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Biometrics Authentication using Electrocardiogram Approach

P.Preetha[#1], R.Sankar[#2]

[1]*Master of Computer Application 2rd Year, S.A Engineering College, Chennai-77.*
preetha.paramasivam@gmail.com
[2]*Asst Prof., Department of Computer Applications, S.A. Engineering College, Chennai-77.*

Abstract — Biometrics is a secure alternative for traditional methods in identity verification [1]. Electrocardiogram (ECG) is an emerging biometric security mechanism. Biometric measures are used in many different areas and industries to provide a relatively high level security. The word biological is based on DeoxyriboNucleic Acid (DNA), behavioural is based on gait or keystroke dynamic, and morphological is based on uniqueness for all people like fingerprint or face etc. [2]. ECG is combined with commonly used face biometric and fingerprint biometric. The uniqueness of the electrocardiogram signal has encouraged its use in building different biometric identification systems. It is also a source of supplementary information to a multi biometric system; it shows moderate performance in a uni-model framework. The concerns involved to use ECG as a biometric for individual authentication are the lack of standardization in signal features and the presence of acquisition variations. Otherwise this make the errant users to hack the data or information.

Keywords — *Human Authentication; Features Extraction; ElectroCardioGram; Biometrics.*

1. Introduction

ECG can also be used as a standalone biometric authentication system. ECG is one of the significant signatures for individual even within siblings or twins. ECG is difficult to mimic and hard to copy or steal. During enrolment, biometric information from an individual is stored. When an individual tries to connect to a system through biometrics information, the presently detected biometric is compared with the information stored at the time of enrolment [4]. The decision of two contexts exits, the identity verification and the identification. Analysis of electrocardiogram for clinical diagnosis has been a research topic for a couple of decades, and recent proposals of using ECG as a new biometrics measure for human identity. Hence an electrocardiogram is a form of aliveness detection [3][4]. The ECG signal could be biometric modality, sufficiently non-vulnerable to spoof attacks and highly secure and insuring robustness of the system. The Electrocardiogram biometric systems inherently have aliveness detection thus can ensure that the individual is present at the time of enrolment. Also the ECG signal is very difficult to regenerate or mimic. Therefore the ECG signal has strong characteristics that can address the issues of previous biometrics. However, unlike most biometrics, ECG is naturally affected by physical and psychological activity of the human body. The unique characteristics of the ECG signal presents a challenge for biometric deployment and measures have to be taken to ensure that ECG biometric systems are robust to such changes. Today the use of ECG signals within a biometric system to identify individual's preliminary. ECG analysis is not only a very useful diagnostic tool for clinical proposes, but also a potential biometric. The physiological and geometrical differences of the heart in different individuals displays certain uniqueness in their ECG signals[6]. ECG is combined with the commonly used face biometric and the fingerprint biometric. Signal processing methods are used to delineate the ECG features and determine the dominant fiducially from each heartbeat.

2. Existing System and Proposed System

There are many existing researches in biometric identifications. The weakness of existing system and strength of proposed system are compared here [5][6].
Universality: The biometric characteristic must be universally applicable. We use the ECG signal, which can be collected from everyone who is alive.
Uniqueness: The biometric characteristic must be able to unequivocally identify the individuals within population.
Permanence: The physiological characteristics are not completely invariant during the entire life of an individual. Because of small variations appear in ECG signals after a five years period can be updated after five years.
Collectability: The biometric characteristic is quantitatively measurable. Using these electrodes, the electrical activity of the heart can be recorded. More precisely, the ECG represents the potential differences between electrodes.
Acceptability: A high acceptability is due to two main reasons:

- The ECG signal is well-known to deal with heart diseases.
- The signal can be easily acquired.

2.1 Disadvantages of Existing System

- Misclassification.
- Not Accuracy.

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- Template size is not perfect.
- Computational requirements.

3. Proposed System Process

Pre-processing: Filtering raw ECG signal to eliminate the noise caused by body movement, misplacement of electrodes and any interference by nearby devices. This stage is used to clean and enhance the quality of the ECG signal.

Feature Extraction: Identification purpose includes DNA, fingerprint, face and etc. The extracted attributes are temporal and amplitude distances between two fiducial points. Feature extraction includes determination of time intervals, amplitudes and angle features from dominant fiducial points.

1. *Fiducial Methods:* It is utilized for the identification purposes. The disadvantage of fiducial features is that it is sensitivity to noise. Moreover, detection of fiducial features in abnormal cases with arrhythmia may include errors in data.

2. *Non fiducial method*: It treat ECG signal or isolated heartbeats holistically and extract features based on overall morphology of waveform.

Feature Selection: Selection of wave boundaries on time and amplitude domain.

3.1 Advantage

- Amplitude features.
- Angle features.
- Interval features.
- Accurate one.

