Application of Real Time Biometric System to Keep Track of Members in Organization

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Abstract: The use of biometric system is becoming increasingly common and with more sophisticated technology growing on daily basis. This paper proposed a real time biometric system that will support organizations or institutions to take members attendance in meetings and other activities and serve as means of keeping track records and updates of members. The proposed system is simple, cost effective and reliable. It uses image processing tool of MATLAB GUI solution with a well-developed Microsoft Access Database (MAD). The MATLAB GUI access the database and implement the recognition task.

Keywords: Biometric System, MATLAB GUI, MAD, Recognition

I. INTRODUCTION

The use of conventional techniques for identification purpose is gradually becoming obsolete due to increasingly demand for more sophisticated method of improving security and getting the details or biography of members of organization. That is, such technology should be geared towards providing efficient and reliable security for public and private organizations. This is because the older identification methods which uses identity (ID) card, knowledge of social security number or personal identification number (PIN), keys, badges, or password is not reliable [1]. They are usually in form of external objects or memorized codes and as such are easily forgotten, lost, forged, or stolen, resulting to false authentication and associated implications [2]. In order to overcome these limitations, a technology that uses one or more human intrinsic qualities such as fingerprint, iris pattern, voice, palm print, ear, face, or even DNA of an individual to determine an identity [2] known as biometric system has become increasingly common.

A biometric system can be designed to carry out one of two basic function either verification/authentication or identification [3,4]. Identification implies distinguishing a user from group of users in biometric database. Often referred to as "one-to-many" On the other hand, in verification/authentication, a user biometric sample is compared to a stored sample of that user in database. This can be referred to as "one-to-one [4].

Though many applications of biometric technologies have emerged with even more sophistication and robustness, fingerprint biometric system remains the most commonly used technology apparently due to the inherent ease in data acquisition, distinctiveness and reliability. The fingerprint applications are often said to be the first [2] and have been deployed as an automated technology for

achieving a match between two human fingerprints [5]. It has been deployed over a century but has become automated due to recent advancement in computing capabilities [5]. Today, fingerprints are used in such areas like access control to secure places or location in a building and automated teller machines (ATM).

One of the issues that have threatened the progress of social organizations is lack of commitment of members in taking part in activities such as meetings and payment of dues. An automated real time system to take membership attendance and participation in the weekly meeting or other activities is presented in this paper based on fingerprint technology. The proposed system takes into account the date and the time of participation of the member. It eliminates the tediousness, time consuming and the boring task of the traditional way of identifying members who are present in each meeting or any other activity. This system can also be used to check staff or workers lateness and irregularity in public or private workplace.

II. LITERATURE REVIEW

A. Fingerprint

The feature pattern representing the ridges and valleys on the tip of one finger [6] is known as fingerprint. It is used for verification of a person from group of people. Despite the growing technologies in this area, fingerprint remains the most widely used biometric recognition system because of its distinctive features such as uniqueness, universality, permanence, accuracy and low cost [6]. Fingerprint processing involves four steps: sensing, feature extraction, template matching, and output [1]. Figure 1 and 2 illustrate image capture of fingerprint using optical sensor and a block diagram of fingerprint recognition system. The processing can be classified into enrolment and authentication as shown in Fig. 2. During the enrolment stage, the fingerprint of a user is taken using optical sensing device and then followed by high computational algorithm process to extract required features. In the authentication stage, the user's fingerprint is matched with existing fingerprints in the database –that is template matching. An output is established either as accepted or rejected. The user is accepted by granting access if the enrolled fingerprint matches with already stored fingerprint in the database or rejected by denying access if it does not match any stored fingerprint in the data base.

B. Previous Works

Suryawanshi et al [7] developed a real time attendance monitoring system that makes use of fingerprints technology. The system is developed interfacing a fingerprint module with UART1 port of ARM7 to take the attendance of students in an educational institution. A fingerprint biometric system based on discretized texture descriptor is designed and implemented in MATLAB environment by Kamboj and Rani [8]. In Ravi et al [9], a fingerprint recognition system that makes use of minutia score matching method is developed using MATLAB codes. Fingerprint recognition system identifying a suspect by police using MATLAB application is developed by Hai [10]. Ohaeri and Esiefarienhe [11] studied minutiae point extraction for fingerprint identification system using synthetic fingerprint generator (SFinGe) software and carried out image process simulation results in MATLAB. Tukur [5] examined and implemented a fingerprint recognition system using image process tool in MATLAB.

