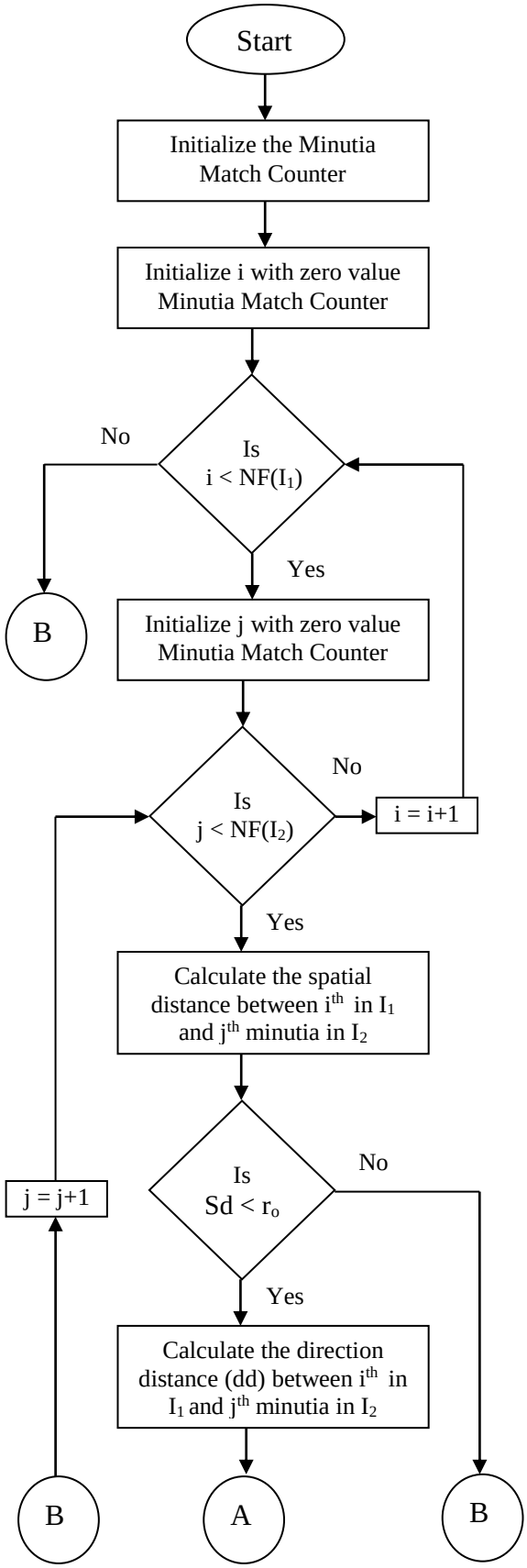
Where r_0 = spatial distance threshold.

Θ_0= Threshold for direction difference.

During the matching process, minutia match counter is incremented by one each time one pair of a minutia matched. After the completion of matching task, the minutia match counter holds the total number of matched minutiae.

Based on the minutia match count, percentage matching score is calculated. Now the calculated value of percentage

match score is compared against the threshold value. If the percentage match score is greater than threshold value then the match is declared as the successful match.