4. Methodology

The Electrocardiogram (ECG) biometric systems inherently have aliveness detection and thus it can ensure that the individual is present at the time of enrolment. Also the ECG signal is very difficult to regenerate or mimic. Therefore the ECG signal has strong characteristics that can address the issues of previous biometrics. However, unlike most biometrics, ECG is naturally affected by physical and psychological activity of human body. The unique characteristics of the ECG signal presents a challenge for biometric deployment and measures have to be taken to ensure that ECG biometric systems are robust to such changes.

Body posture: A factor that has been marginally examined in the prior art is the effect of body posture. The electrical heart vector changes according to the body position. Using limb leads, this work demonstrated that body position influences the cardiac response. Based on the findings of sutherland, when transitioning from the supine to upright position, there is an interior torso shift of the P-wave but no change in the amplitude of the local extrema.

By using this methodology it can help to detect or filter the ECG waves in the above diagram. Two things can be discussed in which one will be a normal one and another will be abnormal one. So in this, we can filter the normal one and move on to abnormal. This is considered as a secured method and contains 4 things namely QRSwaves, normalization, convolution and final one is classification method.

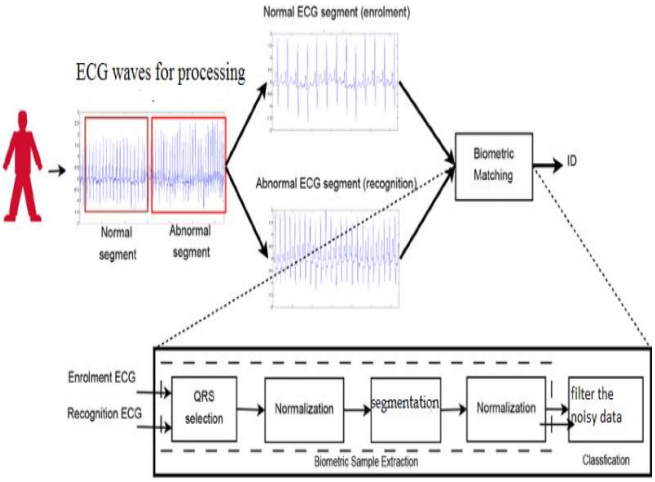

Fig.1: ECG signal processing while filtering the noisy disturbances

5. Implementation

The collected ECG data usually contain noise, which include low-frequency components that cause baseline wander, and high-frequency components such as power-line interference. To minimize the negative effects of the noise, a noiseless procedure is important. In this paper, we use a Butterworth band pass filter to perform noise reduction. The cutoff frequencies of the band pass filter are selected as 1Hz–40Hz, based on empirical results. The first and last heartbeats of the noiseless ECG records are eliminated to get full heartbeat signals. Then a threshold is used to remove the errors which is not suitable for the result.

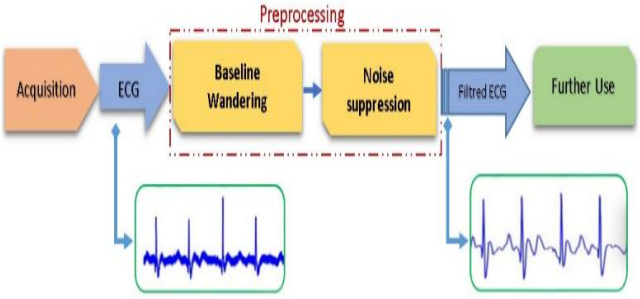

Fig.2: Segmentation process after filtering the noisy data

After finishing the preprocessing method, we move on to processing method. The three methods are segmentation, averaging and normalization.

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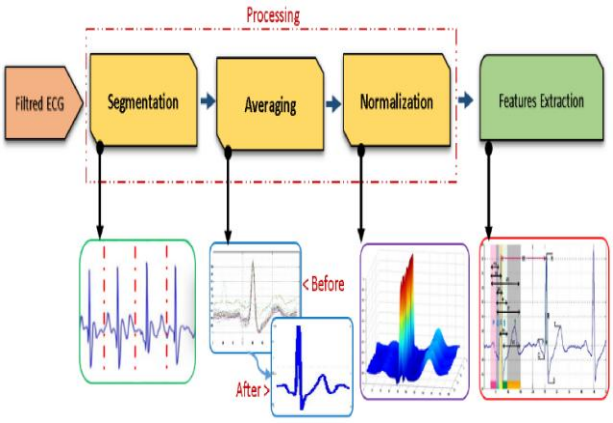

Fig. 3: Preprocessing verification pipeline system

6. Conclusion

ECG is used to verify our body completely which may vary after a long period of time. This method is a secure one. Moreover, the ECG hardware recorder should be designed for low cost, easy application, ambulatory measurement as security tool in daily life. The electrocardiogram is an effective and powerful tool to be used as biometrics. This type of signal is relatively easy to acquire and simple to process due to its low dimensionality.

The developed system is easy to implement in low power devices, including smart cards, PDAs and other wearable devices. ECG waveform impacts the biometric accuracy in identity.

7. Future Enhancement

One of the main challenges of working with the ECG signal as a biometric is susceptibility to physical activity. Therefore in the evaluation of ECG biometric systems, performance under such factors must be assessed in future.

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