Wireless Intelligent Gadget for Disaster Relief

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ABSTRACT
Efficient monitoring of physiological signals of injured people in a disaster affected area is always a challenging and tedious task. In this paper we propose an emergency medical service system which can be used in disaster hit areas. Our proposed system aims at reducing this problem and help doctors to serve the injured and save lives. The system designed is easily portable. This system can also be efficaciously link the disaster affected community with the doctor who is willing to assist from anywhere in the world. The proposed portable system can measure physiological signals of people without the requirement of elaborate patient monitoring system, which also consumes lot of power. The expedite response underpins our system and by its exclusive usage in the most challenging environments makes it a perfect solution for patient monitoring in disaster affected areas. The experimental results show the performance of our system is comparatively similar to the manually measured parameters.

Keywords
Disaster relief, gadgets, wireless mobile technology.

1. INTRODUCTION
Disasters (Natural and manmade) are one of the major threats to the existence of humans ever since the primitive age. Even though disasters are unpredictable, humans can reduce the effect of these disasters using efficient disaster management techniques. Three most important problems faced by paramedics in monitoring of injured people in disaster affected areas are network, space and power. In this paper we aim at solving these problems faced during the monitoring of patients in disaster hit areas, to a great extent. In this system, mobile phone display is used to monitor the vital parameters of the patients. The proposed system can be operated using battery, so power requirement is not at all a matter of concern. Mobile phones with wide varieties of features and applications are available in market today at affordable cost. In this system we are incorporating some revolutionary features of medical applications available with the phone.

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2. PROBLEM DEFINITION

Occurrence of disasters is spontaneous and the accurate prediction of natural disasters is close to impossible. So, the only way to reduce the effects of natural disasters is the quick and effective response. The major problem faced by the population of a disaster affected region is the lack of good medical facilities like the service of an efficient doctor who can attend to everyone in a limited time. Many physicians who volunteer at disaster hit areas have a bare minimum of knowledge in disaster medicine.

Governments and other organizations have worked very hard to create vast emergency response networks to deal with mass casualty situations. As per the report by 'THE HINDU' (one of the leading newspaper dailies in India) dated 25th January 2011, India stands 2nd after China on the list of countries affected by the natural disasters. About 373 natural disasters claimed the life of 296,800 people in 2010 all over the world.

Same was the case when the Tsunami struck India during 26 Dec 2004 in which around 9700 people lost their life and 6000 people were reported missing (Government of India, 2005). The tsunami hit along the southern coastal areas of Kerala, a state in India. The people were accommodated in the refugee camps and were provided food, by the government. During the relief activities, the main element that hindered the progress in relief work was the lack of proper and immediate health care facility. Many people affected by the disaster couldn't get proper medical aid at right time which led to the worsening of their injuries. Doctors were not sufficient and medical equipments were not enough to monitor all the people staying at these camps. It took a lot of effort for the people to come back to their normal life. The communication systems were restored within a short period of time but there was a lack of doctors and equipments to provide the medical service.

3. RELATED WORKS

The health monitoring system in [1] only deals with the monitoring of the electrocardiogram (ECG) activity in sleep apnea patients which only gives limited information about the present condition of the patient. This system has no application in disaster affected areas. Paper [2] deals with the monitoring of heart beat; it does not use any other sensors for monitoring other biological parameters like blood pressure and temperature. The system proposed by the authors is not portable and thus would be difficult to use in disaster affected areas and they haven't utilized the wireless technology to its full capability.

Paper [3] is based on web grid for monitoring biological signals in disaster affected areas but the authors haven't given any details about the sensor module which can detect the body parameters of the affected person. The authors have given more importance to the data transfer rather than its acquisition. [9] Discusses about "Emergency Telecommunications", which creates an international framework for the provision of telecommunications resources for disaster mitigations and relief operations . This is all about the various issues and solutions that came up in Tampere Convention (Treaty) on "Emergency Telecommunication s", adopted in 1998.

The paper [12] describes the design and implementation of a light-weight, autonomous, patient-centric, portable medical unit that allows for anytime/anywhere monitoring and can find use in many monitoring scenarios like home-care, hospital wards, emergency help and disaster relief. Paper [10] also discusses the same scenario but including the use of PDA's and laptops. The paper [11] is presenting, a Pervasive Mobile Health Device that can help patients with life-threatening allergies to manage their health in normal life and in emergency scenarios. This topic also is closely related to the various assistive technologies for disaster relief that we discussed here. The device proposed here can be modified for more applications, even though it is specifically deigned for allergic-patients. This makes use of various wireless network and mobile phone options for the communication between doctors and the injured. In [8] authors have proposed health monitoring system in the case of emergency. The system they proposed is very costly compared to our proposed system and also they haven't used mobile technology which is very common and cheap in this new age.

4. SOLUTION

In the proposed system we are considering two scenarios. Firstly, we will consider the worst case scenario in which no network connectivity is available and secondly, the scenario in which network connectivity is not affected. The proposed system acts as an efficient tool in both these scenarios.

