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Electrocardiogram based Authentication System using Video Streams

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Abstract. **Today, most applications still establish user authentication with traditional authentication system be it, text based passwords or graphical passwords. For a long time the motive of security researchers is to design a secure as well as user-friendly authentication system. Majority of systems have started shifting towards biometric system for objective to perform individual identity verification. In recent researches the electrocardiogram (ECG also called EKG) signal is investigated as a Biometric feature for human being identification. ECG is internal body physiological biometric characteristic. Present invention introduces a new class of authentication scheme called "Video-password using ECG". This paper deals with the detection of QRS complex of ECG signals using derivative based/Pan-Tompkins/wavelet transform based algorithms. In this authentication system theuser input ECG signal of which QRS complex is detected and based on this, video is divided in frames which are later matched to our database.**

Keywords: **Biometric, ECG, QRS, Authentication.**

I. INTRODUCTION

Biometric provides a way for identification and verification. Biometric characteristics are classified as shown in Fig. 1. For many years external and behavioural biometrics like fingerprint matching, iris recognition, face recognition [1-2], Gait, voice etc. were used. The problem with such biometrics is that they can be easily deceived without liveliness check. ECG was used for many years as a diagnostic tool but in the last few years studies have been conducted for use of ECG in biometric and it isproved to be potentially useful biometric tool for individual identification [2,3]. ECG measures the electrical activity of the heart.A typical ECG tracing of a cardiac cycle consist of a P wave, QRS complex and a T wave. Among these QRS complex is considered fairly constant irrespective of change of heart rate. Present invention makes use of this QRS complex in video password scheme. Traditional text password authentication system has shortcoming such as vulnerability to being guessed by attacker [4]. Image password scheme has drawback of theft and that does not provide assurance of security. Video password authentication system eliminates these shortcomings employing QRS complex of ECG while framing.

II. RELATED WORK

Variations in video password authentication scheme are based on knowledge and memorability. Thorpe work

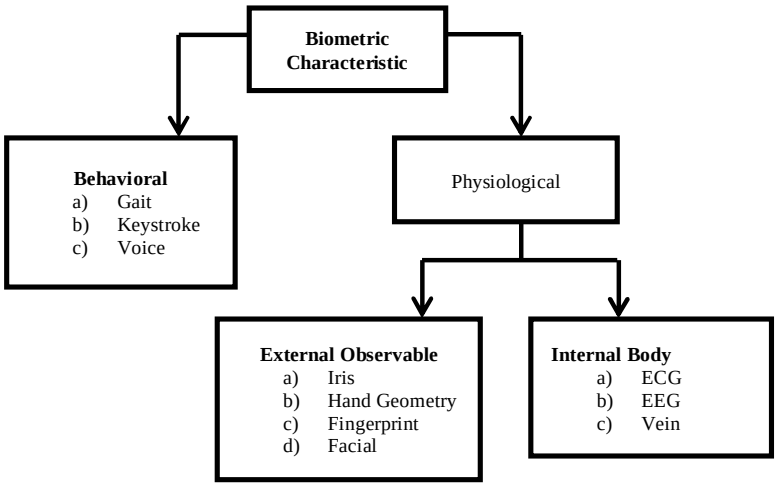

Fig.1.Classification of Biometric Characteristics

requires the user to watch video and memorise its parts (e.g. scene sequence, movements and/or sounds)[5]. Traditional text based passwords are also knowledge based which has drawback of memorability and guessing by an adversary [6].Present work makes use of ECG as biometric in video password schemes. In ECG various features are unique which are incorporated in various researches for biometrics[7]. Fiducial points in heart beat to extract the unique attribute were used previously but their fiducial point detection is a complex procedure, work investigated temporal features out of which 15 were extracted from lead I ECG others were normalised by dividing them by the distance from the start of the P wave to the end of T wave and then showed the uniqueness of individual ECG [8]. In similar work, lead I ECG signals were recorded and identification algorithm was developed, then two research algorithms namely template matching and distance classification methods were evaluated for ECG identification during signal development [9]. By applying the high-order Legendre Polynomials the most unique signature bearing parts on QRS Complex of ECG was found for human identification [10]. Also for extracting ECG features from wavelet coefficients, the discrete wavelet transform was applied. From the experimental result it was demonstrated that the proposed approach worked well for normal 35 subjects while the accuracy reduced on 10 arrhythmia patients [11]. The complexity-based approach was introduced to deal with abnormal ECG for biometric identification purpose [12].

