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Prudent Real Time Portable Remote Patient monitoring Using Low Cost ECG & Body Sensors

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Abstract— This document gives formatting instructions for authors preparing papers for publication in the Proceedings of an IEEE conference. The authors must follow the instructions given in the document for the papers to be published. You can use this document as both an instruction set and as a template into which you can type your own text.
Existing patient monitoring system does not provide real time data to doctor. Cost and complexity of other patient monitoring system is high. Existing patient monitoring systems monitors only heart rate of patient. In existing patient monitoring system there is no voice based interaction with doctor. Existing Patient monitoring system is only taking reading, taking log and forwarding log (making available log).
Our Patient monitoring system is light weight, easy to use, simple and cost effective Real Time Expert system. Our system will not only continuously monitor patient health but also will analyze the readings and if parameters are abnormal then will promptly inform to attending doctor directly to his mobile and his caretaker(or relative). System will also generate audible alarm in addition to this all; system will also place a call to a doctor. If Doctors mobile is not reachable then it will continuously retry to call Doctors Mobile by adding the doctor's number to emergency call list, the call can be placed even if there is a network failure. The system can be used with moving patient also .Power supply required for our system can be provided from simple battery, hence our system can be used in remote area where power supply is irregular or not available at all. Our system can be used with any GSM service provider

Keywords—ECG:-Electro cardiogram, BAN: Body Area Network, BSN :- Body Sensor Network, PPG:-Photoplethysmography (PPG)

I. INTRODUCTION

Flexibility is main motto of system. In third world countries like India having large population and number of persons with hereditarily prone to heart related problems having large patient who have heart attack.

In such cases, after heart attack patient needs to be monitored continuously for preventing or tackling second heart attack; but for such monitoring requires patient to be kept continuously under medical supervision in hospital .Cost of hospitalization is high and time of relatives ofpatient wasted in hospital. Number of hospitalization facility is very low comparing with population.With the increase in the number senior citizens and chronic diseases, the number of elderly patients who need constant assistance has increased. [5]

Traffic scheduling is used in the patient-attached device which determines whether to transmit and what to transmit over an available wireless connection. [6].

Modern bedside monitoringrequires not only the networking of bedside monitors with a central monitor but also other standard communication interfaces.

II. BACKGROUND AND RELATED WORKS

An ECG is a graphic produced by an electrocardiograph, which records the electrical voltage in the heart in the form of a continuous strip graph. It is the key tool in cardiac electrophysiology, and plays a vital role in screening and diagnosis of cardiovascular diseases. A single normal cycle of the ECG represents the successive arterial depolarization and ventricular depolarization, which occurs with every heartbeat. These can be roughly related with the peaks and other ECG waveforms, which are labelled as P, Q, R, S, and T.

III. MOBILE HEATH CARE SYSTEMS WITH WEARABLE DEVICES

A variety of approaches attempt to address the issue of reliable and efficient message delivery from deployed sensors to central processing units. Large no of solutions are provided in Under this circumstance, the reliability of transmission is defined as the probability with which a message is successfully delivered from the source to the receiver, along with minimizing the power consumption of message delivery. It is a significant challenge to find the right trade-off between reliability and energy efficiency, because a system always wants to maximize the amount of delivered messages with the minimum energy budget.[2]

IV. BODY SENSOR NETWORKS

A body sensor network (BSN), which is also known as a body area network (BAN), consists of miniaturized, low-cost, and wearable or implantable biosensors, and is able to provide continuous monitoring of a patient's physiological and contextual states . In addition to the design of biosensors, wireless communication and energy management are vital factors to conceive a BSN. With respect to wireless communication, it mainly uses a point-to-point connection between sensors and a monitoring object, and can thereby ensure a BSN's connectivity. Figure shows an example of a BSN. Generally, a BSN consists of portable devices such as PDAs, cellular phones, and medical sensors, and uses wireless communication technologies such as Bluetooth, IEEE 802.x, and General Packet Radio Service (GPRS). To this day, the development of BSNs needs a multidisciplinary collaboration of biology, electronics, chemistry, and mechanics. Predict the human physiological states of restlessness, exhaustion, and stress. Different monitoring sensors are integrated to attach to a patient's body, aiming to gain signals about EEG, ECG, EOG, and EMG. The BAN is a typical wireless sensor network and comprises two modules: a personal dataprocessing unit (PDPU), which controls all sensors and is connected to external networks, and a sensor communication module (SCM) which uses wireless links. The issue of context awareness is well studied in a lot of research. A patient may be physiologically very sensitive to context or environment changes, and such contextual factors include the patient's activity, current temperature of the outside environment, time of day, and so on.Many artificial intelligence techniques including artificial neural networks, Bayesian networks, and hidden Markov models, are applied to sense environmental changes. Then the collected data is classified based on the abovementioned AI techniques to deduce the context of a BSN accordingly. A BSN-based context-aware QRS detection algorithm makes use of context information observed by the BSN to improve the QRS detection performance. Intelligence is involved in BSNs to filter out irrelevant information, make decisions in an expert -like approach, and consider a user's preferences. The incremental diagnosis method (IDM) can detect a patient's medical condition through wearable sensor systems by dynamically adjusting the sensor set based on the patient's state. The core of the IDM is an inference engine, which has three components:

• Feature extraction: The frequency and energy of each sensor are extracted as the features for physical activity recognition.

