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Heart Based Biometric Authentication: A Survey

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***Abstract*---** The enormous growth in technology and technology based applications it has become important to maintain safety of information that is being stored and shared across all platforms and networks and to allow only authenticated people to access secured information.Various biometric authentication has been discovered and used to authenticate users.This paper describes various approach of Heart Based Biometric Authentication.The Heart based biometric system works on Electrocardiographic i.e.ECG signals of heart that is nothing but the heartbeat of heart.Heartbeat recognition has unique features .This method of authentication shows uniqueness and more reliable results.

***Keywords* ----** Biometric, authentication,ECG,heartbeat recognition,heart electrical signals.

1.INTRODUCTION

The password and tokens from ancient times has lots of drawbacks and has the inadequate levels of security .This security levels inturn gives access to unauthorized people which can harm the security.The systems can be replicated and tokens can be lost.To overcome this Biometric authentication has been introduced.Various Biometric authentication techniques are used nowadays.

The biometric systems uses physical and behavioral characteristics of person.These features of biometric data make it secure as biometric inputs are very difficult to get hacked.The various biometric authentication techniques are Face Recognition,Fingerprint ,Iris or Retina Recognition,signature ,keyboard dynamics etc.These biometric systems has featured as well as drawbacks,so no alone system is consistent and safe.The advancement in Biometric authentication involves unique characteristics i.e. human ECG.The other systems are costly and lacks in uniqueness.The ECG signal from human body is used as Biometric authentication method.

2.RELATED WORK

The Biometric system previously proposed are mostly on-the-person or one-shot authentication,studies shows Falconi et al.,installed Electrocardiogram sensors into mobile phones,Silva et al.,installed sensor into keyboard wrist rest Lourenco et al.,embedded into car steering wheel.The very first to investigate ECG biometric was Biel et al.

Table 1:Various Methods

Name of Researcher	Year	Method	Result
Alajlan, Islam et al	2013	FAGA(Fuzzy Adaptive Genetic Algorithm)	Reduction in error
Islam and Alajlan	2014	Model based alignment	70.53% accuracy
Li and Li	2014	PCA,LDA,WCCN	23.6%EER
Nomura, Ishikawa et al	2014	Chaos indicator	93.7% NN accuracy
Pathoumvanh, Airphaiboon et al	2014	Heart rate variability (HRV)	97% accuracy
Brás and Pinho	2015	Non fiducial (R peak)	1-NN 99 %accuracy
Ramli, Hooi et al	2016	Portable ECG kit	2.00% EER

3.ECG AND THE HEART

The ECG measures the electrical activity of heart.The heartbeat pumps the blood to body the heartbeat is series of events.The heartbeat consists of P-wave,T-wave and QRS complex the P wave represents the representation of atria while QRS complex represents depolarization of ventricles and T wave represents depolarization of ventricles.The electrical activity of heart which is measured in graph as time versus voltage is called electrogram.Ten electrodes are placed on the patients limbs and chest.The overall goal of ECG is to check electrical functioning of heart.

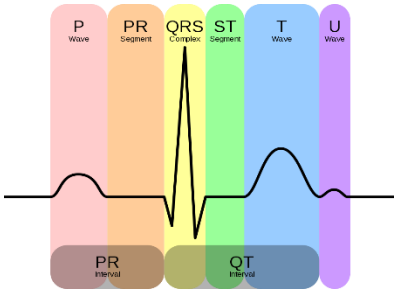

Fig1: Normal ECG[1]

3.1 ECG Heart Biometrics Related work

The different methods of ECG biometrics has been invented by researchers some of them are listed below.

Table 2: Showing Related Work of ECG Biometrics

Name of researcher	Method	Results
Zhang and Wu	ECG	97.55%
Zhang, Y et al. [4]	fiducial and non-fiducial features	improve efficiency
Camara et al. [6]	Continuous Authentication	97.4% to 97.9%
Zhang, Q et al. [3]	MCNN	93.5% for all data sets
Labati et al. [7]	CNN	CNN's architecture complex
Zhang, et al. [8]	pre-trained NN	accuracy of 97.7%
Cao et al. [9]	machine learning , data augmentation	improvement
Alotaiby et al. [10]	statistics for feature extraction	accuracy of 99.61%

3.2 Features of Heart Based Biometrics:

1.Stability : The heartbeat signal is permanent and stable.

2.Robust : The signal from heart can not be forged and therefore is robust.

3.Accuracy : These features provides maximum accuracy to system.

4.Uniqueness : The pattern of our heartbeats is unique and thus the intervals of heartbeat is different too.These variations provide uniqueness.

4.WORKING OF ECG BASED BIOMETRIC SYSTEM

The Heart based biometric system works by receiving ECG signals from receiver at the receiver end and then processing of signal and then transmitted over the global network. The previous systems does not provide security and can be attacked.To avoid this various techniques have been introduced by researchers.The basic working system is shown below.

