

# Novel Method for Reducing False Alarm Rate in Mobile based Tele-Care System

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**Abstract**—Tele-monitoring system is the method of patient monitoring, provided that medical practitioner and patient are separated by a large distance and it also involves inaccessibly monitoring the patients who are far away from the health care provider. This article deals with the techniques which are deployed for reducing the false alarm rate of cardiac tele-surveillance system and it talks about a few of the vital challenges and opportunities of communications research in the areas of Telemedicine and E-Health. Especially, we focus on some of the key communications challenges for understanding interoperable and future-proof of Mobile Tele-health systems, need for doing research in this broad area with the help of statistics collected from various health organizations and how drawbacks of some existing technologies can be solved. I have over-viewed this telemetry technology and present the state of the art on each aspect. Some research problems that need to be solved in this area are also described.

**Keywords:** Biomedical Communication, Biomedical Signal Processing, Biomedical Telemetry, Electrocardiography, Healthcare, Telemedicine.

## I. INTRODUCTION

Tele-health is a fast-growing inter-disciplinary area, in which electronic information and communication technology is used to deliver health and medical information and services over large and small distances [1]. According to WHO, an estimated 17 million people die of cardiovascular diseases, particularly heart attacks and strokes every year. A substantial number of these deaths can be attributed to tobacco smoking, which increases the risk of dying from coronary heart disease and cerebro-vascular disease 2–3 fold. Physical inactivity and unhealthy diet are other main risk factors which increase individual risks of cardiovascular diseases [2].

Tele-health includes telemedicine, which offers empowerment, a better quality of life, and reduced cost of care for patients with chronic disease, such as cardiovascular disease, diabetes, chronic respiratory diseases, and cancer [3]. However, Tele-health also includes applications for healthy people, who want to maintain or improve their health. Mobile Tele-health systems are becoming

more important all the time, especially in the care of patients that are isolated or traveling, far from a reference hospital. These systems must be embedded in low cost, small devices with low power consumption, and should have an interface that is usable by the patient. Incorporating technologies such as Bluetooth, Global System for Mobile (GSM) allows the wireless transmission to health centers [4]. The application of wireless communications is already quite common in hospital and emergency settings [5]. Another very common form of telemedicine that has generated a lot of interest in the networking community is remote patient monitoring [7], which facilitates an improved quality of life for the patient by enabling the measurements to be made anywhere there is a phone connection, and by reducing the need for routine trips to the clinic. While such systems have demonstrated positive outcomes, e.g. in terms of reduced number of trips to the emergency room [4], wireless monitoring promises further improvements by providing continuous monitoring, patient mobility, and improving patient compliance with frequent and better quality measurements [4]. When appropriate health professionals cannot be physically present to diagnose patients, telecommunications technology can be used to connect these professionals to those in need of their expertise [8]. In hospitals and homes, telemedicine has been shown to reduce the cost of health-care and increase efficiency through better management of chronic diseases, shared health professional staffing, reduced travel times, and fewer or shorter hospital stays [9].

We focus on using telemedicine to improve outcomes when dealing with acute incidents involving critical care patients. By relaying real-time telemetry and video from ambulances, we hope to provide expert opinions on complex injuries, and to aid the inhospitalities in better preparing themselves for incoming patients [19]. In many situations, the timely application of an appropriate therapy is of critical importance, and mobile telemedicine can help [9]. Patients with heart arrhythmia usually need to be monitored and controlled in hospital for one to several days. These patients are treated to reach on normalizing their heart arrhythmia or achieve an average heart frequency [8]. Sometimes it is necessary to monitor some heart patients in longer period of time to provide more certain documentation for the treatment's correctness, but the patients often are released from the hospital to give the priority to other heart patients on the

waiting list, whom need to be hospitalized immediately [6]. Furthermore, some of heart medicaments are effective only when the patients have minimum activity, namely, when they are hospitalized, but these medicaments are not so effective at home, where the patients have normal or higher activity level [7]. If the heart rate crosses the threshold set by the doctor depending on the patient, a Short Messaging Service (SMS) is generated by Microcontroller unit automatically and it will be transmitted to the doctor's mobile through the GSM Modem [29-31]. The SMS gives the ECG and heart rate of the patient so that medical aid can be rushed to the spot.

This paper describes a novel method to reduce the false alarm rate of portable system with wireless transmission capabilities for the acquisition, processing, storing and visualization in real time of the heart rate to a mobile phone.

