Remote Health Monitoring Systems for High Risk Patients

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Abstract

Remote health care monitoring (clinical care at a distance) using the capability of telecommunications systems in crisis situations is relatively a new telemedicine application. The monitoring systems can be wired connections or wireless connections. Several telemedicine applications using wired communications were presented whereas nowadays the evolution of wireless communication means enables telemedicine systems to operate everywhere in the world. This paper reviews telemedicine innovations that may be applicable in crisis situations with a Human's electrocardiogram (ECG) and proposes a conceptual model for remote health care system for high-risk patients with cardio- vascular diseases.

Keywords: *Wireless ECG, Telemedicine, telecommunication, crisis.*

1   Introduction

Delivering expert health care services to patients located in rural areas and improving hospital visits services are the objectives behind the development of different telemedicine applications.

Remote health monitoring is defined as the use of telecommunication and computer technologies together to facilitate remote health care delivery. Geographically dispersed populations can be better served. Therefore, developing low-cost remote health monitoring systems can bring a specialist located hundreds of miles away into the actual examination rooms via a live interactive system.

Several telemedicine applications have been successfully implemented over wired communication technologies like POTS, and ISDN. However, nowadays, modern wireless telecommunication means like the GSM and GPRS and the forthcoming UMTS mobile telephony standards, as well as satellite communications, allow the operation of wireless remote health care systems freeing the medical personnel.

Sensors can collect the vital signals of such patients and transmit them through wireless networks to expert systems for diagnosis and management. Remote health monitoring systems has to guarantee reliability, efficiency, portability, functionality, usability and maintainability.

Telemedicine is applied to many fields such as Tele-radiology, Tele- pathology, Tele-cardiology, Tele home-care, Tele-oncology, Tele-surgery and Tele-psychiatry.

2   Tele-cardiology

Cardiovascular disease is the leading cause of death; 7.2 million People die because of heart diseases every year [1]. This arise a great concern among cardiology specialists to deploy abroad system for remote initial and follow-up consultations, chronic illness self-managing and services interconnection, relying on the available technologies related to telemedicine and as a result, remote health monitoring topics become a very active research area. The transmission of Electrocardiograms (ECG) in the early1900's evolved to the development of portable telemedicine equipment and web-based services. From an engineering point of view the signals generated by the bio-potentials found in the muscles of the heart can be processed and transmitted through any network meant for voice or digital data communication. Therefore, the development of Tele-cardiology has been in constant growth coupled with the evolution of electronics and telecommunications. Tele-cardiology uses terminal units to transmit ECG signal and other vital signs between remote health care units via telephone, computer networks or wireless connections. Portable device can record and send ECG, echocardiogram and other vital signs. Thanks to developments in technology and ever decreasing costs, Tele-cardiology has the potential to save time, money and lives. Tele-cardiology, it would seem, is set to revolutionize cardiac care in the community, making savings and bridging the gap between primary and secondary care.

3   Transmission of Electrocardiograms (ECG)

In order to assure a safe and adequate medical support at a distance, the particular telemedicine network, service, application or device should pay attention to the following points: type of information to be sent: audio, data, image, video, type of communication and networking: networking architecture, POTS, ISDN, ATM, GSM, satellite and wireless, displays: analogue, digital, computation/storage

system, human and organizational factors. Effective health response to disasters will depend on the following important lines of action: disaster preparedness, emergency relief and management of disasters, and this are facilitated by the presence of modern communication like Internet and satellites.

Given the rapid progress of telecommunication and information technology, greater access to them, and lower costs, a more effective application of these tools is at hand and can markedly change the face of disaster management for the 21st Century.

Information technologies such as expert systems, modeling, World Wide Web, and miniaturization have a strong potential to shift the emphasis of crisis management – from that of reaction to mitigation to prevention of disasters (through prediction, simulation, and intelligent engineering). Emergency communications systems should have the ability of being quickly prepared and installed in areas where terrestrial communications lines or systems are unreliable, damaged, or non- existent, systems should be also compact, reliably-powered, easy to use and repair, lightweight, rugged, and highly mobile or transportable.

Computer miniaturization has downsized the desk top personal computer to portable laptop units and pocket-sized Personal Digital Assistants (PDA) with personalized interfaces, some of which are pen/touch based or even voice driven. Work is already underway to tailor these devices for specialized areas including disaster/humanitarian rescue. PDA devices have some important key quality characteristics, information management, portability, and to varying degrees, e-mail, fax, graphics capability, connectivity, digital photography, handwriting recognition, and voice recognition and recording. Phone line, Ethernet, radio frequency, and diffuse infrared transmission schemes have all been used for sending and receiving information.

Many telecommunication technologies are available and can be delivered on a variety of transmission media: single channel non-trunked transmission, trunked multiple channel systems, microwave transmission, LANs connectivity under wireless, satellite and GSM transmission.

The technologies for the mobile systems are GSM (global system for mobile communications), CDMA, TDMA and personal data communication systems. CDMA is a method to share limited radio resources uses a different coding over wide band channel and each mobile is assigned to a unique code. TDMA is another method to allow multiple users to access the voice network using a single radio channel. GSM represents a digital encoding of speech for satellite distribution to mobile phones. GSM advantages are: mobility, small cell size, security, service integration.

