Authentication of Fingerprint Recognition Using Natural Language Processing

Shrikala B. Digavadekar[1], Prof. Ravindra T. Patil[2]
[1] Tatyasaheb Kore Institute of Engineering & Technology, Warananagar, India
[2] Tatyasaheb Kore Institute of Engineering & Technology, Warananagar, India

ABSTRACT

Authentication of fingerprint recognition using natural language processing is based on voice recognition technique. The proposed system uses a keyboard processing module, a vocal module and a natural language processing module. The password provided by the user as an input to the system is first recognized by keyboard processing module and then the system displays a message for the user to give voice input. Voice recognition is carried out by using Mel- frequency cepstral coefficients (MFCCs) and Dynamic Time Warping (DTW). Feature extraction using MFCCs involves the use of Hamming window. The system allows the user to use any word in the natural language for voice recognition. If both the password and voice are properly recognized then only further fingerprint matching operations are possible. Fingerprint matching is performed by using minutiae based approach.

Keywords - Natural Language, Voice Recognition, Mel- Frequency Cepstral Coefficients (MFCCs), Dynamic Time Warping (DTW)

Index Terms- Natural Language, Biometry, Fingerprint Recognition, Human-computer interaction

I. INTRODUCTION

Fingerprint-based identification is one of the most important biometric technologies. Human fingerprints are used for personal identification in various applications and the validity of fingerprint identification has been well established. Fingerprints are believed to be unique across fingers of same individual. Even identical twins having similar DNA, are believed to have different fingerprints. These observations lead to the increased use of automatic fingerprint based identification in both civilian and law-enforcement applications.

Although biometric features are widely used for recognition and identification all over the world, these systems do not always provide a natural access for the users and operators. A valid solution to this problem can be found if the user can interact with the system by using his/her own natural language . Such interaction can be provided by using a Natural Language Interface (NLI) system [3].

A natural language interface (NLI) is a system that allows a computer user uses his/her own language while interacting with a computer system.

The system accepts an input from a user, and transforms it into a formal language statement which can be executed by its processor.

The system accepts an input from a user, and transforms it into a formal language statement which can be executed by its processor. Most of the users do not have previous experience with any kind of biometric recognition system hence they must be guided by a specialized operator in order to reduce the “fail-to-enroll” error (FTE) [1].

An interface based on natural language allows natural human-computer interaction [2]. It allows all the functionalities offered by a fingerprint recognition system. All users can interact with the system using natural language words through a keyboard to perform the intended operation. In this way the interface makes the system more usable.

II. SYSTEM DESCRIPTION

The proposed system is composed of three modules- a keyboard processing module, a vocal module and a natural language processing module along with a biometric recognition system. The structure of system is shown in the figure (Fig. 1).

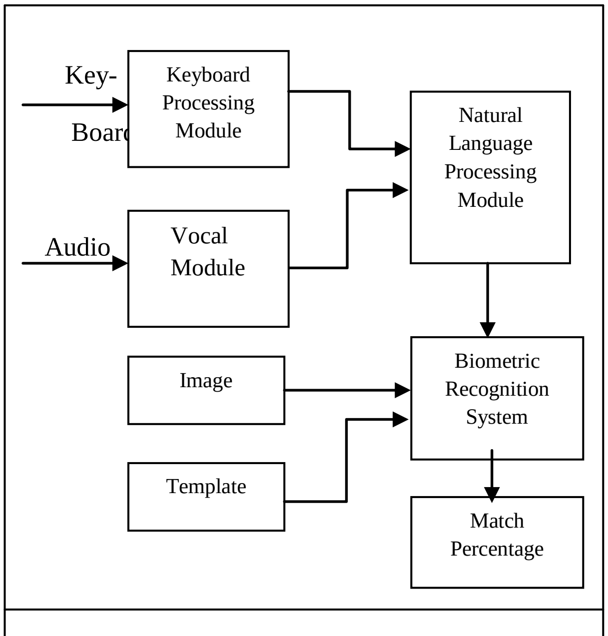

Fig 1 General structure of proposed system

The system consists of-

1. Natural Language Interface
2. Biometric Recognition System

Natural language interface is composed of two modules-

1.1 Keyboard communication processing module

1.2 Vocal communication processing module

1.1 Keyboard communication processing module:

Keyboard communication processing module (Fig. 2) accepts its input from the keyboard. Whenever user wants to find his/her fingerprint in the database of system, he/she will enter the password provided to him/her through keyboard. The keys of keyboard are assigned for different operations hence it is also possible for a user to perform a specific operation using the keyboard.