4.1 Scenario 1: When there is no network available

In this worst case scenario, the very few doctors and paramedics present at the disaster affected area can monitor the vital body parameters like heart rate, blood pressure, body temperature and ECG of the patients using the sensor module. The sensors are integrated to a small system and from this set up the data are sent to the mobile phone through Bluetooth transceiver. The Bluetooth module which is already present in the mobile takes this data and processes it using the Patient Monitoring Application (PMA). The PMA developed, is capable of processing the data from the four sensors and displaying it in the phone itself.

4.2 Scenario 2: If the network is available

If there are no network problems, the application allows video chat with the medic after the parameters are sent. Thus one can access any doctor in any part of the world at any time for medical assistance.

This system thus could turn out to be a life saving device as the whole system is mobile and handy. The vital parameters of the injured requiring immediate check-up could be sent to the doctors far away who are willing to help but couldn't make it to the spot due to any constraint. Thus any advice on first-aid or any medical assistance can be given to the affected individuals easily. As the entire system is easily portable, a number of injured individuals can be monitored in a short span of time. The PMA is capable of keeping record of the details of each individual for any future reference. The system records the data and can be retrieved whenever required by the medic for further analysis.

5. IMPLEMENTATION

The system proposed here is implemented using components which are cheap and easily portable. So the system design is simple and can be implemented easily. To avoid the muddling up of the four sensor outputs, we accept the value from each sensor only after a specified amount of time. We send the data of the body temperature in a time interval of 30 minutes; heart beat every 15 minutes and blood pressure every 5 minutes. Since the ECG being the most crucial one we monitor and send the ECG value continuously.

5.1. Integrated Sensors

5.1.1 Heart Rate

Heart rate is the number of heartbeats recorded per minute typically recorded as Beats per Minute (BPM) as in [7]. In the proposed system, we are using a reflective sensor HLC 1395 which make use of a technique called Photoplethysmography (PPG). PPG is a simple and low cost optical technique that can be used to detect the blood volume changes in the micro vascular bed of tissues. The HLC1395 is a miniature infrared sensor designed to sense reflective objects at short distances. The sensor is configured with the IRED cathode and the phototransistor emitter connected to a common lead. The output voltage is of 0.50mV and it can be suitably amplified manifold using an Op-amp and filtered using a diode and capacitor circuit. The heart rate is related to the blood flow and is counted with the help of a microcontroller. A notch filter or low pass filter can be used for filtering.

5.1.2 Temperature

The Body temperature is an important measure in determining the health status of the patient. So the temperature sensor must be sensitive to even a very small rise or fall in temperature. For the proposed system we use the IC DS1620 which is a Digital Thermometer and Thermostat provides 9-bit temperature readings, which indicate the temperature of the device as in [6]. The IC is available as 8-pin DIP or SO package. It measures temperatures from -55°C to +125°C in 0.5°C increments. The data can b e read from/written via a two-wire serial interface. The temperature value of the patient is read using the microcontroller at regular interval of time.

5.1.3 ECG

An ECG sensor is important for patient monitoring system because their analysis give clear information about cardiac regulation and well insight about pathological conditions. Also, the system should be user friendly, simple, reliable and of affordable cost.

The three electrodes of the ECG sensor are connected to the body as in figure 1. These signals are passed through protection and selector circuits for protecting the sensitive amplifier from transients and ambience. These signals are then passed though multiplexers followed by a differential amplifier and band-pass filter. This amplified signal is then connected to the analog input of the microcontroller (through AN0 pin of PIC16F877A microcontroller), which calculate the digital equivalent of the input signal. Also a Bluetooth controller is interfaced to the microcontroller for transmission and receiving the data, commands etc from the cellular phone.

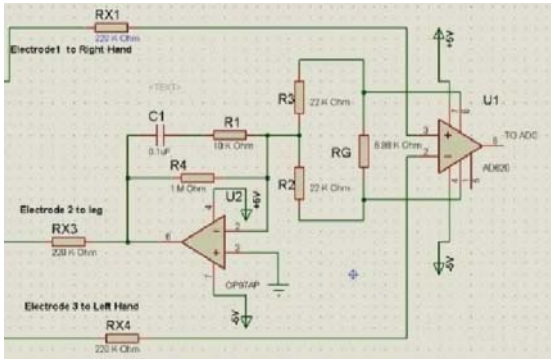

Figure. 1 ECG Sensor circuit

5.1.4 Blood Pressure

High blood pressure is a common risk factor for heart attacks, strokes and aneurysms, so diagnosing and monitoring it are critically important. However, getting reliable blood pressure readings is not always easy. Traditional blood pressure monitoring requires a cuff, wrapped around the upper arm and inflated until blood flow is completely cut off. The examiner then gradually releases the pressure, listening to the flow until the pulse can be detected.