## II. RELATED WORKS

It is laudable phase for the formulation of research problem for this investigation. After a robust literature survey related to this research work, it is found that all the existing patient monitoring systems are internet or Web based. Generally, by comparing with the old patient monitoring systems, a centralized server was required for gather bio-signals from the patient [10]. For a test case the information acquired from the bio-signals are shared between the doctor and patient within a short range since it is based upon establishing a communication link through Bluetooth [11]. In the paper [12], continuous monitoring of cardiac patients was not possible. The existing systems create an ECG sensor system that can be wirelessly connected to a handheld device that can graphically present the heart signals [18]. During the second phase, analyzing the heart rate of the patients is achieved by fixing a threshold using Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW) as a tool and to trigger an alarm during panic conditions to the nurses in hospitals. But all the existing models that we have discussed do not provide accurate results as produced by the infrared sensors and these do not offer any means to alert the nurses directly during the night hours, as the alarm is placed near the patients. It requires additional labor to inform nurses about the panic condition of the patients. Even though some of the Tele- health system are mobile based, it requires a centralized monitoring server [23]. It should be noted that the system becomes unavailable, if the server fails [14].

## III. DATA COLLECTION AND ANALYSIS

Cardiac abnormalities were common in the stress filled life style. Actually 9221 ECG's were analyzed, only 112 (less than 1.5 %) were normal, 1483 (16.08%) showed only minor abnormalities and 7626 (82.7%) showed major abnormalities. AF±atrial flutter was present in 2336 patients (25.33%). Excluding patients with paced rhythm (494 patients), QRS prolongation  $\geq 120$  ms was observed in 2378 patients (26% of non-paced patients). Only 1569 (17.02%) ECG's had pathological Q-waves indicative of

myocardial infarction but may have been obscured by bundle branch block or paced rhythm [15]. Of patients with T-wave abnormalities, all but 46 had another associated ECG abnormality. Of patients with moderate to severe T-wave changes, 1698 (20.25%) patients were treated with digoxin, which was rather less than in the overall population [18]. Of the 5718 patients for whom an assessment of cardiac function was available, only 67 (1.17%) ECG's were normal, 697 (12.19%) had minor and 4954 (86.64%) had major abnormalities AF±atrial flutter was present in 1378 patients (24.1%) and was more common in those with major valve abnormality but no major Left Ventricular Systolic Dysfunction (MLVSD). Excluding those with paced rhythm, a broad QRS complex ( $\geq 120$  ms) was observed in 1479 (25.86%) patients and was more common in those with MLVSD compared to those with a major valve abnormality but no MLVSD, mild echocardiographic abnormality or no echocardiographic abnormality. ECG appears to have limited utility in refuting the presence of High fidelity (HF) in a secondary care setting. Very few patients had a normal ECG and therefore even though a completely normal ECG made a diagnosis of MLVSD very unlikely, in agreement with previous reports, it was of little practical assistance. Moreover, 20% of patients with a normal ECG had some form of Major Structural Heart Disease (MSHD). Although T-wave abnormalities were one of the most common abnormalities, they rarely occurred in isolation and did not seem more prevalent amongst patients on digoxin. Excluding T-wave changes from the classification of the ECG would have made little difference to our findings [20]. MSHD was common, as might be expected in this study population. However, no single ECG variable increased the probability of MSHD to  $>90\%$  (a specific test) or reduced it to  $<20\%$  (a sensitive test). Major ECG abnormalities, particularly broad QRS with a Left Bundle Branch Block (LBBB) pattern and anterior Q-waves, increased the probability of finding MLVSD to  $>70\%$  and multivariable models improved diagnostic accuracy further but still lacked precision [17]. These results suggest that the ECG, used alone, is of limited practical clinical use as a screening tool for selection of patients with suspected heart failure for cardiac imaging in a secondary care setting [26].

Our analysis has a number of limitations. The method of data collection was designed to reduce patient-selection bias but may not always have been effective. However, the survey enrolled a large number of patients over a short time and their characteristics were close to epidemiological predictions. This study was designed to capture information after the hospital episode was complete to prevent interference with usual clinical practice. Consequently, many patients with suspected HF did not undergo cardiac imaging as recommended in guidelines, particularly those without gross ECG abnormalities and it seems reasonable to suppose that they would be less likely to have MSHD and MLSVD [16]. Had they undergone imaging, it might have improved the diagnostic performance of the ECG. A prospective study design might have produced a different result, but would have brought its own biases. One other observation deserves mention. The Euro Heart Failure survey is an agreement with many other hospital discharge surveys that suggest that only

about half of patients have LV systolic [25] dysfunction. There is a widespread perception that the other half has diastolic heart failure. However, the clinical diagnosis of heart failure with a normal ejection fraction should not be equated with diastolic heart failure [28]. Valve disease is another major cause of heart failure as are poorly controlled hypertension and atrial fibrillation. Many of these patients probably have abnormal long-axis systolic function. The classification of major structural heart disease adopted in this survey is, we believe, a useful template for use in future surveys [27]. In this classification, diastolic LV dysfunction severe enough to cause heart failure appears rather infrequent. Ultimately, natriuretic peptides may be a better guide to diagnosis and outcome for this group of patients than echocardiography [24].

#### IV. PROBLEM DEFINITION

After the vigilant evaluation of all the above discussed accessible systems especially, as cited in [20-24], the following troubles can be recognized. The further research in this vicinity should be free from the following drawbacks and demerits. Then only the future research product will be user-friendly with high accuracy level of abnormality detection.