1.2 Vocal communication processing module:

This module allows the user to interact with the system by using words in natural language. Audio input from the user is processed through the module to recognize the user (Fig. 4)

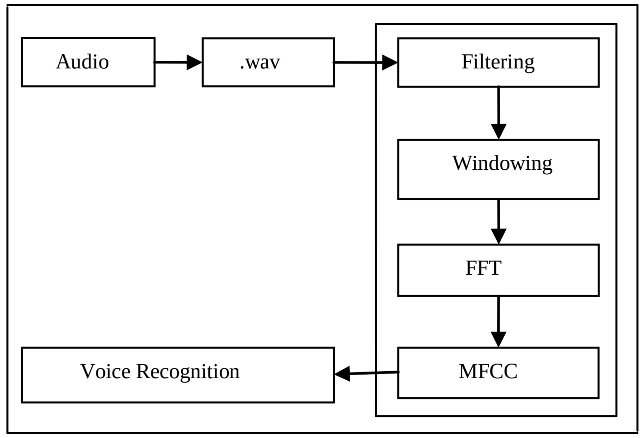

Fig 2 Vocal communication module

2. Biometric Recognition System:

If both the password and voice are recognized properly then only biometric system will perform further operations to match the fingerprints and gives the corresponding result. Following different operations (Fig. 3) are carried out during this matching process-

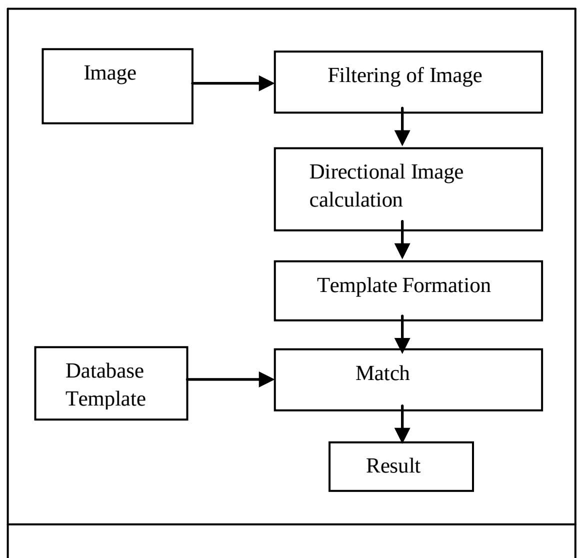

Fig. 3 Biometric Recognition System

III. IMPLEMENTATION

The proposed fingerprint recognition system can be implemented by using MATLAB software. A user that wants to find his fingerprint in the database first enters a password through the keyboard. This is followed by a voice input from the user. Voice recognition is carried out by using Mel frequency Cepstral Coefficients (MFCCs) [9].

Feature Extraction using Mel-Frequency Cepstral Coefficients:

MFCC is based on known variation of the human ear's critical bandwidth with frequency. MFCC has two types of filter which are spaced linearly at low frequency below 1000Hz and logarithmic spacing above 1000Hz. A subjective pitch is present on Mel Frequency Scale to capture important characteristic of phonetic in speech.

The overall process of the MFCC is shown in figure (Fig. 4)

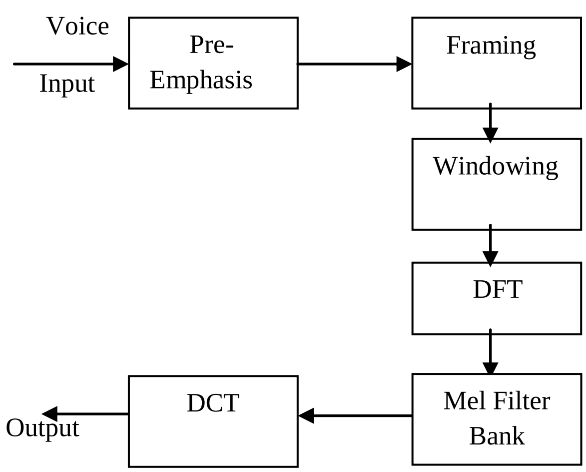

Fig. 4 MFCC Block Diagram

MFCC consists of seven computational steps. Each step has its function and mathematical approach.

1. Pre-emphasis:

This process passes the signal through a filter which emphasizes higher frequencies and thus increases the energy of signal at higher frequency.

Y[n] = X[n] – 0.95 X [n-1]…….. (1)

Where a= 0.95, which make 95% of any one sample is presumed to originate from previous sample.

