Study of Truthful Detection Technique on the Basis of Arrhythmia by Noncontact Heartbeat Monitoring

S. Praveen [1], K. Gopal [1], Dr. N. Suthanthira Vanitha [2]

[1] First Year ME-Embedded System Technologies, Knowledge Institute of Technology, Salem, TN, India.

[2]Head of the Department/EEE, Knowledge Institute of Technology, Salem, TN, India.

Abstract

This paper deals with the detection of truthfulness from the person's thoughts and activities, this technique is particularly proposed in favour of judicial department to reduce their source and time delay for finishing the criminal affairs. For that the parameter used was sensing the Arrhythmia which is variation of heart beat at various situations. Any kind of thinking of human the heartbeat varies, this is due to variation of electrical impulses produced in part of the heart known as sinus node. During the investigation of an illicit person the electrical signal produced in sinus note varies according to various emotions like fear, truthfulness and lying etc., this variation is Arrhythmia that is observed and the signal value is determined with help of Non-Contact Heartbeat Detection, main advantage of this method is Heartbeat is monitored without the knowledge of that person. This is the main parameter which is considered for detection of truthfulness during investigation.

Keywords--- Arrhythmia, Noncontact Heartbeat Monitoring System, Sinoatrial Node, Adrenal Glands, Heartbeat rate.

1. Introduction

Due to the increase in crime rate the judicial department is unable to finish the cases within less time period some severe cases like terrorist attack, bomb blast and corruption activities took 10 to 20 years to find the solution. Indian judiciary would take 320 years to clear the backlog of 31.28 million cases pending in various courts including High courts in the country, Andhra Pradesh High Court judge Justice V.V.Rao said on March 6, 2010, 06.05pm IST. At the end of 2011 it is increased to 32 million cases according to the statement of pending cases on March 3, 2012. Delay is mainly happening due to the hiding of truth by the criminals, during the enquiries conducted by the CBI or enquiry commission. CBI took many years

Byusing various methods for getting the true statement from the illicit persons. As a whole enquiry sector needs a technology which detects weather the person speaking truth or not. This paper gives the solution for this complex problem by detecting truth by an innovative approach. Arrhythmia employed as one of the parameter because when a person is trying to say false statement or hiding truth the heart beat and pulse change occurs (i.e.) increase in heart beat and pulse rate.

2.Arrhythmia as Parameter

Arrhythmia is Heart rate variability which is a physiological phenomenon where the time interval between heart beats varies. This variation in the heart beat occurs due to the Sinoatrial Node (SAN) which is responsible for heart's electrical activity. It is located in the wall of the right atrium and it is referred as natural pacemaker of the heart [3]. The mammalian heart is accomplished by Pacemaker cells in the Sinoatrial Node region which generate electrical impulses or action potentials.The Sinoatrial Node receives several different inputs and the instantaneous heart rate and its variation is the results of these inputs. The inputs are various actions and emotions of the human such as exercising, running, sleeping, fear, laughing etc. During different activities various voltages are generated in sinus node, the voltage produced in sinus node is directly proportional to the heart beat [5]. So according to above statements it is possible to find out that whether the person is speaking and thinking truth or not, because whenever a person tries to lie during the enquiry his heart beat increases due to fear because,adrenaline glands produce more adrenaline thus elevating your heart rate [8].

3. Cause of fear while lying

Lying can cause many changes within human body, for example when we tell a lie, our heart rate and pulse increases. The Scientific reason behind this was while telling lies our mind has to concentrate more, as a result hypertension, fear and stress increases. The Adrenal Glands are pair of glands present at the top of human kidney, that is responsible for responding fear and stresses, under normal unstressed conditions the human adrenal glands produce the equivalent of 35 to 40 mg of cortisone acetate per day, while responding to fear rapidly more Adrenaline was produced by Adrenaline Glands and so the heartbeat rate increases. This is the basic concept used in this paper for finding the truthiness during investigation of the judicial cases, the heartbeat of the person who is under enquiry is monitored continuously by Noncontact Heartbeat Monitoring technique [6].
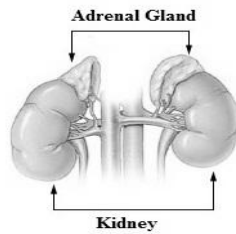

Figure 1. Shows Adrenal Glands in Human Kidney

4. Variation of heartbeat rate due to fear:

When a person is under the investigation is an illicit then in most of the situation they try to lie for escaping from law or to divert the case then,as referred above while lying the person will get into fear. Fear triggers the chemical adrenaline, which speeds up human heart [3]. The normal heartbeat rate varies according to different age groups shown in table 1 [13].