- In the traditional medical method, the mobility of both the doctor and the patient are restricted.
- Centralized server is required
- Some existing methods are web-based; without internet they cannot be utilized.
- Continuous monitoring is impossible.
- Large in size.
- Not suitable for Remote Area (Rural).
- On average, false alarm rate of existing systems is above + 10 %
- Some of the systems give more false alarms due to various environmental constraints.
- Common to all aged peoples which will also increases False Alarm Rate, since Heart rate is a variable one based on the age and gender.
- Mostly all the available systems perform feature matching operation for any incoming ECG and make classification for sending information to doctors which produces high false alarm rate.
- Poor Accuracy level in abnormal classification of ECG.
- Time required for transmitting SMS to reach doctor's Mobile from the patient side is more.

These kinds of problems should be overcome by the future proposed systems and methodology (i.e) No need for centralized server and continuous monitoring is possible.

#### V. RESULTS AND DISCUSSION

Heart rate is the number of heart beats per unit of time. It is typically expressed as beats per minute (bpm) which can vary as the need of the body for oxygen changes, such as during exercise or sleep. The normal heart rate of human body (both men and women) is variable and depends on their age. Maximum heart rate (HRmax) is the highest heart rate an individual can safely achieve through exercise stress and depends on age. The most accurate way of measuring HRmax is via a cardiac stress test. In such a test, the subject exercises while being monitored by an ECG.

**Table 1.** Test Data of Heart Rate for Various Age group of Men

Range of Age		17 - 25	26 - 34	35 - 45	46 - 54	55 - 65	> 65
Heart Rate in Beats per minutes (BPM)	Athlete	48-54	48-53	49-55	50-56	50-55	49-54
	Very Good	55-60	54-60	56-61	57-62	56-60	55-60
		61-64	61-64	62-65	63-66	61-66	61-64
	Average	69-72	70-73	70-74	71-75	71-74	69-72
	Poor	> 81	> 81	> 82	> 83	> 81	> 79

**Table 2.** Test Data of Heart Rate for Various Age group of Women

Range of Age		17 - 25	26 - 34	35 - 45	46 - 54	55 - 65	> 65
Heart Rate in Beats per minutes (BPM)	Athlete	55-61	55-60	55-59	54-61	55-60	55-59
	Very Good	62-66	61-65	61-65	62-66	61-65	61-65
		67-70	66-69	66-70	67-70	66-69	66-69
	Average	75-79	74-77	75-79	75-78	75-78	74-77
	Poor	> 86	> 84	> 86	> 85	> 85	> 85

During the test, the intensity of exercise is periodically increased (if a treadmill is being used, through increase in speed or slope of the treadmill), continuing until certain

changes in heart function are detected in the ECG, at which point the subject is directed to stop.

Typical durations of such a test range from ten to twenty minutes [14]. From the robust literature survey, it has been known that heart rate is readily calculated from the ECG as follows.

1.  $HR = 1,500 / R\text{-}R \text{ interval in millimeters}$   
(OR)
2.  $HR = 60 / R\text{-}R \text{ interval in seconds}$

From the Tables 1 and 2, it is clear that age tuner is the mandatory feature for the mobile based cardiac tele-alert system, in order to make the system as user friendly and reduce its probability of false alarm. It is also inferred that "Men are at greater risk of heart diseases than pre-menopausal women". Due to the variations in the heart rate based on age and gender, age tuner becomes an essential part for the cardiac tele-alert system to reduce false alarm rate.

## V. CONCLUSION

The increasing request of patients, suffering of chronic diseases, who wish to stay at home rather than in a hospital and also the increasing need of homecare monitoring for elderly people, have led to a high demand of wearable medical devices. Also, extended patient monitoring during normal activity has become a very important target. Low power consumption is essential in continuously monitoring of vital signs. A Survey on wireless cardiac Tele-health system has been presented for future research directions. The most important value of this Mobile Tele-health system lies in the detection of ECG and heart rate of patients who are located in the remote areas or in travel and are not in a position to report to the doctor for immediate treatment, an alert SMS can be transmitted using the GSM technology to the doctors and advises can be sought for saving the life of the patient. This system could be used as a forewarning system for monitoring during normal activity or physical exercises. It enables the cardiac patient to be on the move globally carrying out his day to day work. It is also clear that the system can be used out of hospital settings. This system enables the doctor to receive/analyze the patient report and also deliver doctor's treatment and specialist advice to remote patient. The doctor doesn't need to be sitting in front of a stationary computer within the medical facility. Research needs to be done for finding more efficient methods for signal enhancement. By comparing this Cardiac Tele-Monitoring System with the existing systems (as discussed in Part II), it is necessary to include lot of enhanced features which is required for the current scenario. These study results have great significance in researching, preventing and finding epidemics in cardiovascular system for the country.

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