2. Framing:

The process of segmenting the speech samples obtained from analog to digital conversion (ADC) into a small frame with the length within the range of 20 to 40 msec. The voice signal is divided into frames of N samples. Adjacent frames are being separated by M (M<N). Typical values used are M = 100 and N= 256.

3. Hamming windowing:

Hamming window is used as window shape by considering the next block in feature extraction processing chain and integrates all the closest frequency lines. The Hamming window equation is given as:

If the window is defined as W (n), $0 \le n \le N-1$ where
N = number of samples in each frame
Y[n] = Output signal
X (n) = input signal
W (n) = Hamming window, then the result of windowing signal is shown below:

$$Y(n) = X(n) \times W(n) \ldots. (2)$$

$$w(n) = 0.54 - 0.46 \cos\left(\frac{2\pi n}{N-1}\right), 0 \le n \le N-1 \quad \ldots (3)$$

4. Fast Fourier Transform:

Fourier transform is used to convert each frame of N samples from time domain into frequency domain. Fourier Transform converts the convolution of the glottal pulse X[n] and the vocal tract impulse response H[n] in the time domain. This statement supports the equation below:

$$Y(w) = FFT[H(t) * X(t)] = H(w) * X(w) \ldots. (4)$$

If X (w), H (w) and Y (w) are the Fourier Transform of X (t), H (t) and Y (t) respectively.

5. Mel Filter Bank Processing:

The range of frequencies in FFT spectrum is very wide and voice signal does not follow a linear scale. Hence the signal is passed through a set of triangular filters (Fig. 5) that are used to compute weighted sum of filter spectral components so that the output of process approximates to a Mel scale.

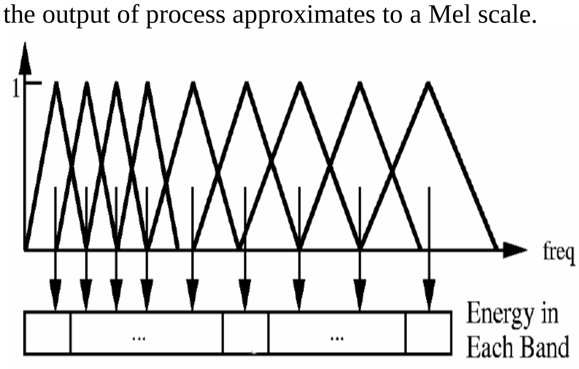

Fig. 5 Mel scale Filter Bank

Each filter's magnitude frequency response is triangular in shape and equal to unity at the centre frequency and decrease linearly to zero at centre frequency of two adjacent filters. Then, each filter output is the sum of its filtered spectral components. After that the following equation is used to compute the Mel for given frequency f in HZ:

$$mel(f) = 2595 * log10(1 + \frac{f}{700}) \ldots\ldots (5)$$

6. Discrete Cosine Transform:

This is the process to convert the log Mel spectrum into time domain using Discrete Cosine Transform (DCT). The result of the conversion is called Mel Frequency Cepstrum Coefficient (Fig. 6). The set of coefficient is called acoustic vectors. Therefore, each input utterance is transformed into a sequence of acoustic vectors. [9]

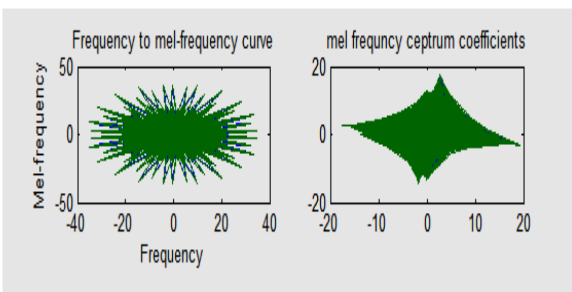

Fig. 6 Frequency to Mel frequency curve & Mel Frequency Cepstral Coefficients obtained using MATLAB

Feature Matching using Dynamic Time Warping (DTW):

DTW algorithm is based on dynamic programming techniques. It is used for measuring similarity between two time series which may vary in time or speed. The principle of DTW is to compute two dynamic patterns and measure its similarity by calculating minimum distance between them (Fig. 7)

