HOME BASED HEALTH MONITORING SYSTEM USING ANDROID SMARTPHONE

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Abstract: Patient monitoring systems are gaining their importance as the fast-growing global elderly population increases demands for caretaking. These systems use wireless technologies to transmit vital signs for medical evaluation. The aim of the project is to provide a better health care to people from house in more economic and pertinent friendly manner. The need of home based health monitoring system is increased now days because health care cost is increasing exponentially in last few decades. In the proposed home based health monitoring system using android smart phone includes the aspects of acquisition of medical parameters like Body temperature, Pulse rate and ECG. Processing of a collected data using ARM7 (LPC2148) processer and processed data is then displayed on doctors or relatives android mobile phones. Also the data can be displayed on personal computer. The system is utilizing a low cost component to transmit data like ECG to physician for monitoring; diagnosis and patients care at significantly low cost, regardless of patient's location.

Index Terms: Body temperature, pulse rate, ECG, GPRS modem, Android smartphone,

I. INTRODUCTION

In intensive care units, there are provisions for continuously monitoring patients. Their heart rates, temperatures, ECG etc. are continuously monitored. But in many cases, patients get well and come back to home from hospital. But the disease may return, he may get infected with a new Disease, there may be a sudden attack that may cause his death. So in many cases, patients are released from hospital but still they are strongly advised to be under rest and observation for some period of time (from several days to several months). In these cases, our system can be quite handy.

Patient's data (temperature, heart rate, ECG etc.) will be frequently measured and sent to server. Period of sending (say every 3 min) can be set. Heart rates can be sent every minute and temperatures can be sent after half an hour etc. But these can be parameterized to ensure that when a patient is normal, not many readings will be sent so that sensors have a longer life-time. But when the patient is ill, readings will be taken frequently and sent to server. Monitoring person learns patient specific threshold. Say the regular body temperature of a patient is 37□c whereas one person feels feverish if his body temperature is 37.0□c. By employing an averaging technique over a relatively long time, Observer can learn these thresholds for patients.

Using android application, one can view his medical history date wise, event wise etc. android application can perform data mining on a particular patient data to discover important facts. Suppose a person has medium high temperature that starts at evening and lasts till midnight. If this phenomenon continues for several days, observer can detect this fact and inform to doctors saying "You frequently have short-period fever that may be a symptom of a bad disease. Consult patient immediately". This system can transmit continuously data. Suppose a patient has come back home after cardiac surgery. If the patient has cardiac problems like arrhythmia, then there will be irregular variation of heart signal. This may occur only once or twice a day. But if system transmits continuous data, such variations will be immediately detected and alerts will be issued.

Early detection and diagnosis of potentially fatal physiological conditions such as heart attack require continuous monitoring of patients health following transfer from hospital to home. Studies have shown that 30% of patients with a discharge diagnosis of heart failure are readmitted at least once within 90 days with readmission rates ranging from 25 to 54% within 3 – 6 months. In response to these types of needs, home based health monitoring systems are being proposed as a low cost solution. Such a system consists of physiological data that stores, process and communicate through a local manner such as smart phones, personal computers. Such systems should satisfy strict safety, security, reliability, and long-term real-time operation requirements.

In the proposed system we present a bio-sensor based remote health monitoring system that uses the sensors for collecting data from patients, intelligently predicts patient's health status and provides feedback to patients and doctors through their mobile devices having android application. The patients will participate in the health care process by their mobile devices and thus can access their health information from anywhere any time. Moreover, so far there is no automated medical server used in any of the work related to mobile health care. To maintain the server a large number of specialist are needed for continuous monitoring. The presence of a large number of specialists is not always possible. Moreover in the third world countries like ours specialist without

proper knowledge may provide incorrect prescription. That motivates us to work for an intelligent medical server for mobile health care applications that will aid the specialists in the health care. As a large amount of medical data is handled by the This system is expected to monitor patient under critical care more conveniently and accurately for diagnosing which can be interfaced with android mobile to bring it under network system widely for the doctor to monitor the patient's condition sitting in his own office without being physically present near to the patient's bed.

Our paper is organized as follows. Section II provides a brief discussion of previous work on healthcare systems. Section III describes the reliable transmission protocol, followed by the fall monitoring system in Section IV. The simulation results and the implemented prototypes are shown in Section V. Section VI presents our conclusions.

II. RELATED WORK

A. Patient monitoring systems

A reliable transmission protocol for zigbee based wireless patient monitoring implement a zigbee device for fall monitoring, which integrates fall detection, indoor positioning, and ECG monitoring etc. When the Triaxial accelerometer of the device detects a fall, the current position of the patient is transmitted to an emergency center through a zigbee network.

