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Acquition of ECG and Iris data for biometric authentication

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***Abstract*---**Use of Electrocardiographic signals is not new in the field of medical diagnosis to diagnose one's heart health since long decades. But now the same signals can also be used in recognizing a person and thus as a biometric trait. Acquisition of such a vital signal can be done through wired and wireless contacts of electrodes. Several works are already being carried out in these fields. This is because of the universality, individuality, permanence, recordability of the signal from the subject. The data can be collected from the subject using single lead, three leads or even 12 leads. The ECG can be also be recorded through the subject's fingertip using one lead ECG setup. However these signals will be vulnerable to numerous types of noises like base line wander, powerline interference, high frequency noise and low frequency noise. Thus it's a challenging factor to design a biometric system by eradicating these noises. This paper presents a data acquisition system using ECG as well as IRIS where IRIS also provides unique information about individuals. Added advantage of iris capture is that it is a non-invasive procedure which does condenses the noises using several techniques. IRIS human authentication also provides a faster identification technique.

***Keywords*---**electrocardiogram, IRIS, biometric traits, authentication, data acquisition.

Introduction

Biometric technology is one of the challenging fields in the current society as the security is expected in each and every field today. As the level of security breaks and scams increases, it is required to go with a very high level security to identify

and authenticate. Biometrics will meet these desires as it has shown a suitably high accuracy, distinctiveness, uniqueness and stability. ECG biometric authentication has shown very good performance in certain cases where person identification has become an easy task. Typical authentication system provides access to only the person who is legal and stops the imposters from to accessing the security [5]. Biometric identification is done in two phases: the enrolment phase and the verification phase. In the enrolment phase the persons either physiological or behavioural data is captured and processed and later saved in a database.

In the verification phase the data of the subject is captured and processed. Later the processed data is verified by comparing it with the data saved in the database by the use of matching algorithms. Use of ECG can be a typical method to identify person where ECG is the action potential generated by the electrical activity of the heart. This electrical activity is generated from the sinoatrial node where the electrical impulses travel through purkinje fibres to the whole cardiovascular system. ECG signals are recorded from the surface of the body. Usually it is low frequency weak signal that has to be amplified. It is the simplest and fastest test to evaluate working of once heart. Earlier, ECG machines were analogue in nature where hard copy of the reports was provided. Now, with the extended use of computers, and analogue to digital converters, digital forms of ECG can be recorded and can be used for various purposes like detection of abnormality and identification of person as the ECG signals have extremely discriminative characteristics in the field of biometric authentication [1]. However ECG is susceptible to many kinds of noise. Thus the ECG data acquired should be passed through relevant filters and later processed.

Basics of ECG

An ECG is the study of the action potentials generated by the cardiovascular system within the heart. An electrical impulse will be generated from sinoatrial node and spreads thorough out the heart starting from atrium, atrioventricular node and ventricular septum of the heart. These impulse generated makes the four cavities (chambers) of the heart to contract and relax in a synchronized pattern. Heart's functioning can be understood by studying these patterns.

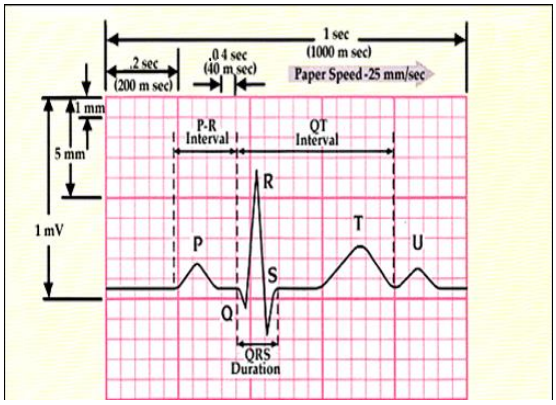

Fig 1. A typical ECG

The Patterns of ECG Signal
P Wave

The P wave is represented by the depolarization of the left and right atrium and also performing atrial contraction. The amplitude of P wave is 0.25mm at maximum and 0.11 sec in duration.

QRS Complex

The QRS complex is the combination of the Q wave, R wave, and S wave. During the production of QRS complex, the electrical impulse spreads through the ventricles and represents ventricular depolarization and it starts before ventricular contraction. The Q wave will be negative always and that the R wave is the first positive wave of the complex and the S wave is the first negative wave deflecting after an R wave. The amplitude R wave is 1.6mV and of Q wave is 25% of R wave. The duration of QRS complex is 0.06 and 0.10 secs.

T Wave

T wave occurs after QRS complex and results in ventricular repolarization. Its amplitude is 0.1 to 0.5mV and its duration is 0.1 to 0.25 sec.