With the new monitor as in [4] no cuff is required; instead, the device takes advantage of a method called pulse wave velocity, which allows blood pressure to be calculated by measuring the pulse at two points along an artery. That posed a challenge because blood pressure in the hand varies depending on its position: If the arm is raised above the heart, the pressure will be higher than if it is below the heart. As the wearer raise the hands up and down, the hydrostatic pressure changes at the sensor.

5.2 Intelligent Wireless Controller.

This is one of the most important modules in this PMS. It consists of a microcontroller and Bluetooth module for interfacing all the sensors with the mobile phone. The Bluetooth module makes the system compact, simple and wireless. The microcontroller is pre-programmed to collect the analog data coming from the sensors and simultaneously converts them to its corresponding digital value. These digital equivalents of the vital parameters are then transferred to the Bluetooth module for its wireless transmission to the mobile phone. We are using BCM2033 single-chip Bluetooth system which has UART interface and it is a complete 2.4-GHz radio transceiver as in [6].

5.3 Mobile Phone

This module forms the soul of this patient monitoring system. Any basic model of cell phone with Bluetooth facility and application software support can be used for this PMS. The cell phone basically collect the data sent via Bluetooth, process it using a patient monitoring application which we have developed, and sent it for expert's review.

If the parameters sent are heart rate, body temperature and blood pressure which do not involve complex computations, any cheap and reliable cell phone models can be used. Moreover such mobile phones (like iPhone or android phone) also provides some additional features like video calls, and video conferencing which can give the doctor a better idea of patient's physical condition. Thus this system is reasonable in terms of affordability and productive by means of purpose.

6. ALGORITHM

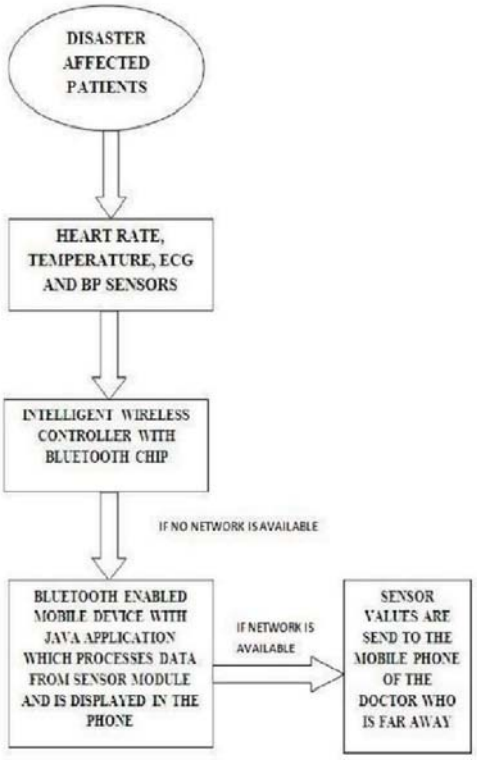

Figure. 2. Algorithm of the system

7. ARCHITECTURE

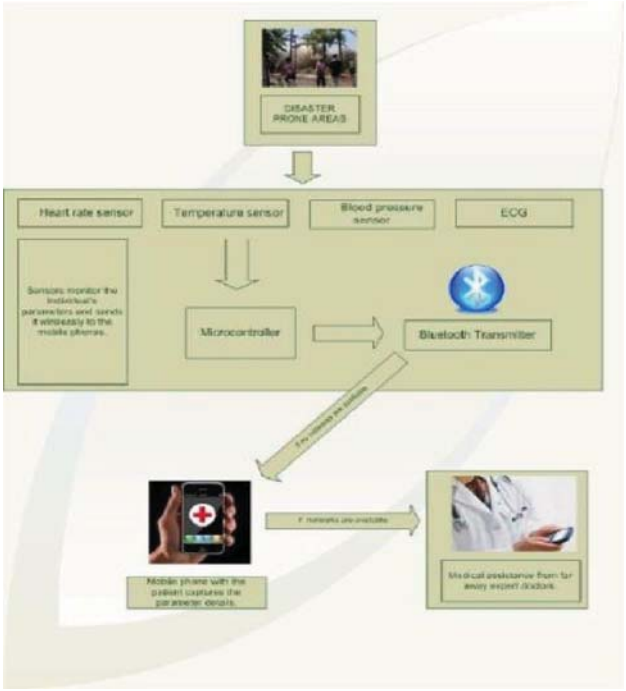

Figure. 3 System Architecture

8. FUTURE WORK

The application of our system can be extended to higher levels because our system can be used in remote areas where people don't have access to quality medical facilities and service of a good doctor. Our system can be used as an effective tool for consulting a doctor who can be anywhere in the world and can assist the patient whenever there is a request for consultation. Secondly, the scope of our system can be further extended to urban areas where people are in a rat race to make their both ends meet, time is as precious as the oxygen that we breathe in. People cannot afford to waste their time, standing in long queues waiting for their turn to consult a doctor.

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