

A Review on Remote Monitoring System for Moving Patients

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Abstract: Timely monitoring and quick diagnosis of ECG rhythm can save many lives. Wearable health monitoring technology is an emerging technology for frequently recording the physical parameters of the patient. This signal is widely adopted to access and diagnose major as well as minor cardiac diseases and health risks. In many fields, to make the user's life more comfortable Internet of Things (IOT) devices are also used. Smart sensors devices are used to collect heartbeat which is used to monitor the condition of the patient. Communicating the information to the doctor and giving the exact diagnosis to the patient through the IOT is a challenging task. This paper gives a comparative study on health monitoring and detection of the patient. ECG monitoring system in the form of mobile, wireless and remote technologies are reviewed in this paper. Further objective of this paper is to identify the research gaps in existing systems and finalise the research statement for further work.

Keywords: Wireless ECG monitoring system, Wearable monitoring system, we-health care, tele-health care, android health monitoring system, expert ECG systems.

I. INTRODUCTION

Currently, the health care system is changing from a classical path to a rejuvenated patient centred point of view. Now-a-days, researchers and engineer's exceptional concept and techniques from the field of computer science, electrical engineering, medicines and biomedical engineering are tremendously in demand for the development of the monitoring system. Now, the recent research should give the higher quality and finer health care services to the people any time and any place in a patient friendly way and should be modest. There are 2 problems why we are doing this research. (i) patient needs to be continuously monitored by the professionals, (ii) patient should be physically present there and should be wired with the biomedical instruments. These 2 factors consume more time and based on this the patients oriented approach has been adopted.

In the past 25 years, the prevalence of heart disease, stroke increased by over 50% with the largest in Kerala, Punjab and Tamil Nadu. An alarming rise has been witnessed in the occurrence of heart disease, stroke, diabetics and cancer. There is a vast variation among states and shows that the prevalence has gone up in every Indian state between 1990 and 2016. Heart disease is now the leading individual cause of disease burden in India and stroke is the fifth leading cause [1]. Heart disease and stroke together contributed to 28.1% of total in India that of 15.2% in 1990. 17.8% of death was caused due to heart disease and stroke contributed 7.1% of deaths. The ratio of deaths and disability from heart disease was significantly higher in men than in women, but in stroke ratio was similar for both men as well as women. Due to cardiovascular diseases deaths rose from 13 lakhs in 1990 to 28 lakhs in 2016 [1]. The number of accustomed cases of cardiovascular diseases has increased from 2.57 crore in 1990 to 5.45 crore in 2016. In India, in 2016, more than half of the cardiovascular disease deaths were found in people younger than 70 years. "This proportion was the highest in lower developed states, which is a major cause for concern with respect to the challenges posed to the health systems and reducing premature deaths caused by cardiovascular diseases in the economically productive age groups requires urgent action across all states of India," the researchers have observed [1].



II. LITERATURE SURVEY

There are different systems reported in literature out of that few important systems are reviewed. Some of them are:

Table 1: Literature Review

Ref No.	Name of Author	Objectives	Technology	I/P parameters	Discussions	Cost
2.	Karandeep Malhi et al.	To detect if a person is medically distressed and sends an alarm to the receiver unit	Zigbee	Wearable physiological parameters	The algorithms were tested and found to be accurate and reliable at the development stage	High
3.	Hyejung kim et al.	A mixed signal ECG system-on-chip i.e. capable of implementing configurable functionality with low power consumption.	Image Processing, Bluetooth protocol	System-on-chip	An adaptive sampling ADC significantly reduces the equivalent data rate of the ADC o/p without affecting the information content, loop buffer integration enables reduction in the access power of the program memory	Very high
4.	Reza S. et al.	To design of a novel wireless n/w structure to monitor patients with chronic diseases	Wireless sensor network	Home	A small attached to the internet through a home asynchronous digital subscriber line router and this monitors the patient without a computer.	High
5.	Emil Valchinov Et al.	The electrodes manufactured on the std. printed circuit board can operate on top of the skin and through the clothing can be embedded within comfortable layers of fabrics	Wireless technology	Wearable	The proposed dry contact electrode can tolerate coupling impedance up to several hundred megaohms relatively to its variation allowing sensing of local biopotential through clothing or hair	Mode rate
6.	Christopher G. et al.	The ability to record and analyse the varying color signals of a finger tip placed in contact with its optical sensor	Optical recordings, image processing	Wearable	The mobile phone cameras have the potential to monitor the pulsatile PGG signal	Mode rately high
7.	J.P. Tello et al.	To detect the electrocardiographic and temperature signals	GPRS, Bluetooth, PC	Wearable	Tested different patients with the help of doctors, obtaining a positive response	Mode rate
8.	Yuan wang et al.	Presents a multifunctional WBAN with real time embedded data analysis ability.	Embedded data analysis, wireless sensor networks.	Wearable on Wrist	Confirmed the benefits of Wi-Fi based WBAN, including the high data rate, low packet loss, multi-nodes synchronize operation, and portability	High
9.	Maradugu anil kumar et al.	To monitor the health of the patients continuously.	Android application	Wearable	This system provides low complexity, low power consumptions and highly portable for health care monitoring of patients and it can eliminate the need of utilization of expensive facilities.	Mode rate