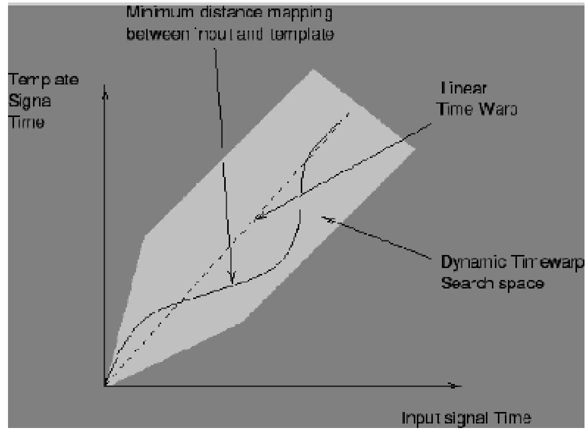

Fig. 7 Dynamic Time Warping

Biometric Recognition System:

If password and voice both are properly recognized then only further operations are performed by biometric recognition system to match the two fingerprints. If one of them fails, error occurs. After successful recognition of these two, system displays a message for the user, 'load fingerprint' and user gives his fingerprint image as input to the system through a sensor.

Biometric recognition system gives out the result by comparing two fingerprints one given as input by the user and other one which is already stored in the database. This fingerprint matching is carried out by using minutiae based approach. During this process, different image processing operations such as fingerprint enhancement, histogram equalization, binarization, directional image calculation are performed by the system (Fig. 8)

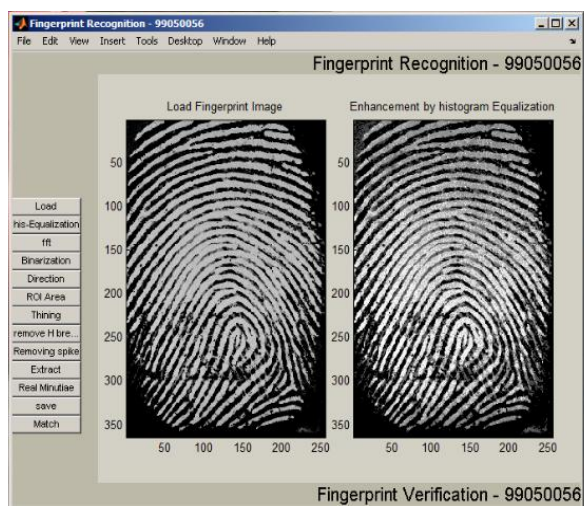

Fig.8 Biometric System Interface showing Histogram Equalized Fingerprint Image

IV. CONCLUSION

The proposed fingerprint recognition system based on natural language processing is more secure as compared to other fingerprint recognition systems as voice recognition is an important part of the system. It is not possible for any user to directly load his/her fingerprint before voice recognition is successfully completed. Any user can easily interact with the system as it is possible to use his/her own natural language.

In this way the use of keyboard and voice recognition provides a more robust fingerprint recognition system that can be used at any place where security is important.

V. REFRENCES

[1] **Conti V., Militello C.; Sorbello F.; Vitabile S.,** "A user friendly interface for fingerprint recognition systemsbased on natural language processing", CISIS 2009 pp:736-741

[2] **A. Jaimes and N. Sebe,** "Multimodal human-computer interaction: A survey", Computer Vision and Image Understanding, Vol.108, Issue 1-2, October 2007, pp.116-134.

[3] **Jusoh, Shaidah; Al-Fawareh, Hejab M.,** "Natural language interface for online sales systems", Intelligent and Advanced Systems, 2007. ICIAS 2007 International Conference on, 25-28 Nov. 2007 pp: 224-228.

[4] **Davide Maltoni; Dario Maio; Anil K.Jain; Salil Prabhakar,** "Handbook of fingerprint recognition", Springer, 2003.

[5] **Marsic, I.; Medl, A.; Flanagan, J.,** "Natural communication with information systems", Proceedings of the IEEE, Volume88, Issue 8, Aug. 2000, pp: 1354-1366.

[6] **Sharma, R.; Pavlovic, V.I.; Huang, T.S.,** "Toward multimodal human-computer interface", Proceedings of the IEEE Volume 86, Issue 5, May 1998 pp:853-869.

[7] **Ephraim P. Glinert, Meera M. Blattner,** "Multimodal Interaction", IEEE MultiMedia, vol. 03, no.4, p. 13, Winter,1996

[8] **Anil K Jain, Salil Prabhakar, Arun Ross,** "Fingerprint Matching, data acquisition and performance evaluation", Department of Computer Science and Engineering, Michigan State University East Lansing

.

[9] **Md. Rashidul Hasan, Mustafa Jamil, Md. Golam Rabbani Md. Saifur Rahman,** "Speaker identification using mel frequency cepstral coefficients", ICECE 2004,