Design and Implementation of Real Time Embedded Tele-Health Monitoring System is utilizing Team viewer software and low cost component to transmit ECG data to physicians for monitoring, diagnosis and patients care at a significantly low cost, regardless of patient's location. The physiological parameters such as ECG, Pulse rate and Temperature are obtained, processed using ARM7 LPC 2148 controller and displayed in a MATLAB graphical user interface. If any vital parameter goes out of normal range then alert SMS will be sent to Doctors computer.

In Microcontroller Based Health Care Monitoring System Using Sensor Network, Blood Presser reading, heart rate or body temperature exceeds the standard range for any patient, the system is able to notify using an alarming circuit. The whole system is controlled by microcontroller ATMEGA8L. Light signal is used in sensor network section of this embedded system as light does not have any harmful effect on human body when it works in continuous mode. Pulse rate calculation and body temperature determination is also embedded in this system using sensor network.

In Development of a Non-invasive Continuous Blood Pressure Measurement and Monitoring System, it measures blood pressure using volume oscillometric method and photoplethysmography technique during a long time period continuously. The rate of change of blood volume in an organ such as finger has a linear relationship with blood pressure. This rate of change of blood volume in finger is measured by an optical sensor network which estimates blood pressure.

In PPG-based Methods for Non Invasive and Continuous Blood Pressure Measurement, an Overview and Development Issues in Body Sensor Networks the PPG signal can be easily acquired from an optical sensor applied on the epidermis and used, alone or integrated with the ECG signal, to estimate the blood pressure. On the basis of such methods new instruments and sensor-based systems can be developed and integrated with computer-based health care systems that aim at supporting continuous and remote monitoring of assisted livings.

Home based health monitoring systems are being proposed as a low cost solution. Such a system consists of physiological data that stores, process and communicate through a local manner such as smart phones, personal computers. Such systems should satisfy strict safety, security, reliability, and long-term real-time operation requirements. This system is expected to monitor patient under critical care more conveniently and accurately for diagnosing which can be interfaced with android mobile to bring it under network system widely for the doctor to monitor the patient's condition sitting in his own office without being physically present near to the patient's bed.

B. Data Transmission Scheme

Data is to be transmitted to remote location as per our projects main requirement.

There are various communication technologies used for data transmission these are ZIG-BEE, BLUETOOTH, GSM, and GPRS.

ZIG-BEE is used to create personal area networks built from small, low-power digital radios. It is based on an IEEE 802.15 standard. It has Short-range wireless transfer of data at relatively low rates. It transmits data over longer distances by passing data through intermediate devices to reach more distant ones. It has Low data rate, long battery life, and secure networking applications. It’s Data Rate of 250 kbit/s. but zigbee is not suitable for medical application Zig-Bee may not be suitable for transmitting vital signs, especially for emergency messages, since these messages are critical for diagnosing the illness of patients as well as providing important clues to the urgency level.

BLUETOOTH has packet-based protocol with a master-slave structure. The Bluetooth Devices communicates with each other on a secure connection through an unlicensed short-range radio frequency. Easy discovery and setup of services between devices. Bluetooth may not be suitable for transmitting vital signs, especially for emergency messages, since these messages are critical for diagnosing.

GSM Standard for mobile communication. SMS was developed as part of the GSM Communication.

Useful when the mobile phone user is not expect to answer or respond immediately. By using GSM only GPRS (General Packet Radio Service) is Based on GSM and IP. The Data Rate of GPRS is up to 40 Kbit/s. It is one of the quick and cost- effective solutions. It has 3GSM networks and services. The GPRS is useful in medical data transmission because it has direct data uploading capability to server.

Interfacing GPRS modem to controller the data can be transmitted from patient side to server. Then the smart phone is having an application that will make that received data available globally.

III. SYSTEM ARCHITECTURE

A. Body Temperature sensor

The body temperature can be measured by putting sensor in contact with the body. Sensor used in the system is LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the degree centigrade temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient degree centigrade scaling. The LM35 does not require any external calibration or trimming. The LM35 is rated to operate over a 0° to +150°C temperature range. As the body temperature can't reach 150°C the LM35 can be used efficiently.

B. Pulse Rate Counter

Pulse rate of a body can be counted by change in blood flow in blood vessels. In the system the IR led and IR detector is used to fulfil the requirements of pulse rate counter. Fig 1 shows the positioning of IR LED and IR detector.