It provides mobile telephony and if used with a personal computer, a suitable modem and appropriate software, it can transmit and receive text, data and video. Some computer manufacturers offer portable computers with interfaces to cellular

telephones. An explosive growth of this technology and the large areas covered by mobile phone networks make this technology very suitable for possible telemedicine applications.

Different monitoring systems are commercially available and some of the research proposals about monitoring systems are classified in respect of the following features [2]:

-Systems that record signals and perform analysis off-line. These systems only record the vital signals and no real time classification is done.

-Systems that perform remote real time monitoring. Here the ECG signals and additional parameters [7] are captured and sent to a monitoring Centre through mobile phones. The limitation here is that the analysis is not performed in the place where the signal is acquired.

-Systems that provide local real-time classification. These systems use intermediary local computers between sensors and the control centers or a hospital. These computers perform local real time monitoring. If some anomalies are detected, it sends alarms to the hospital.

In 2001 there have been notion of telemedicine using the mobile phone [3], a Telemedicine framework designed[4] yet it did not discuss the issue of processing raw ECG signals on the mobile device. Guidelines for designing telemedicine for the future were given [5] [6].

The proposed model for remote health care system for high-risk patients with cardio- vascular diseases differentiates with the following factors: online service for ECG signal processing on wearable unit and transmission of abnormal data upon its detection, using GSM module; transmission of only abnormal ECG data, thus saving transmission costs and preventing network congestion and continuous monitoring of patient's cardiac status anytime and anywhere.

A wearable unit on the patient acquires and process ECG signal in real time, if an emergency occurs, an alarm message transmitted via Bluetooth wireless communication technology to GSM module as shown in figure1. An emergency recognizes as a number of abnormalities for predetermined period.
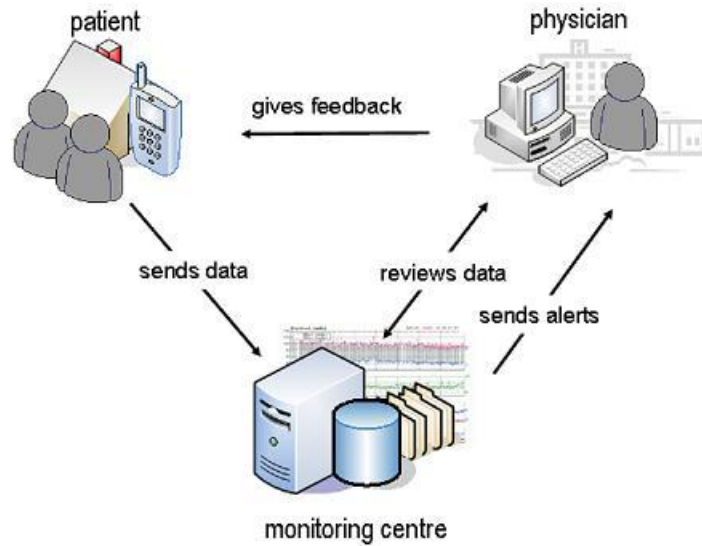
Figure 1.General diagram of the proposed system

With the proposed conceptual model, long term monitoring, real-time transferring of the data to the central server and alarming the related institutions on an emergency situation is achieved. In this way, patients obtain more freedom while they are doing their daily activities.
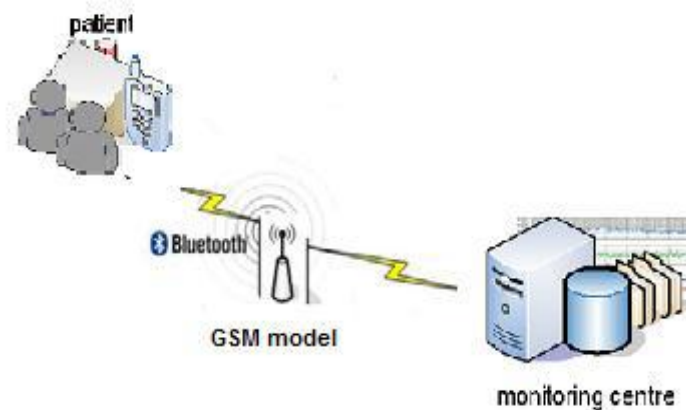

Figure.2.Vital signal transmission model

The amplitude of the ECG signal varies between 0.05 mV - 10 mV and must be amplified with an amplifier and then filtered with a passive filter, after that for transferring the ECG data signal to GSM module a microcontroller must be used and the GSM module sends date to the central monitoring center figure[2].

4   Conclusion

Communications play an important role in the field of remote health care system applications and thus applications play important role in disaster management. Systems must be reliable and able to withstand environmental conditions, interference, and power interruptions. Telemedicine equipment should be quick and easy to repair. A conceptual model of wearable ECG monitoring unit and clinical alarm system is presented and if an emergency situation occurs, an alarm sends to the central server using GSM module and wireless technology. The system increases the patients' movement freedom.

5   Open Problem

As a result of the advances in the upcoming wireless communications means and embedded computation technologies, remote health monitoring systems become a very active research area. In recent years, several telemedicine applications have been successfully implemented over wired communication technologies.

Appropriate solution for delivering health care everywhere in the world, thus expanding telemedicine benefits, applications, and services is the use of a portable wireless health monitoring and alarm system.

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