III. Proposed Methodology

Thismethodinvolves two stages-

1. Database creation
2. Matching process

A. Database creation- It will be created in five steps. Fig.2.

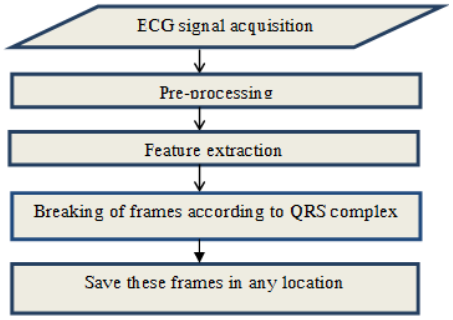

Fig.2. Database creation steps

ECG signal acquisition. ECG signal data file is taken from MIT-BIH Arrhythmia database in which ECG of inpatient men and women of age between 47 to 84 years are present [13]. Fig.3. shows the ECG waveform of one such recording.
Pre-processing. ECG data contains low and high frequency noise which corrupts the signal. To remove these noises, de-noising procedure must be used. We use band-pass filter to remove such type of noises.
Feature Extraction. After the reduction of noise, we extract the unique features of ECG signal. Basically, there are many features of ECG signal that are constant with the heart rate such as QRS complex, QT interval etc. In our work, QRS complex is used for the authentication of human being. We use Pan Tompkins algorithm to evaluate the QRS complex.
Breaking of frames according to QRS complex- After the computation of QRS complex, the video which is saved in the system breaks into number of frames according to the value of QRS complex. Then, the selected frames are saved in any predefined location for further matching procedure.

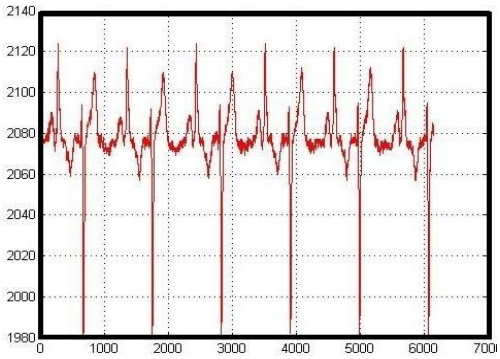

Fig.3. Acquired ECG signal

B. Matching

The whole procedure discussed above repeats for the matching purpose with additional two steps. Fig.4. represents the matching procedure.

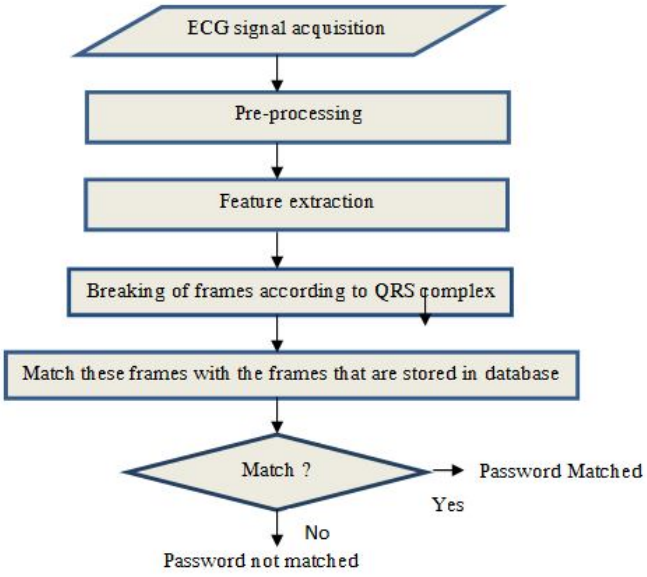

Fig.4. Matching Scheme

IV. DISCUSSION AND RESULT

Present invention results into an effective authentication system which cannot be deceived and spoofed. Since it employees QRS complex which is a unique feature of human heart beat so the individual have the assurance that his data is safe even after his death. The basic shape of the normal ECG signal is shown by

Fig.5. where the sequential depolarisation of the right and left atria are reflected by P wave and the ventricular repolarisation is reflected by T wave. The depolarisation of the right and left ventricles are reflected by QRS complex [14]. We compute QRS complex via Pan Tompkins algorithm which is optimum.In Pan Tompkins algorithm following computations has been done.