III.METHODS AND MATERIALS

We will discuss some methods which are existed

- (1) Signal processing
- (2) Wireless and Mobile ECG monitoring system.
- (3) Smart wearable monitoring system

(1) Signal Processing

Signal processing and analysis plays an important role in ECG wearable and wireless monitoring systems. There needs to be developed of the diagnostic of such systems to reduce false alarms and afford extended continuous monitoring. The major concerns related to the wireless systems in power consumption. Battery powered portable wireless devices can be designed to perform most of the signal processing locally and transmit results remotely but transmission, in itself normally consumes more power than processing.

ECG signals has been designed for novel, unbiased and normalised adaptive noise reduction system to suppress random noise. The system involves :

- (a) An infinite impulse response comb filter, an additive white noise generator, two-stage moving-average filter to test the systems performance in terms of signal to noise ratio [17].
- (b) low cost online acquisition of ECG signal using MATLAB, LabView and time plane feature extraction from digitalized ECG samples using a statistical approach [12].
- (c) a mobile based ECG detection and analysis algorithm [14]
- (d) ARTIFACT, a software tool for processing ECG data [13]
- (e) ECG signal processing and digital filtering on 8-bit microcontroller [15]
- (f) mean shift based self-adaptive model [16]

Between a fixed Base station and the mobile stations wireless communication takes place within a coverage area with an acceptable signal to noise ratio. The implementation complexities of the mobile station receiver are reduced, and the power consumption in the mobile terminal can be decreased. This reduction usually conflicts with lowering the SNR threshold value. Additional to this the physician's mobile should follow the medical protocols for the diagnosis accuracy. The algorithms and software related to ECG signal processing are discussed [10].

(2) Smart wearable monitoring system

The most trending modules of smart wearable monitoring technology is biomedical sensors which are directly attached to the patient or to the electrode embedded garments. Wireless sensors which measures basic parameters are the emerging devices for improving quality of care simultaneously reducing the cost.

Table 2: Classification of Techniques for Smart wearable monitoring system

Sr. no	Ref. no.	Method	Description	Critical analysis
1.	36, 30	LOBIN	(i)Combination of e-textile and WSN integrated into a smart shirt (ii)Planer-fashionable circuit board technology developed for a long period of time(24hr.)	Issue of electrodes drying & signal quality
2.	34	RR	t-shirt based wearable system has been developed	Issue of electrodes drying & signal quality
3.	39	MOPET (mobile personal trainer)	Wearable system that oversees a physical fitness activity for exceptional training and motivating users	Textile integrated inactive electrode as opposed to commercial wet Ag/AgCl electrode has been developed and tested with the signal integrity during five-cycle washing test.
4	41	BIOTEX (biosensing textile sensor)	Measures physiological parameters and chemical composition of body fluids(sweat)	Textile integrated inactive electrode as opposed to commercial wet Ag/AgCl electrode has been developed and tested with the signal integrity during five-cycle washing test



5.	32	Blue box	Novel hand-held device capable of collecting and wirelessly transmitting key cardiac parameters of ECG, bioimpedance, also measures RR intervals and QRS durations	In real time, common data transmission often had some data processing and network delays
6.	31		Measured the degree of skin hydration by finding the optimal conditions between three electrodes and skin	In real time, common data transmission often had some data processing and network delays
7.	37	Stress eraser	Designed to enhance the heartrate variety.	In real time, common data transmission often had some data processing and network delays
8.	40	e- chair	Designed to measure physiological signals including blood pressure, body temperature, HR, weight, height, body fat percentage	In real time, common data transmission often had some data processing and network delays

(3) Wireless and Mobile ECG monitoring system.