• Naïve Bayes classifier: This classifier model infers a patient's state probabilities based on the sensor feature vector extracted in the previous step.

• Sensor selection: This step determines if the diagnosis meets the required level of accuracy, and a utility function decides if the suggested actions are recommended to the user or not. Thus, a small number of sensors are required for initial detection, while additional sensors are added when necessary.

V. ECG MORPHOLOGY

Each beat of the heart can be observed as a series of deflections away from the baseline on the ECG. [1] These deflections imitate the time growth of electrical activity in the heart which initiates muscle contraction. A single sinus (normal) cycle of the ECG, equivalent to one heartbeat, is traditionally labeled with the letters P, Q, R, S, and T on each of its turning points. The ECG may be divided into the following sections.

• **P-wave**: A small low-voltage deflection away from the baseline caused by the depolarization of the atria prior to atrial contraction as the activation (depolarization) wave front propagates from the SA node through the atria.

• **PQ-interval:**The time between the beginning of atrial depolarization and the beginning of ventricular depolarization.

• **QRS-complex**: The largest-amplitude portion of the ECG, caused by currents generated when the ventricles depolarize prior to their tightening. Although atrial repolarization occurs before ventricular depolarization, the latter waveform (i.e. the QRS-complex) is of much greater amplitude and atrial repolarization is therefore not seen on the ECG.

• **QT-interval:**The time between the onset of ventricular depolarization and the end of ventricular repolarization. Clinical studies have confirmed that the QT-interval increases linearly as the RR-interval increases. Extended QT-interval may be associated with delayed ventricular re-polarization which may cause ventricular tachyarrhythmia's leading to sudden cardiac death.

• **ST-interval:**The time between the end of S-wave and the commencement of T-wave. Considerably elevated or depressed amplitudes away from the baseline are often associated with cardiac illness.

• **T-wave:**Ventricular depolarization, thereby the cardiac muscle is prepared for the next cycle of the ECG.

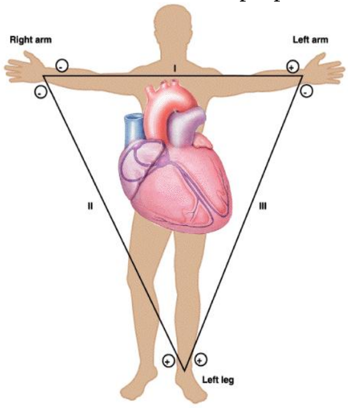

Fig. 1. ECG Connecting Points

VI. ECG CIRCUIT DETAILS

In our system we are going to use light weight inexpensive 3 Lead ECG circuit. This 3 lead ECG system is capable of detecting heart health will provide information to DSP system (LPC2148board) which in turn will analysis the reading & will take action accordingly.

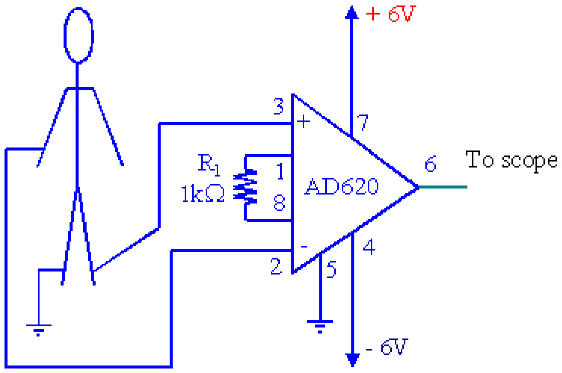

Fig 2: ECG Circuit Diagram

VII. ECG DURING TRANSPORT

The anaesthesiologist holds the key position during transport of a critically ill patient. ECG monitoring using a standard battery operated transport monitor gives information on arrhythmia and heart rate. Commonest problem encountered is motion artifact. Dedicated filtering system and special electrodes are available. One such is RAM (reduced artifact monitoring) electrode. The conductive adhesive gel is flexible and remains in contact even when there are tugging. It also reduces problems of artifact.

VIII. SENSOR MICROCONTROLLER MODULE

The Sensor Microcontroller unit consists of four sensors which could measure parameters like

1) Body Temperature: Temperature sensors in the medical field have been used from time immemorial to measure the body temperature and monitor the medical state of patients. With a temperature sensor connected to the body of him, measurement of complete temperature of the patient will be precise, and the system allows for continuous monitoring of a patient's differential change in temperature. The LM335 sequences are precision, easily-calibrated, integrated circuit temperature sensors. They are two terminal devices like a zener and have a break down voltage directly proportional to the absolute temperature at +10mv/°K. The LM335 operates in the range of -40°C to +100°C as given in. LM335Z can measure temperature ranging from -40°C to +100°C. The output from the temperature sensor is an analog signal and it is fed into the analog input of the PIC16f877A microcontroller. Within the microcontroller, the analog output from each sensor is converted to a 10 bit digital value using the ADC module present inside the microcontroller. The 10 bit ADC transformed data is sent to the transmitter of the wireless sensor module via RC6 pin of PIC16F877A using USART module available in the PIC microcontroller.