Data Acquisition of ECG signals

To record an ECG, a number of electrodes are affixed to the body of the subject. These electrodes are usually called leads. If the lead is connected to the right leg of the subject, it is called RL. In the similar way, there are Left Leg (LL), Left Arm (LA) , Right Arm (RA) and six chest leads from V1 to V6 connected to the chest of the subject. To normally record an ECG, four electrodes are used. The RL lead is always uses as ground reference. Apart from using chest leads, three bipolar limb leads also provide a better ECG where Lead I: LA + RA Lead II: LL + RA and Lead III: LL + LA are used. The ECG recorded from any one of the following leads is time variant. Of all the 3 leads, lead II produces the greatest R Wave peak. However, ECG data can be acquired through wired and wireless technologies. Wired technology is used in the proposed work.

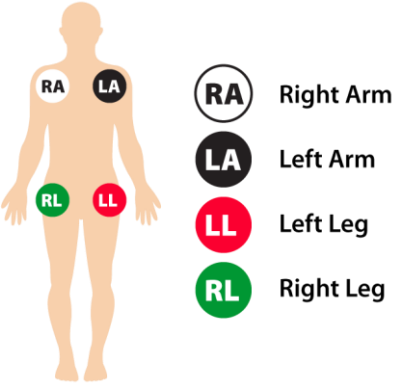

Fig 2. Locations of electrodes on the body

System Components
AD8232

To acquire an ECG AD8232 chip is used which makes use of single lead. This particular chip is designed to extract, amplify, and filter the acquired bio potential signals to remove noises like motion artefacts, electrode placements etc. This measures the electrical impulse of the heart and calculates the voltage difference between the positive and negative electrodes. Later, the acquired signal is converted to digital form using ADC and transmitted to Arduino. The pins used on the board are RA, LL, LA and RL. RL will be always considered as ground. Along with RA, LA, RL and LL, there are other pins SDN, LO+, LO-, OUTPUT, 3.3V, GND to operate the system. It also has an LED indicator to indicate the heartbeat rhythm.

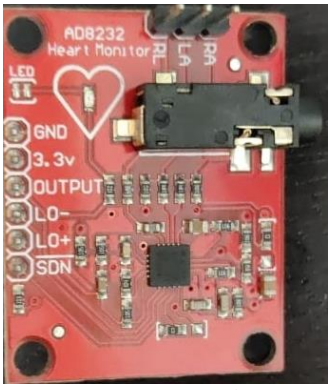

Fig 3. Heartrate monitor sensor

Fig 4. Arduino UNO Board (controller)

Controller

The microcontroller used here is Arduino Uno which is based on the ATmega328P. It has a set of 6 analog and 14 digital pins respectively. When the Arduino board receives a signal from the sensor; it will be passed through a low pass filter with cut-off frequency of 1 Hz to remove artefacts from movements [13].

Basics of IRIS image

The iris of a human being is a circular in structure which controls the size and diameter of the pupil which is the innermost structure. Even the colour of the eye is defined by the iris. It consists of 2 layers, the fibro vascular layer and the stroma. The stroma helps the pupil to contract and relax in the circular motion. Iris is one of the automated methods of biometric identification which uses mathematical patterns as these iris images are complex, unique, stable and can be observed from some distance. IRIS is the internal organ protected against damage and wear by extremely clear and delicate membrane. The iris is mostly horizontal in structure suspended between ciliary fibres. This helps in easy contraction and relaxation of iris. The geometric configuration is only controlled by two complementary muscles that control the diameter of the pupil. This makes the iris shape far more predictable than, for instance, that of the face. At the same time the IRIS data exhibits excellent performance with respect to both technological and operational evaluation [5]. And the IRIS biometry is applied in various fields and has provided a good result.

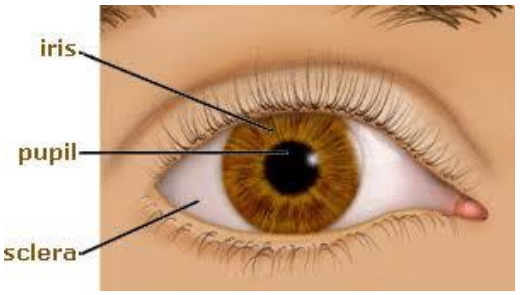

Fig 5. Human IRIS image

Process of Iris Recognition

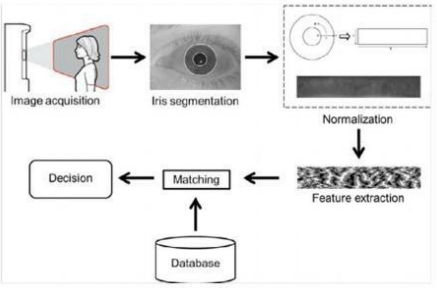

Fig 6. Iris Recognition System the above figure shows the procedure for iris capture