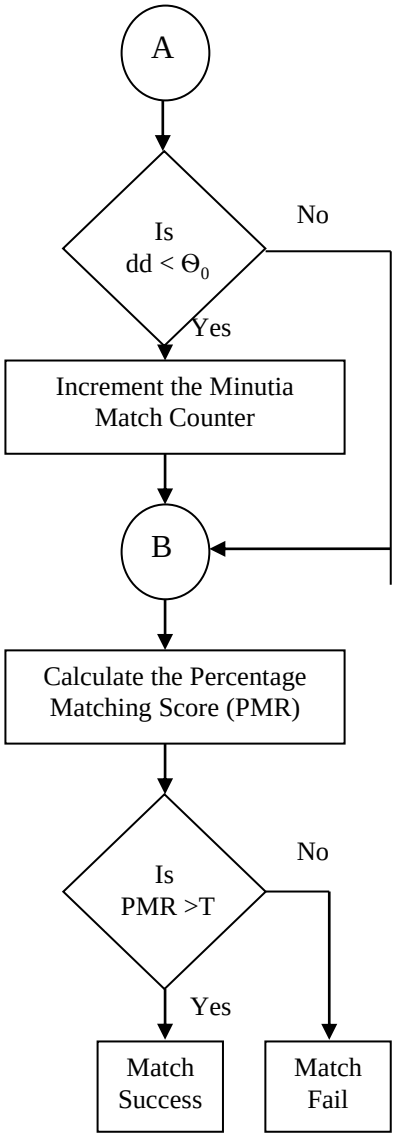


Figure 5. Elastic matching flow chart

C. Delete and Delete All Modes

The Increment and Decrement Keys on the keyboard are utilized for incrementing and decrementing the SDRAM memory pointer. Deletion mode allows user to delete a preferred fingerprint in the SDRAM by making use of increment, decrement and Delete keys. Suppose for example, if a user wants to delete any particular fingerprint from the SDRAM database, first he/she has to select the memory location from which the print is to be deleted by using increment/decrement keys and then press the Delete key.

The Delete All mode permits user to delete all the prints in the database.

V. IMPLEMENTATION OF DATABASE MANAGEMENT SYSTEM

In this paper, a three module database system is proposed where a database in MS access is already created. It stores the employee details such as ID, name, department; college name etc along with their fingerprint template. ID is used as primary key which uniquely identifies each student. The system database consists of a collection of records, each of

which corresponds to *organizations*. Each record contains the following fields: Name of the person, ID, number of leaves, department, college name, contact number, address etc. along with templates of the person's fingerprint and other personal details of the employee. There are two users for this system. First user is Administrator and second one is Employee.

Administrator login is password protected. The supervisor acts as administrator. Administrator has the privileges to add, view and delete employee records. He can also view the reports of attendance marked. He has to provide details of employee who have applied for leave/permission. Thereby such employee's login is blocked during the period of their leave.

During the attendance time, each employee has to provide his/her ID number and the fingerprint template. The template stored corresponding to the ID number and the one provided are matched using a fingerprint matching algorithm that extracts features from both the templates. If there is a match the attendance is recorded. Administrator can check the list of employees who have not mark their attendance within the stipulated time. The system will take care of all the payroll activities like managing each employee's attendance, the number of leaves taken by that meticulous employee and calculation in a very quick manner and it avoid. Data storing is easier. Paper effort will be reduced and the company staffs spend more time on monitoring the progress. The system is customer friendly and easy to use. All the main data's will be stored in the database and it avoids any miscalculation.

The system is based on maintaining each employee records and calculating his/her salary depending on the workdays. The initial activity is based on saving the employees details where each employee will be given a unique Employee identification. Now based on the no of days an employee attended per month, salary will be calculated by scrutiny the no of workdays of a company and his/her basic salary and a separate salary slip will be provided for reference. Admin has the authority to add employee details. And he also has the exactly to edit or delete employee information to/from the list. Admin provides a exclusive username and password for each employee through which he can login all the information's are being saved in the database.

A. Various Sub-modules in the Database

The following sub modules are available in the implemented database management system.

- **Employee:** When a latest employee joins the company, his record is saved in the database.
- **Workdays:** the management has the authority to add the no of workdays of a company per month.
- **Salary Calculation:** Here salary is calculated for each employee based on their attendance. As soon as the pay is paid to an employee, a salary trip will be generated.
- **Salary Report:** Here the user can seem to be through the salary given to an employee for a particular month and year.
- **Register:** As soon as the employee joins the company, the admin provides unique username and password to him.
- **Display:** A user can view information regarding employees working in that company, crop, dealers and a demand sheet to be submitted to the manufacturers.
- **Logout:** This module allows the user to Logout the application. Extra operations cannot be performed after user exits.

B. Algorithm Design of Database management System

The step-by-step instructions of the database management algorithm design are furnished below.

***Step 1*:** START
Step 2 : IF record present in database
(a) Preview record as table or as complete analysis
(b) Or update record
(c) Or Delete record
(d) Or print record
(e) Or partial view employee fingerprint image in a maximized window
(f) or count record in database
ELSE GOTO step 3
Step 3: Register new employee
(a) Supply employee's profile
(b) Load employee's photograph
(c) Save record in database

VI. RESULTS

The various experimental results acquired from the embedded fingerprint recognition system are discussed below.

A. Simulation Results

To check the functionality of fingerprint image processing algorithms such as pre-processing algorithm, feature extraction algorithm and matching algorithm, they are firstly verified in MATLAB environment. After the accomplishment of verification phase or simulation phase, the equivalent 'c' code is developed on the Visual DSP++ project management environment. The MATLAB results corresponding to various image processing algorithms are furnished below.