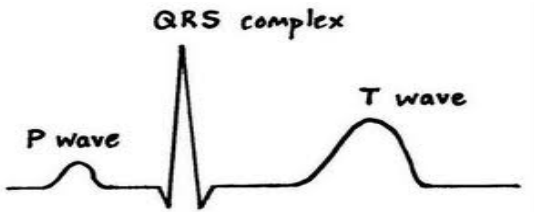

Fig.5. Basic shape of an ECG heartbeat signal

Derivatives: Three derivatives of ECG signal are computed. Assuming ¥ be first derivative,

¥ = diff(ecg) (1)

Assuming Ý be second derivative,

Ý = diff(¥) (2)

Assuming Ø be cumulative derivative,

Ø = 1.3 * ¥(1:6500) + 1.1 * Ý(1:6500) (3)

The first, second and cumulative derivative id a sample heart beat is shown. Fig.6.

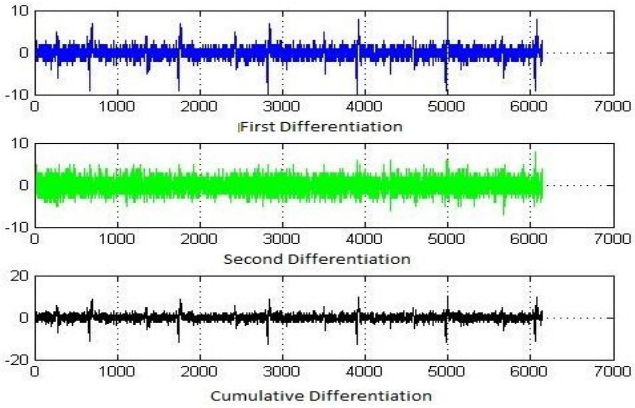

Fig.6. depicts ¥, Ý and Ø consecutively

Fixing threshold: Threshold is fixed to find out the QRS complex that is peak point. Fig.7. represents QRS detected waveform while Fig.8. represents QRS detected against time period.

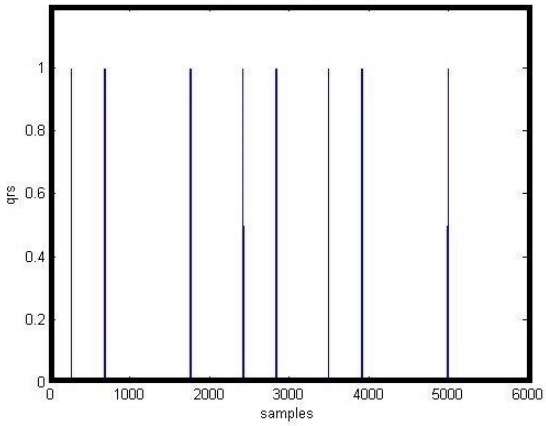

Fig.7QRS waveform detected

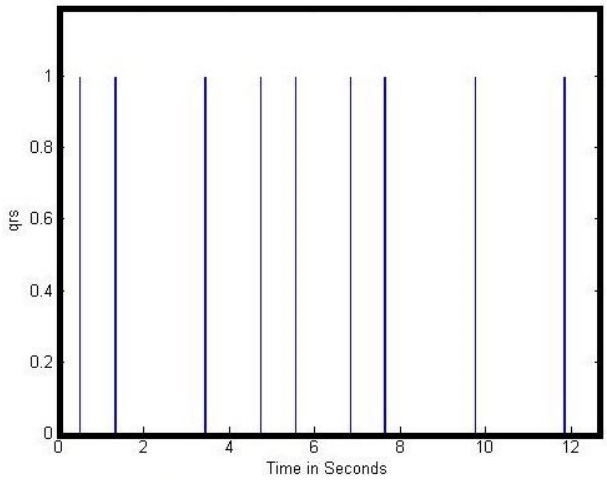

Fig.8 QRS detected = No. of Heart Beat in 12 seconds

V. CONCLUSION

In the present paper, we incorporate the uniqueness property of QRS of the ECG signal into the video password scheme and put forward a new class of authentication system. The proposed system provides a higher class of security system that can never be deceived. The analysis on security indicates that video password have the potential to be an assuring class of authentication system.Also it is proved that the QRS complex of the ECG signal is stable against heart rate variability and is invariant towards the change of heart rate.The combination of these two makes our security system robust and sturdy.

VI. FUTURE WORK

We plan to make our security system more robust by adding additional security features.Here, we make use of the QRS complex as the unique feature for individual identification. There are many more unique features in the ECG signal that can be used as potential biometric for human identification.We can also make our system more flexible by making it compatible for different video parameters like video type and video size.

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