I. METHODOLOGY

The organizational membership identity recognition system is a unimodal biometric system. It uses fingerprint biometric technology to register and take record of membership attendance and

participation in activities. It keeps tracks of members by providing records of their participations. It is developed using image processing tool of MATLAB®. A Microsoft Access Database is used to store memberships' details. Figure 3 is flowchart of the fingerprint recognition technology.

Fig. 1 Captured fingerprint

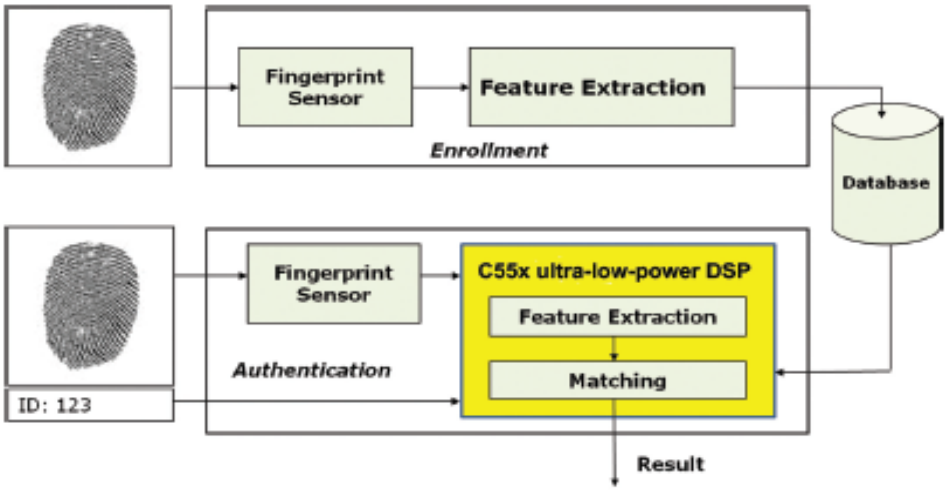

Fig. 2 Block diagram of fingerprint recognition system [2]

A. Fingerprint Recognition

There are basically two functions that the fingerprint recognition process performs. These are: enrolment and verification. The enrollment function is essentially a key factor in determining the quality and accuracy of the verification process. During the enrollment process, fingerprint image is captured. The effective of this process can be affected by the way user placed his finger on the fingerprint reader. For the verification process, the features of the enrolled fingerprint is extracted and a template matching is performed. There are several algorithms that can be used for carrying out the fingerprint matching, which include correlation-based matching, minutiae-based matching, ridge

B. Minutiae Extraction

One of the most essential aspect of biometric systems is the extraction of the right feature that will lead to efficient and accurate results. The fingerprint minutiae are the major features used in fingerprint matching. Minutiae are features associated with specific forms of fingerprint ridges. The ridge ending, bifurcation, and short ridges are the major minutiae features [6] extracted from the stored fingerprint image and the input fingerprint image. A valid fingerprint is accepted based on several similarities between minutiae pairs of the stored and input fingerprint images.

In image processing, segmentation is basically necessary especially in the area of feature extraction that focuses at identifying points in fingerprint image. That is points where image brightness changes

sharply or has discontinuities [5]. Ridge thinning, minutiae marking, and false minutiae removal processes are employed at the final step of minutiae point extraction [5].