Figure 6. Input image

Figure 7. Segmented image

Figure8. Normalized image

Figure9. Image with directions

Figure 10. Enhanced image **Figure 11.** Binarized image

Figure 12. Thinned image **Figure 13.** Image with minutia

B. Hardware Result Testing

The main objective of this work is to enroll fingerprints of different persons and add them to the database which would be referred at the time of verification. The hardware kit of the transmitter module is shown in Figure 14.

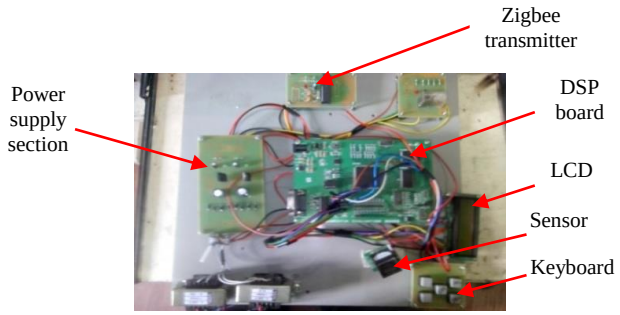


Figure 14. Hardware kit of the transmitter module

In this embedded fingerprint recognition system, the Blackfin Evaluation Board PS-TYRO-BF532 is used as the main module. This board is mainly designed for Signal and Image Processing Applications. This Board evaluating, most of the peripherals like EBIU, Timers, Programmable flags and SPI of the BF532 Processor. The physical layout of Blackfin Evaluation Board BF532 is shown in Figure 15.

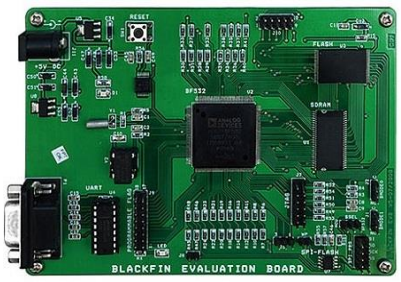


Figure 15. Physical layout of Blackfin evaluation board BF532

For the trial run of the system, fingerprints of persons were captured and then added them to database using the hardware kit in the laboratory. The templates stored were named from Person_1 to Person_50. This registration can be done with the help of new user registration mode. The system is tested with 50 registered users; in all cases it provides satisfactory result. Fig. 16 shows the System result when a registered user accesses the system.

Figure 16. Display of registered user accesses

The system is also tested with 50 Unregister users; in all cases it provides satisfactory result. Figure 17 shows the System result when an unregistered user accesses the system.

Figure 17. Display of unregistered user accesses

C. Database Testing

The database management system designed is tested with several options available in the database The database management system receives code from receiver section for initializing the port setting. Figure 18 shows the port setting of the database.

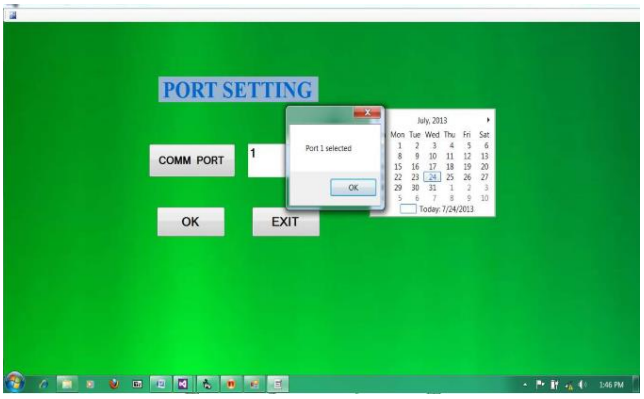


Figure 18. Initialization of COM port

The designed database management system main menu is shown in Figure 19.

Figure 19. Main menu of database management system

The new user can be registered into the database management system using "Registration Menu". Figure 20 shows the registration menu of database management system

Figure 20. Main menu of database management system

The Figure 21 shows the database management system when electronic option is selected

Figure 21. Database management system Display shows " electronics department menu"

Figure 22. Database management system Display shows when " Delete option is selected in the main menu"

To search no leaves of any one particular person in any one month, search option the database is used. The Figure 23 shows the search option in the database.