A Wireless body area network (WBAN) allows the synthesis of intelligent systems, minute components, low power sensor nodes attached to the body for monitoring physical activities. The methods which are being overviewed through various papers are classified below:

Table 3 : Classification of the techniques for Wireless and Mobile ECG monitoring system

Sr. no.	Ref. no.	Method	Description	Critical analysis
1.	22	Shimmer WSN mote	Low complexity energy efficient ECG compression has been developed for compressed sensing, signal acquisition and compression	Issue of accuracy and power
2.	23	Holter - based potable	Real time and continuous monitoring and recordings of the patient's ECG signal has been developed.	Constant threat of data security
3.	25	Wavelet transform	Several mobile phone-based ECG feature detection systems was developed.	Delay in results, alerts due to data loss, buffering delay, processing delay.
4.	19	Heart saver	Developed for real time ECG monitoring and automatic detection of several cardiac pathologies.	Issue due to fixed place or small area to monitors patients.
5.	28	Planar fashionable circuit board technology	An attachable ECG sensor adhesive bandage was implemented for continuous ECG monitoring with low cost sensor chip dry electrodes for less skin irritation and long-term monitoring.	3g data suffer the connectivity, signal strength, low battery lifetime, transmission speed.

IV. RESEARCH GAPS

The current technology in the field of wearable ECG monitoring systems with a summary of current and future challenges were reviewed and the idea is to carry forward the review done. The research in the field of development and implementation through innovative technology and the critical review of knowledge-based approaches to ECG pattern interpretation, comprehensive surveys and reviews of wireless body area networks, wireless sensor networks for healthcare and mobile telemedicine, reviewed wearable monitoring systems in smart homes. In the table below, the related works done by the people are reviewed and described. In above system few research gaps are identified by me and that gaps are related to:



Table 4 : Research Gaps

Year	Inventor	Invented
1950	Benjamin	A historic view of diagnostics problem solving by the computer
1950	Skordalakis	An syntactic ECG processing
1950	Pahlm & Sornmo	A brief review of the problems pertinent to signal processing of ECG analysis was carried out
1970	Mcfee & baule	Related to Mathematical, physical and engineering approach of ECG and magnet cardiography
1970	Frank et al.	The accuracy of continuous real time ECG monitoring system
1970	Nygards & Hultings	An automated system for ECG monitoring
1980	Pahlm & Sornmo	A review of computer-based systems for the analysis of ambulatory ECG recordings was reported
1990	Afonso at al.	A review of ECG enhancing techniques to eliminate noise problems and the comparison of their performance on stress ECG signals under adverse noise conditions.
2000-2007	Davenport C, Latre B et al.	Review of the ECG signal collection, analysis, technologies used, limitation and future recommendations

Terminology is a discipline that systematically studies the concepts which are necessary to understand these state of art devices and systems which are now dominating and revolutionizing wearable monitoring systems. A wearable monitoring system is related to the textile-based systems which collect monitors and processes ECG data on a wearable garment which is used as a sensor.

The terms of wireless wearable telehealth monitoring system for the collection of vital data for patients by wearing the sensors directly on the body are Wireless Sensor Area Network (WSAN), Wireless Sensor Network (WSN), Wireless Body Area Network (WBAN), body area network (BAN), Personal Area Network (PAN). The papers reviewed in the next section are related to somewhat similar design concepts and architectural models.

V. CONCLUSION

The user acceptability, efficiency on developing the ECG monitoring systems are compared. Here, in this paper, over 24 ECG monitoring systems were reviewed and are classified into mobile ECG monitoring wearable, wireless systems with signal processing algorithms. The results of these reviewed paper suggest that these wearable ECG monitoring systems focus on the health of the people who are suffering from heart disease problems. The life of the patient can be saved to some extent. The manifold systems and algorithms were also discussed for health care monitoring using the Internet of things. Here, it is seen that this system overcomes the drawbacks from the existing mechanisms which makes the system more efficient methods to monitor the health parameters of the patients. There is a wide scope to work on this project. Work can be done to further improve the performance of the battery life, noise interference is to a great extent, lack of user's acceptability.

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