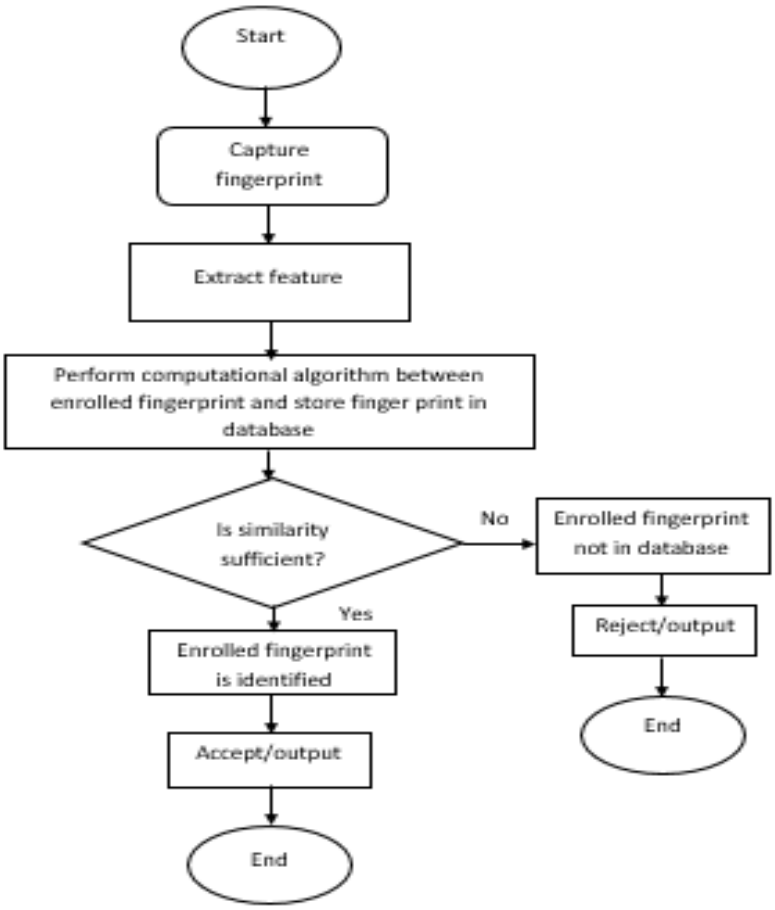

Fig. 3 Flowchart of fingerprint recognition process

C. *Matching Technique*

In minutiae-based fingerprint matching, the number of minutiae on both query and reference fingerprints are usually returned. Similarity scores are then generated. According to forensic guidelines, when a minimum of 12 matched minutiae are recorded by two fingerprints, they are said that to have come from the same finger [6,12].

Two sets are compared for matching algorithm [6]:

$$\left.\begin{aligned} T &= \{m_1, m_2, \ldots\ldots, m_j\} \\ I &= \{m_1, m_2, \ldots\ldots, m_i\} \end{aligned}\right\} \quad (1)$$

T is from the reference fingerprint and input, I is from the query and returns similarity score $S(T, I)$.

D. *Fingerprint Algorithm*

The execution or implementation of fingerprint system can take the following steps [5]:

i. Acquisition of image

ii. Edge detection

iii. Comparison of Images

iv. Decision making

1) Acquisition of image

Image acquisition is carried out using an optical sensor fingerprint reader.

2) Edge Detection

Edge detection is a technique for the segmentation of image. It divides spatial region on which the image is specified into significant parts or feature [1]. Several edge detection techniques exist in literature for extracting edges. Example of such techniques is the computation of a local derivative operator like Roberts, Prewitt, or Sobel operator [5].

Detection of changes in intensities for finding edge scan be achieved using gradient based classical operator, expressed as First order or Second derivatives. The difference between corresponding pixel intensities of the image is used for calculating edge.

The gradient of a two-dimensional (2D) function, $f(x,y)$ representing a first order derivative is defined as the vector [13,5]:

$$\nabla f = \frac{g_x}{g_y} = \frac{\partial f}{\partial x}, \frac{\partial f}{\partial y} \tag{2}$$

The vector gradient is given by:

$$\nabla f = mag(\nabla f) = \left\lfloor g_x^2 + g_y^2 \right\rfloor \tag{3}$$

Maximum rate of change angle is given by [13,5]:

$$\alpha(x,y) = \tan^{-1}\left(\frac{g_x}{g_y}\right) \tag{4}$$

The second order derivative is:

$$\nabla^2 = f(x,y) = \frac{\partial f}{\partial x} + \frac{\partial f}{\partial y} \tag{5}$$

Two marks are provided by Prewitt operator: 1). for horizontal edge detection. 2). for vertical edge detection. These marks are used for edge detection and are known as derivative masks [5]:

$$Vertical = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad Horizontal = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

3) Comparison of Fingerprint Images

Matching algorithm for performing comparison of images is based on comparing the black and white dots that are present in fingerprint image. This can be achieved in MATLAB by using the basic scripting to match the black and white dots.

Generally, the quality performance of a fingerprint system will be based on the False Accept Rate (FAR) and False Reject Rate (FRR) [14]. FAR is the possibility of a biometric to erroneously identify an individual rather than reject the person. For FRR, it is a measure of the possibility that the system will fail to identify a member or user.

Mathematical expression of FAR and FRR are state by (6) and (7).

$$FAR = \frac{NFA}{N} \times 100 \tag{6}$$

$$FRR = \frac{NFR}{N} \times 100 \tag{7}$$

NFA –No. of False Accepts, N –sum of the number verification. NFR –No. of False Rejects.