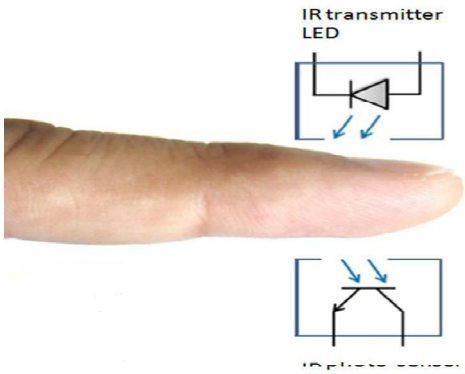


Fig. 1. IR LED and detector position

Putting any finger between the gaps causes change in IR light to be received at receive. The light must pass through finger and detected at other end. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and pulses are counted. The signal getting from this SMS can be sent but medical data cannot be transmitted.

arrangement is very weak and noisy. Following fig is showing the pulses waveform. Contains AC and DC components, also Systolic peak and Diastolic peak as shown in fig. 3 Systolic peak measures the pressure that is contraction of various arteries. Diastolic peak measures the pressure that is exerted on the wall of the various arteries.

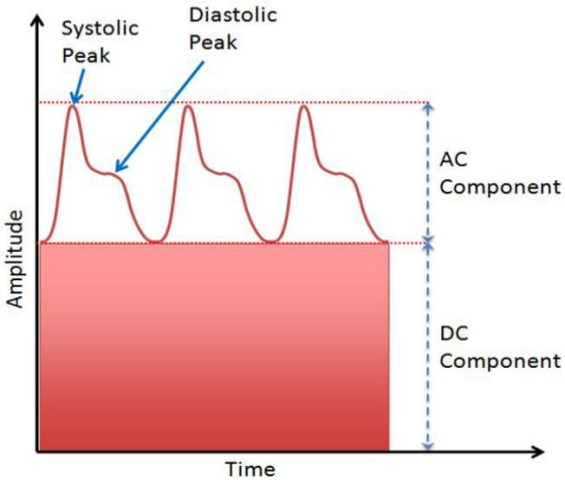


Fig. 2. Pulse waveform from sensor

The PPG signal coming from the photo detector is weak and noisy. So we need an amplifier and filter circuits to boost and clean the signal. In Stage I instrumentation, the signal is first passed through a passive (RC) high-pass filter (HPF) to block the DC component of the PPG signal.

$$\text{Cut-off frequency} = \frac{1}{2\Pi RC} \qquad (1)$$

The cut-off frequency of the HPF is 0.5Hz, and is set by the values of R (=68K) and C (=4.7uF). The output from the HPF goes to an Opamp-based active low-pass filter (LPF). The Opamp operates in non-inverting mode and has gain and cut-off frequency set to 48 and 3.4Hz, respectively. In order to achieve a full swing of the PPG signal at the output, the negative input of the Opamp is tied to a reference voltage (Vref) of 2.0V. The Vref is generated using a zener diode. At the output is a potentiometer (P1) that acts as a manual gain control. The output from the active LPF now goes to Stage II instrumentation circuit, which is basically a replica of the Stage I circuit. Note that the amplitude of the signal going to the second stage is controlled by P1. The Opamp used in this project is LM324 from Microchip, which is a Quad-Opamp device and provides rail-to-rail output swing.

Stage I filtering and amplification

The second stage also consist similar HPF and LPF circuits. The two-step amplified and filtered signal is now fed to a third Op-amp, which is configured as a non-inverting buffer with unity gain. The output of

the buffer provides the required analog PPG signal. The potentiometer P1 can be used to control the amplitude of the PPG signal appearing at the output of the buffer stage.

Stage II instrumentation circuit
The fourth Op-amp inside the LM324 device is used as a voltage comparator. The analog PPG signal is fed to the positive input and the negative input is tied to a reference voltage (VR). The magnitude of VR can be set anywhere between 0 and Vcc through potentiometer P2 (shown below). Every time the PPG pulse wave exceeds the threshold VR, the output of the comparator goes high. Thus, this arrangement provides an output digital pulse synchronous to heart beat. Note that the width of the pulse is also determined by VR. An LED connected to the digital output blinks accordingly.

C. ECG measurement
Electrodes are placed on human body to capture small electrical voltage produced by contracting muscle due to each heartbeat. The ECG signal obtained by the electrodes is in the range of 1 to 5mV. Due to the weak voltage level, the signal is fed into an instrumentation amplifier to amplify and filter the acquired signal. The fig. 5 shows circuit diagram of ECG measurement. The amplified signal is then fed into the ARM7 LPC 2138 having inbuilt AID converter. Digital output of the ADC is sent to local terminal (patient's terminal) via an RS232 interface circuit. The parameters are the magnitude & the duration of each wave, and the intervals, such as R-R PP, Q-T and S-T intervals as shown in fig.3

a) Protection Circuit
Diode (Dl, D2, D3, D4) are used to protect IC from over voltage when input voltage reaches to 0.7V then Diode get clamped and over voltage condition is avoided. Because of this input to instrumentation Amplifier will always be less than 0.7V.