Image acquisition and enhancement

iris image can be captured either using Infrared camera or using visible camera. The camera should be placed between 4 inches to 1 meter fro the subject to capture the data. It can be done automatically or manually. Manual capture of the image requires intense acquition system and automatic capture uses series of

cameras to locate iris. With respect to image enhancement, usually the images captured will be of low contrast. Thus image quality needs to be enhanced by applying enhancement techniques

Image pre-processing

To remove redundant information like noise or artefacts the image has to be pre-processed using median and average filters.

Image normalization and localization

Normalization converts the different sized iris image in to a standard size as the iris image captured will be of different size. Once the camera locates the iris to the fullest, it has to be localized to locate the exact boundary [7].

Feature extraction

There are various feature extraction algorithm to extract the features of the image which includes 2D DCT, Haar transform, Principle Component Analysis, independent component analysis. these algorithms extract the features of the iris for further processing and the templates are created accordingly. [8].

Matching

this is the stage where the similarity between the newly acquired iris images will be matched with that of the templates saved during enrolment phase in the database [10].

Result

Result of ECG data capture

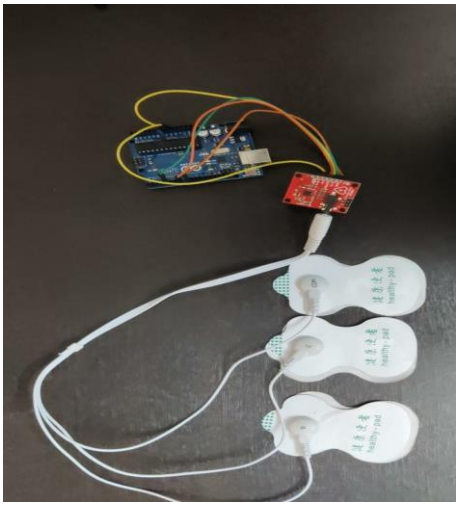

Fig 7. ECG data Acquisition Setup

Fig 8. Experiment with the ECG setup

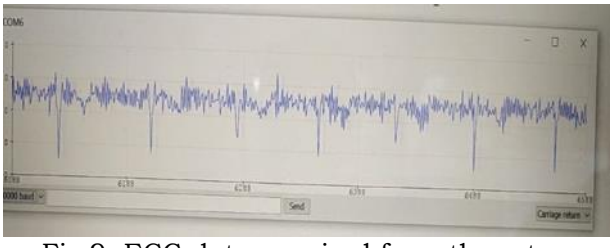

Fig 9. ECG data acquired from the setup

Experimental result of iris capture

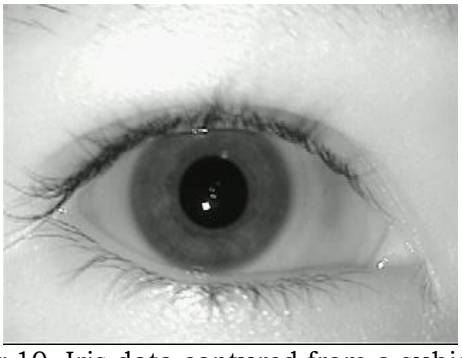

Fig 10. Iris data captured from a subject

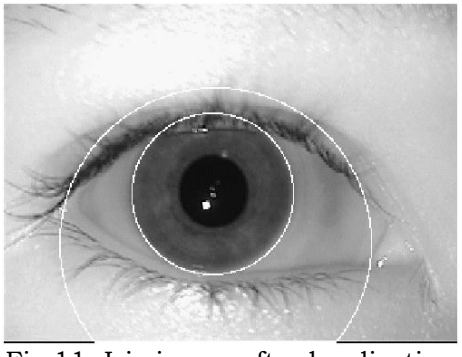

Fig 11. Iris image after localization

Conclusion

This work aims to design and develop an ECG and Iris data acquition system which is cost effective and portable. The combination of these multimodal techniques gives a better accuracy. The system uses AD8232, ATmega328P microcontroller on Arduino UNO board for ECG using 3 leads and a digital camera for iris data acquisition. As a future work, the acquired Iris image and the ECG signals should be pre-processed, localized and normalized before feature extraction based on the requirements. Later the features extracted should be classified using relevant classifiers and the data's of both are to be fused using the fusion technique and then stored in the data base in the enrolment phase. In the verification phase, features of newly acquired ECG and Iris should be extracted, classified and will be matched using matching algorithm to obtain the results.

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