Aligning fingerprint images:

Aligning fingerprint images: each minutia is associated with a ridge. The associated ridge is expressed as series of x-coordinates $(x_1, x_2, ..., x_n)$ points on the ridge. Starting from a minutia point, a sampled per ridge length L for each point is carried out, where L is the average inter-ridge length [5]. And n is set to 10 unless the total ridge length is $< 10 \times L$ [15,5]. The similarity of correlating the ridges is determined from [15,5]:

$$S = \frac{\sum_{i=0}^{m} x_i X_i}{\left[\sum_{i=0}^{m} x_i^2 X_i^2\right]^{0.5}} \tag{8}$$

where (x_i~X_n) and (x_i~X_N) minutia set for each image of the fingerprint respectively. And m is minimal one of the n and N value. If the similarity score is larger than 0.8, then go to step 2, otherwise continue to match the next pair of ridges [15,5]. For each fingerprint, translation and rotation of all other minutia is done with respect to a pre-defined minutia based on the expression given by:

$$\begin{pmatrix} x_{i\_new} \\ y_{i\_new} \\ \theta_{i\_new} \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \times \begin{bmatrix} x_i - x_{ref} \\ y_i - y_{ref} \\ \theta_i - \theta_{ref} \end{bmatrix} \tag{9}$$

Where, θ_i is the ridge angle.

4) Decision making

During the decision making, images are compared based on percentage matched in the pre-defined threshold, typically 90%. If percentage match > 90%, images are matched. Otherwise, that is if < 90%, they are not matched. The final match ratio of two fingerprint is given by:

$$MR = \frac{\sum N_{MP}}{N_{\min template}} \times 100 \tag{10}$$

Where, MR is the match ratio, $\sum N_{MP}$ is the total no. of match pairs.

II. PROPOSED SYSTEM

In this paper a system for complete minutiae extraction for automatic fingerprint recognition is presented. It employs alternatives for improving fingerprint image with increased reliability in the feature's extraction.

The proposed scheme uses well-developed Microsoft Access Database (MAD) to store the fingerprint images and particulars of the members in an organization. The time and date of participation in any activity is important. The system takes members attendance and keep record at the membership in the database. It does this by taking the identity of a member using fingerprint and thereafter automatically updates. Figure 4 shows the proposed simplified fingerprint recognition scheme developed using MATLAB.

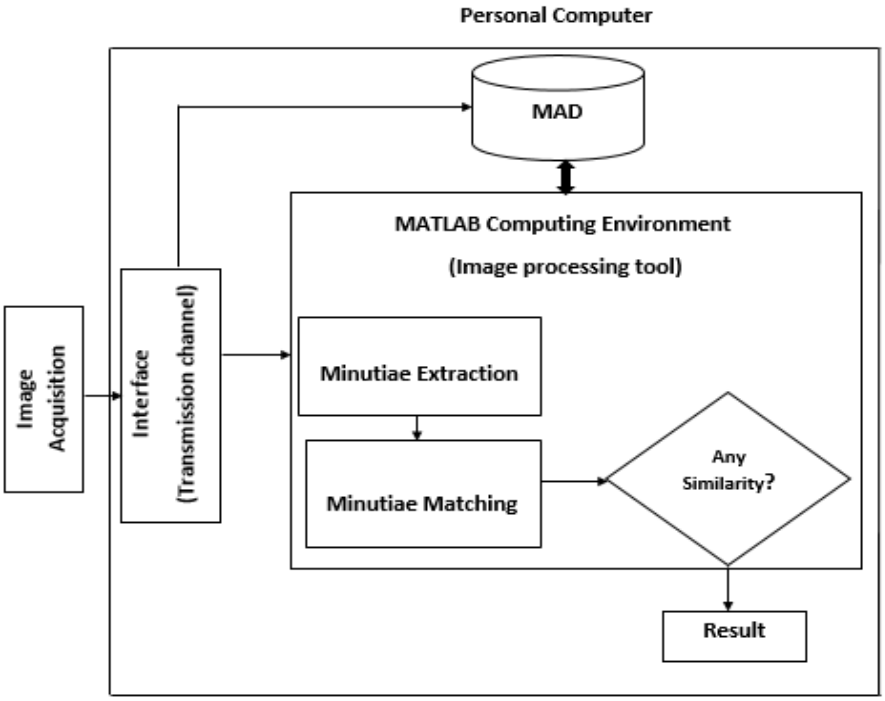

Fig. 4 Structure of the proposed fingerprint recognition system

III. CONCLUSION

With the increasing biometric attendance system for schools and organizations, the proposed system is developed using MATLAB Graphical User Interface (GUI) with a Microsoft Access Database

(MAD) on a personal computer (PC) to provide a simple, cost effective and reliable recognition system for real time operation. The system will help organizations to keep track of members and provide update on them. Rather than the manual or conventional way of taking records of membership participation in activity, the system provides automatic update of member's attendance to meetings and any other activities. This way, a member can easily be detected to have quit or no longer active in the organization.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical statement: The authors declare that they have followed ethical responsibilities.

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This volume is dedicated to Late Sh. Ram Singh Phanden, father of Dr. Rakesh Kumar Phanden.