b) Instrumentation Amplifier
The instrumentation amplifier used is AD620 which has a very high CMRR (90dB) and high gain (1000). The AD620 is a low cost, high accuracy amplifier which requires only one extern al resistor to set gain of the amplifier.

c) Isolation Circuit (IC: MCT2E)
It is NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode. Isolation circuit is used to provide isolation between input and output. It protect patient from shock. For checking the ECG signals on CRO we measure the ECG signals via CRO probes In most of the cases the Patient electrode ground and CRO ground is not the same, for such cases if the CRO ground is not properly earthed then the patient may get a Shock so for this reason we are interfacing a Opto- isolator which provides a optical insulation between the Electrode circuit and the Output circuit.

d) Bandpass Filter (0.5 Hz - 35Hz)
We take the band pass filter the frequency range of 0.5 Hz to 35 Hz. Hence we have cascaded high pass filter and low pass filter. Therefore lower cut-off frequency for HPF is 0.5 Hz.

$$\text{Cut-off frequency} = \frac{1}{2\Pi RC} \qquad (2)$$

Where C = luF, R = 330kohm
Low pass filter allow signal below 35Hz only.

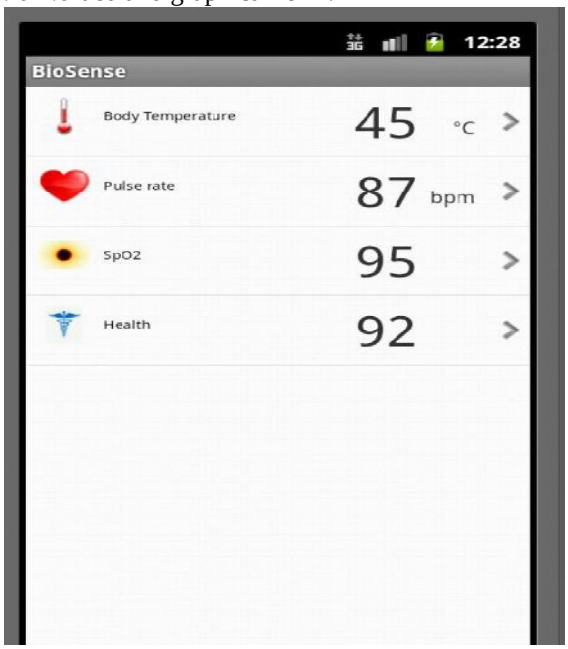
$$\text{Cut-off frequency} = \frac{1}{2\Pi RC} \qquad (3)$$

Where C = O.luF, R = 47kohm

e) Amplifier OP07
8 pin DIP package, low input offset voltage and high open loop gain. This non- inverting amplifier is used for signal conditioning purpose, gain provided by amplifier is 143. Total gain required for ECG circuit is 1000. Using variable resister gain adjusts to 143.

f) Notch Filter
Notch filter is used to provide zero output at particular freq. It eliminates power line noise at 50Hz. It contains H.P.F and L.P.F called twin-T network. Signal having freq between 47HZ to 53HZ .Output of notch filter is+2.5V.Output of notch filter is ±2.5V. It connects to input of adder circuit. Adder circuit shifts the signal from ±2.5V to 0-5V. And this output gives to ADC of ARM7 LPC 2138.

D. Android Application
We are developed the Biosense application to display the processed medical parameter on android mobile with valued and graphical form.



The above screenshot shows the medical data displayed on android mobile

IV. FUTURE SCOPE

The home based health monitoring application is presented which allows doctor to view his patient's medical parameter remotely and dynamically in a Web page in real time and does not need to have any special requirement on his PC or mobile; all he needs is an internet access. In future we can create and save the database of the patient, if patient could come after 1, 2 years then doctor can treat the patient very well.

CONCLUSION

This system reduce costs by enabling in home monitoring of patients, eliminating the need for utilization of expensive facilities, and reducing the need for transportation of patients to physicians and Medical centers.

ACKNOWLEDGMENT

The author would like to thank several colleagues for major contributions of the ideas that led to this paper: Dr. Prof. Sushma shelake mam the PG head of NBN Sinhgad School of Engg. And Prof. P. W. Kulkarni the HOD of E&TC Dept. And Mr. Sonu auti of CIS.

The author would also like to thank anonymous reviewers, who made important suggestions to improve the draft. Despite these contributions, the views expressed in this paper, and in particular the errors, can be blamed on the author alone.

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