Table.1 Shows variation of Heartbeat Rate among various Age Groups

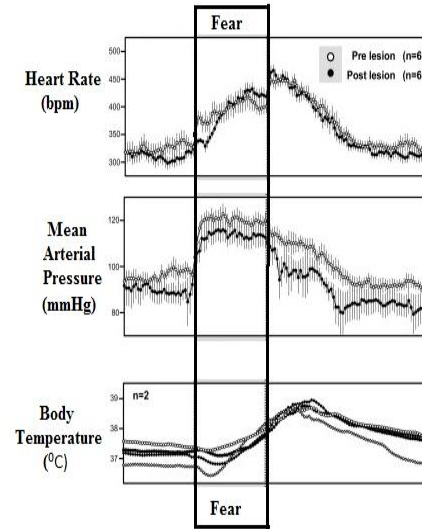| Age Groups	Heartbeats Per Minute
New born baby	100 to 160
1 to 10	70 to 120
10 to 17	70 to 100
Adults	60 to 80
Adults (During Exercise)	120 to 157
Athletes	40 to 70

Figure2. Reference Graph Shows Sudden Raise of Heartbeat Rate

Above mentioned normal Heartbeat rate will be at rest and normal situations of a Human, under different situations and mentality the Heartbeat rate will varies and causes Arrhythmia. Especially during fear situations the Heartbeat will increases rapidly due to excess secretion of adrenaline, heart sound is in the audible range it is 20Hz to 80Hz [10]. By monitoring the heartbeat rate without knowledge of a person with the help of Non-Contact Heartbeat Detection technique the enquiry committee can easily identify the trustworthiness and immorality since it is impossible to control the secretion of Adrenaline which secretes very faster and make heart to pump more blood through blood vessels. The reference graph [11] has shown below shows the sudden increase of Heart rate during the fear period and also increases of Arterial Pressure and Body Temperature of Human. These types of graphs are observed during the period of enquiry.
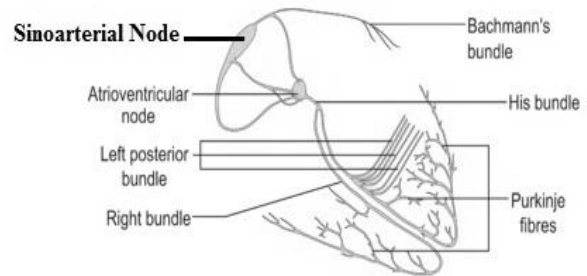

Figure 3. Electrical system of the heart shows the Sinoatrial of the Human Heart

5.Heartbeat Monitoring by Non-Contact technique

During investigation the Heart rate of the person to be enquired is continuously monitored to evaluate the fear, for that an efficient method is needed. The primary tool used for monitoring heartbeat in medical field is Electrocardiogram (ECG), other is pulse-oximeter that measures amount of oxygen in a Human's blood. Additionally, the stethoscope is an acoustic tool that enables physicians to listen to heart sounds and breathing. In summary, all of these tools require a direct physical connection to the patient. But our proposed system needed a Non-Contact technique by which the Heart rate can be monitored without the knowledge of the person. So our proposed system using "Non-contract Estimation of Heartbeat and Respiration Rate using Ultra-Wideband Signals" that monitor cardiac and respiratory activities of human beings, without direct skin contact[1].
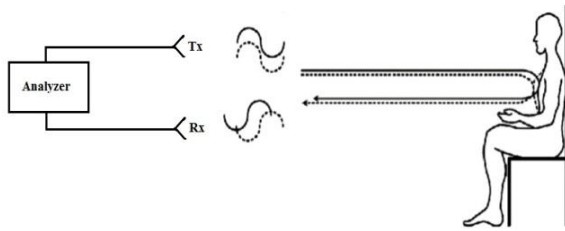

Figure4. Shows Heart and Respiratory Rate Monitoring Using Non-Contact Method

Normally, Human Chest will displace during cardiac and respiratory activities, chest motion due to respiration is between 4 mm and 12 mm, whereas the chest displacement due to heartbeat alone is about 0.3 mm [2].

$$\Delta\theta(t) = \frac{4\pi\Delta x(t)}{\lambda}$$

A person's chest has a periodic movement with no net velocity, and according to Doppler theory, reflects the transmitted signal with its phase modulated by the time-varying chest position. According to below equation, Phase variation $\Delta\theta(t)$ of the reflected signal is directly proportional to the chest position $\Delta x(t)$ that contains information about the movement caused by heartbeat and respiration, where λ is the wavelength of the transmitted waves[1].