2) Blood Pressure: Pressure sensors are important in medical conditions where patients have a frequently varying Blood pressure. These sensors will sense the blood pressure in the patient’s body. Adding wireless broadcast and networking capability will take it to the next level of comfort and sophistication for a number of patients. Traditional blood pressure monitoring requires a cuff, wrapped all-around the upper arm and inflated until blood flow is completely cut off. The examiner then slowly releases the pressure, listening to the flow until the pulse can be detected. With the new monitor as in, no cuff is required. In its place, 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. The two points decided are two points of index figure. That posed a challenge since blood pressure in the hand differ depending on its position: If the arm is raised above the heart, the pressure will be upper than if it is under the heart. The researchers solved that dilemma by incorporating a sensor that measures acceleration in three dimensions, allowing the hand position to be calculated at a few time. This not only compensates for the error due to height changes, but also allows them to regulate the sensor for more accurate calculation of blood pressure. As the wearer increases the hand up and down, the hydrostatic pressure changes at the sensor. Correlating the modify of pulse wave velocity to the hydrostatic pressure change, the system can automatically calibrate its measurement. The alike analog output signal will be fed to microcontroller.

3) Heart Rate: Heart rate is the number of heartbeats recorded per minute typically recorded as Beats per Minute (BPM). In the proposed system, we 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. In this technique, a bright led and a LDR is employed to detect the blood flow at the fingertip or any other peripheral part of the body. The light from the bright Light emitting diode gets reflected from the tissues in the body parts and the amount of light reflected determines the volume of blood flowing. If additional blood flows through it, additional light is reflected back. We have to amplify the signal and remove the unwanted noise signals.

4) ECG: ECG specifies electrical activity of heart measured in millivolt. In our system we have used low cost ECG sensors we have used three lead ECG system which is connected to the body as shown in Fig.2.The corresponding setup and ECG is shown in Fig.3 and Fig.4 respectively.

IX. PATIENT MONITORING SYSTEM OVERVIEW

The overall system architecture of the proposed system is shown in Fig. 3

At the patient's side, the patient is connected to the patient monitor, which is used to acquire ECG signals & provide signals to Doctor using mobile GPRS interface forwards the signals.

X. SENSORS NETWORK

The sensor network consist of temperature sensor, pulse sensor, heart beat sensor & ECG sensors which are connected to patient & central control unit.

Fig. 2. Sensors connected to body

Fig. 3. ECG setup

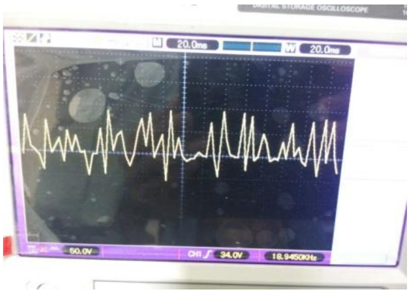

Fig. 4. Ecg of Normal person

XI. CENTRAL DECISION & CONTROL SYSTEM

In our system we have implanted monitoring control & decision making system in LPC 2148 based DSP system. This system will accept reading from all sensor & will manipulatereading & after comparing these reading with system slandered it will take decision accordingly of informing proactively to Doctor & care taker & raise audible alarm .

Fig. 5. LPC Board

Fig. 6.

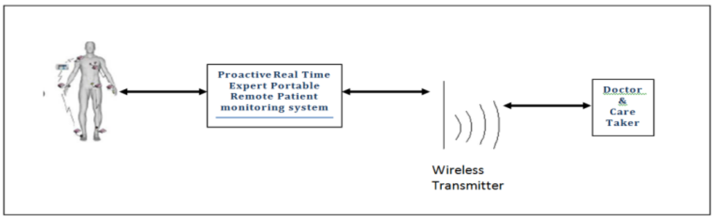

Fig. 7. Block Diagram

XII. COMMUNICATION UNIT

The timely and accurate communication of information is aconsistent challenge for the disaster response community.[3]

The communication unit consist of GSM Transceiver which capable of sending and receiving signals to and from Doctor & care Taker we have selected SIM 300 Transceiver.

Fig. 8. Communication Unit

XIII. CONCLUSION

In this system we have designed an ECG and main system which are both low on cost and portable. It can be used on mobile patient and in remote area asit can be operated using battery and can use GSM for data transmission.

Flexibility is the main motto of our system. In third world countries like India and other south Asian countries which are having large population and number of people who are genetically prone to heart related problems. This system would be of great help in medical field by providing affordable services to the wider society.

Our objective of robust, dynamic, real time & expert system is attained in a major way through this system which is a breakthrough in this field. It is the need of the hour to provide a portable and cost effective solution to the vast majority.

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