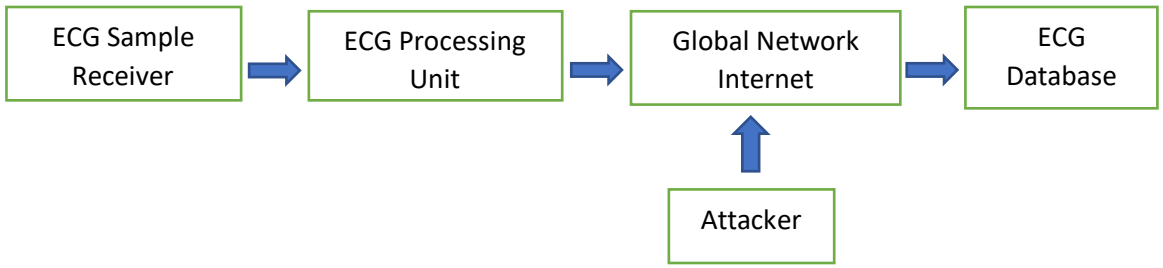

Fig 2: Basic working of ECG biometric system

4.1 Graphical ECG representation:

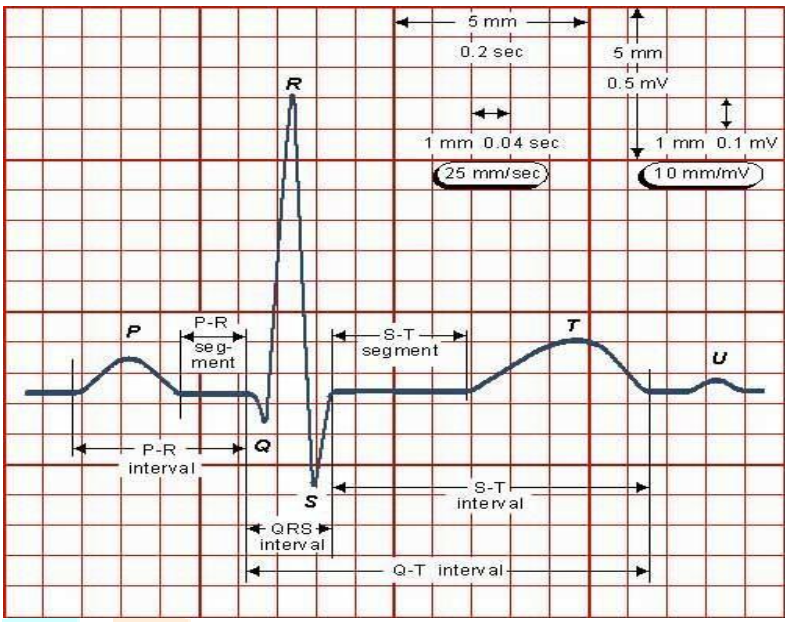

Fig 3: ECG of Heart , Figure referred from the reference [14]

The 5 steps of the electrical pathway of the heart is made up of 5 elements:[12]

- The sino-atrial (SA) node.
- The atrio-ventricular (AV) node.
- The bundle of His.
- The left and right bundle branches.
- The Purkinje fibres.

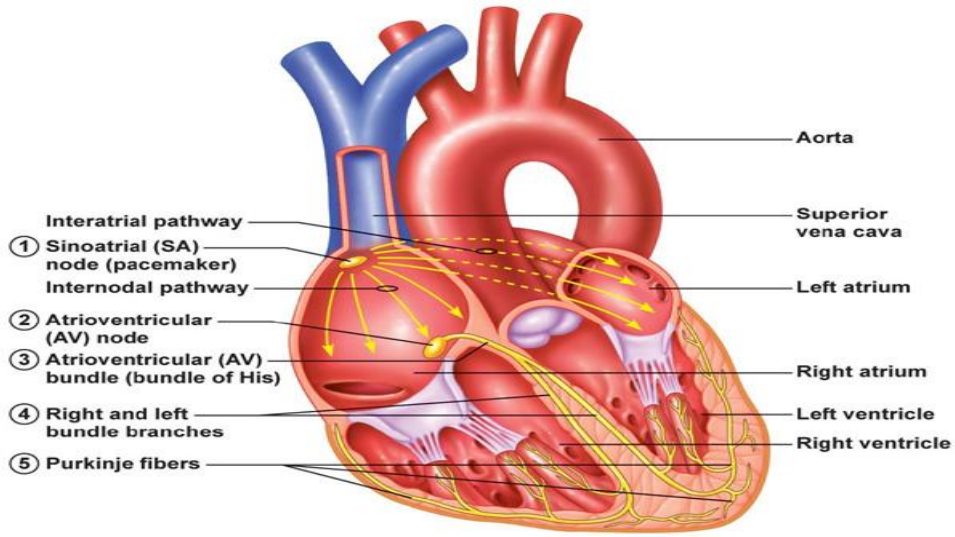

Fig 4: Basics of Heart , Figure referred from the reference [13]

5.ADVANTAGES AND DISADVANTAGES OF TRADITIONAL SYSTEMS

Following table illustrates advantages and disadvanges of typical authentication systems.

Traditional Biometric authentication systems

Biometric authentication types	Advantages	Disadvantages
Fingerprint	• Ease of access • Requires less power • Less cost • Characteristics does not change over time • Can be used in any smart devices	• Vulnerable to foolish attacks • Fingerprints can detoriate upto some extend due to cuts n wear n tear.
Iris	• Ease of access • More accurate • Patterns doesnt change over time • Can be used in any smart devices	• Implementation cost is more • Light sensitivity
Retina	• High accuracy • portability	• Discomfort • Difficult for Artificial characteristics like lenses • costly
Face	• Ease of access • High Portability such as airports • More comfortable to user	• Challenges dealing with facial expressions • Cosmetic changes
Hand Geometry	• Ease of access • comfortable to user	• Dealing with Growing kids • Medical issues
Voice	• Ease of access • comfortable to user	• Costly • Noise reduction • Closed premises
Keyboard Dynamics	• Ease of access • comfortable to user	• Less accuracy • Time consuming

6. APPLICATIONS

There exists various applications of heartbased biometric authentication as follows [15]

6.1 Medical And Healthcare : To maintain the privacy of users as well as to give authenticity biometric authentication has become popular amongst healthcare professionals .Fast identification is useful in emergency conditions.

6.2 Defence Systems : Government security forces should use the best authentication for safety of nation.

6.3 Banking And Financial : The digital era involves financial online transactions on frequent basis debit cards, credit cards,internet banking need most secure method of transfer to limit the online fraud.

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