Reason behind need for Non-Contact Technique is, the person under investigation should not aware of Heartbeat monitoring thus UWB technology could provide a continuous, Non-Contact Technique [4]. Wireless systems may be useful to share the monitored data with other systems and also stored data used as evidence in court. The basic components of a UWB sensing System includes a transmitter, a reflective target, a receiver, and a Signal Processor, in Medical applications frequency of UWB is limited to the 3.1 to 10.6GHz range[1]. The Transmitter generates streams of pulses of very short duration. Breathing activity will cause a Chest movement of about 10mm to 20mm during that period UWB radar signals will be reflected at every dielectric boundary, main reflection will occur at the Air-chest interface [12].

6. Heartbeat monitoring process during investigation

The person to be investigated as usual in a separate room, Transmitter and Receiver are made focus on target which is Human chest. The target can be located behind an obstruction such as a wall because UWB signals are capable of penetrating a variety of materials such as plastic, wood, rubber, dry soil, glass, and concrete [12]. The transmit antenna is connected to a pulser with a Pulse-Repetition Frequency (PRF) of 100 kHz which generates pulses with a width of 1 nanosecond [10]. The continuous pulse of signals reach Human target and reflects at Air-Chest interface, while Respiratory and Cardiac activity contraction and expansion will occurs. During stress situation the expansion and contraction will be more in Heart and so Chest displacement is faster than normal. Hence the phase of the reflected signal will be varying due to displacement of Human chest position. The reflected signals will have both respiratory and heart signals, in those cases the Digital Signal Processing is used to separate the small Heart Signal of 60 to 100 beats per minutes (1-2Hz) from the much larger Respiration Signal of 12 and 25 breaths per minute (0.2-0.4Hz) [12]. So while person under enquiry is hiding the truth means, the heart rate will raises due to fear and stress and using that Heart rate variation the enquiry committee can easily find their statement is not true.

7. Conclusion

This is an innovative theoretical approach that is proposed to aid for judicial department. Our proposed system will help to solve millions of pending cases quickly and reason behind that much of pending cases is lack of effective technique to assist, so our technique will support for finding the truth which is needed to solve a case. Using this method the Heartbeat and Arrhythmia can be monitored without the knowledge of the person under investigation, since we use Non-Contact Technique and the setup can also be placed behind the obstacles. Whenever human telling lies or hiding truth using the monitoring we can enquire them continuously until true statement comes. We hope our system will crack the complex cases such as bomb blast and terrorist attack, while those people try to divert the cases in such situations this technique can be assisted. The parameter used is human activity Arrhythmia and it cannot be controlled because it is activity of Glands, another advantage of this technique is that the monitored heart rate variation is used as evidence in court.

8. References

[1]. Dany Obeid, Sawsan Sadek, Gheorghe Zaharia, and Ghaïs El Zein *"Noncontact Heartbeat Detection At 2.4, 5.8, And 60 Ghz: A Comparative Study"* July 2008.

[2]. Carlos Casillas, RTAC Americas, Guadalajara Mexico *"Heart Rate Monitor and Electrocardiograph Fundamentals"* AN4059, Rev. 0, 3/2010.

[3]. Arie O. Verkerk, Ronald Wilders, Marcel M.G.J. van Borren, Ron J.G. Peters, Eli Broekhuis, Kayan Lam, Ruben Coronel, Jacques M.T. de Bakker, and Hanno L. Tan *"Pacemaker current (If) in the human sinoatrial node"* European Heart Journal (2007) 28, 2472–2478.

[4]. Lorenzo Scalise *"Non-Contact Heart Monitoring"* Dipartimento di Ingegneria Industriale e Scienze Matematiche, Università Politecnica delle Marche, Italy.

[5]. Murugavel Raju *"Heart-Rate and EKG Monitor Using the MSP430FG439"* Application Report SLAA280A–October 2005–Revised September 2007.