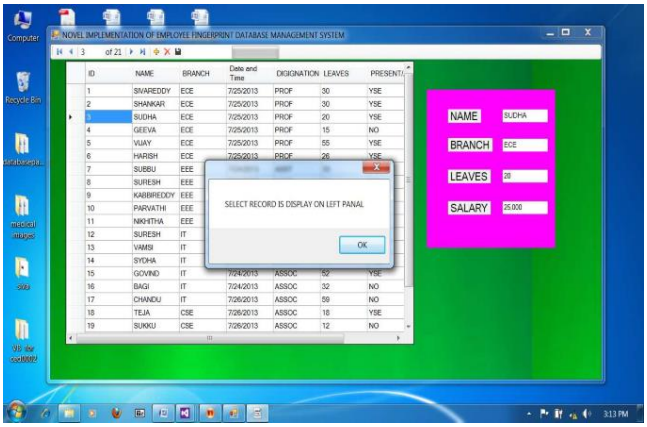


Figure 23. Database management system Display shows when "Search option is selected"

D. Result Analysis

The performance of the minutiae extraction algorithm relies heavily on the quality of the input fingerprint image. If the image quality is good, then the extraction algorithm extracts only a few number of false minutia points along with true minutia points. In case of poor image quality, the extraction algorithm extracts a more number of false minutia points together with required true minutia points. So in order to ensure to extract the true minutiae points (reliable extraction) it is essential to incorporate a good enhancement algorithm. The earlier fingerprint image enhancement methods has a drawback of poor image quality which results in unreliable minutiae extraction (extraction of both true and false minutia points) and thereby reduces the accuracy of recognition result. Hence a hybrid technique-Gabor filter based enhancement was devised to improve the performance of enhancement techniques of fingerprint. The Table I shows the comparison of different enhancement techniques

TABLE I
COMPARISON OF VARIOUS ENHANCEMENT TECHNIQUES

	Existing Methods		Proposed method
Enhancement Method	Without Enhancement	FFT Method[11]	Gabor Filter Method
Ridge Endings	214	186	63
Ridge Bifurcations	98	72	17

The accuracy of the system depends on the quality of the fingerprint. Here accuracy is measured by means of False Rejection Rate (FRR) and False Acceptance Rate (FAR).

Sometimes the fingerprint recognition system may incorrectly reject an access attempt by an authorized user or accept an access attempt of an unauthorized user. To measure these types of incidents FRR and FAR is basically used. A system's FRR basically states the ratio between the number of false rejections and the number of identification attempts whereas FAR is the ratio between the number of false acceptances and the number of identification attempts.

During result testing, this transmitter module gives only two incidents of false rejections for 50 authorized identification attempts. Hence FRR of the transmitter module is 0.04 %.Upon observation; the system also gives one true result for 50 unauthorized user attempts. Thus the system maintains FAR of 0.02%.

Comparing with the existing enhancement algorithms, the proposed algorithm using Gabor filter in spatial domain, not only improves the quality of image but also effectively increases the accuracy by decreasing the error rates FRR & FAR.

Basically the PC based Recognition System (existing system) uses general purpose processor. This transmitter module employs Application Specific Integrated Circuit (ASIC) DSP device and it consumes a very little amount of power compared to general purpose processor.

VII. CONCLUSION AND FUTURE SCOPE

This paper presents an embedded fingerprint recognition system used DSP, Sensor, and SDRAM. This implementation was an effort to understand how Fingerprint Recognition is used as a form of biometric to recognize identities of human beings. In this system, fingerprints of different persons were successfully enrolled and added to the database. During the verification phase, this system can collect real-time fingerprint image signals, process the fingerprint image, extract fingerprint features, form the template based on the extracted features, and then match the template against the templates stored in database to identify/verify the person. Finally, the LCD displays the results of recognition process. A program is coded in 'C' language to implement the algorithms for enhancement, minutiae extraction and matching processing. Apart from that, MATLAB was used to demonstrate the various functions and processing methods used in image processing of the fingerprint. The outputs for all the trial runs were recorded. On observation, the designed embedded recognition gives satisfactory results.

The designed embedded fingerprint recognition system just checks input fingerprint with prints available in the database and informs whether he/she is registered user or unregistered user. This system can be extended to work as wireless fingerprint management system by incorporating the additional database for maintaining the records of student/staff's attendance and wireless channel into the current system.

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