[6]. Kelly M. Rehan *"An Overview of the Adrenal Glands Beyond Fight or Flight"*

[7]. Christian Bruch, MD, Axel Schmermund, MD, Nikolaos Dagres, MD, Thomas Bartel, MD, Guido Caspari, MD, Stephan Sack, MD, Raimund Erbel, MD, FACC *"Changes in QRS Voltage in Cardiac Tamponade and Pericardial Effusion: Reversibility After Pericardiocentesis and After Anti-Inflammatory Drug Treatment"* Vol. 38, No. 1, 2001 ISSN 0735-1097/01. Published by Elsevier Science Inc. PII S0735-1097(01)01313-4.

[8]. D. J. Goodman, R. M. Rossen, R. Ingham, A. K. Rider, and D. C. Harrison. *"Sinus node function in the denervated human heart' Effect of digitalis"*. From the Cardiology Division, Stanford University School of Medicine, Stanford, California, U.S.A.

[9]. Christian Knackstedt, Patrick Schauerte, and Paulus Kirchhof, *"Electro-anatomic mapping systems in arrhythmias"* 0002-9343/04/ 469 doi:10.1016/j.amjmed. 2004.03.041 2004 by Elsevier Inc.

[10]. S.M. Debbal, F.Bereksi-Reguig "Frequency analysis of the heartbeat sounds" IJBSCHS (2008-13-1-12) Biomedical Soft Computing and Human Sciences, Vol.13, No.1, pp.85-90 (2008) 1995 Biomedical Fuzzy Systems Association.

[11]. Hagit Cohen, Jonathan Benjamin, Amir B. Geva, Mike A. Matar, Zeev Kaplan, Moshe Kotler *"Autonomic dysregulation in panic disorder and in post-traumatic stress disorder: application of power spectrum analysis of heart rate variability at rest and in response to recollection of trauma or panic attacks"* Pshychiartry Research Volume 96, Issue 1, 2000.

[12]. Chang Li "Non-contract Estimation of Respiration and Heartbeat Rate using Ultra-Wideband Signals" August 29, 2008 Blacksburg, Virginia.

[13]. HL Chan, CH Lin, YL Ko *"Segmentation of Heart Rate Variability in Different Physical Activities"* 0276−6547/03 2003 IEEE Computers in Cardiology 2003;30:97−100.

About The Authors:

S. PRAVEEN is pursuing First Semester Master of Engineering in the discipline of Embedded System Technologies at Knowledge Institute of Technology, Salem. Affiliated under Anna University, Chennai, India. He is doing minor research under the guidance of Dr. N. Suthanthira Vanitha, Professor & Head/EEE, Knowledge Institute of Technology, Salem. He had published many research papers in various journals and presented number of technical papers in symposium and National conferences. He is doing minor researches on variousfields like Mobile Communication, Microcontrollers, Biomedical Applications, Pressure Die Casting and real time technical social problems. He got lot of first prizes in project contest, technical marketing etc. He is highly appreciated by the head of the department.

K.GOPAL is pursuing Master of Engineering in the discipline of Embedded System Technologiesat Knowledge Institute of Technology, Salem. Affiliated under Anna University, Chennai India. He is doing minor research under the guidance of Dr. N. Suthanthira Vanitha, Professor & Head/EEE, Knowledge Institute of Technology, Salem. He had published many research papers in various journals and presented number of technical papers in symposium and National conferences. He is doing minor researches on various fields like Mobile Communication, Embedded System, Sensors, Microcontrollers, Biomedical Applications and real time technical social problems. He got lot of first prizes in project contest, technical marketing etc.,He is highly appreciated by the head of the department.

DR. N SUTHANTHIRA VANITHA is currently working as Professor and Head of the Department of EEE in Knowledge Institute of Technology, Salem. She received her B.E Electrical and Electronics Engineering in K.S.R. college of Tech, Tiruchengode, 2000, Madras University, M.E -Applied Electronics in Mohamed Sathak Engineering College in Dec'2001 from Madurai Kamaraj University and Ph.D.,-Biomedical Instrumentation & Embedded Systems in 2009 from Anna University, Chennai. She serviced as Lecturer, Assistant Professor & Professor in various Engineering Colleges under Anna University. She is a life member of ISTE & CSI. Her research interests lie in the area of Robotics, DSP, MEMS and Biomedical & Embedded Systems and Power electronics etc. She has published and presented number of technical papers in National and International Conferences and Journals. She is a Technical Reviewer in International Journal of Electrical & Electronics System Research. She has guided number of projects for both UG and PG Students. She is recognized supervisor of Anna University, Coimbatore.