Real Time Health Monitoring using ARM7

Rajashri K. Patil
Department of Electronics and Telecommunication
Ramrao Adik Institute of Technology
Nerul, Navi Mumbai, India
rajashrikp@gmail.com

Abstract - ICUs have become widely established in hospitals as to increase lifesaving ratio of critical patients. While in case of emergencies nurse intimates doctor through some means of communication like mobile phone.
The aspire is to develop a reliable, efficient, deployable remote patient monitoring system for I.C.U. patients. This system enables expert doctors to monitor patients in remote areas of hospital.Mobile phones or personal digital assistants with wireless networking capabilities that process, store, and transfer measured parameters to clinicians for further analysis or diagnosis. The timely manner of conveying real time monitored parameter to doctor is given high priority. Hence Real time Health monitoring is becoming popular for the ICU patients.
In this project, we describe the complete design and development of the biomedical sensors and an energy efficient, cost effective platform which allows easy collection of data and efficient display to local and remote PC.
Keywords-biomedical sensor, GSM, GPRS-http, microcontroller

I. INTRODUCTION

"Repeated or continuous observations or measurements of the patient, his or her physiological function, and the function of life support equipment, for the purpose of guiding management decisions, including when to make therapeutic interventions, and assessment of those interventions" [Hudson, 1985, p. 630].
A patient monitor may not only alert caregivers to potentially life-threatening, life saving events; may provide physiologic input data used to control directly connected life support devices.

II. PATIENT MONITORING IN ICUS

Care of the critically ill patient requires
prompt and accurate decisions so that life protecting and lifesaving therapy can be appropriately applied. ICU's use computers
units for the following purposes. To acquire physiological data frequently /continuously, to store, organize and report data, to communicate information from data producing systems to remote locations, to provide alerts and advisories based on data, to function as a decision-making tool, to measure severity of illness to analyze the outcomes of ICU care in terms of clinical effectiveness &cost-effectiveness.
That is why, the efforts in direction of "Real time monitoring of patients using ARM7 processor using no. of biomedical sensors.

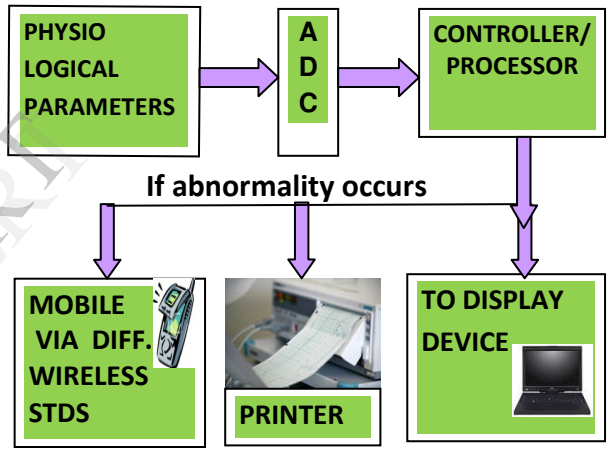


Fig.1 general health monitoring system

The general health monitoring system senses number of physiological signals from sensors. Which are then converted into digital using ADC, amplified, Then these digital outputs are given to microcontroller or to processor. The microcontroller/ processor process this data and then send it to the display system or to the printer or mobile unit .Thus the expert or nurse gets information of patient. But the difficulty is that one assistant is all the time required
near to the patient to read, and to analyze the data. In general health monitoring system the data is continuously monitored but not transmitted to remote server at the same time. If there is any abnormality then only the data is send to the server or remote PC. It means that the data is not analyzed continuously at each and every minute Also due to limitations of different protocols we cannot send this data in real time over long distance (eg. physician / Expert) As we know that the monitoring of movable patient is

done using different wireless protocols. But the key problem is that we cannot use the same system or unit for patients which are fixed or in ICU. So for critical patient we need a fixed monitoring system. Also system must provide a real time data at remote server also. So that quick decision can be made to save patients life .So in this paper we proposed systems which overcome above mentioned limitations.

III. PROPOSED SYSTEM

The proposed system is constructed with low power consumption so that it would not cause much hindrance to the patient. Constructed such that it measures physiological parameters at the patient end without any interference & then transmits the data acquired to remote station. Parameters such as temp, heart rate, ECG can be measured. Then transmitted. These sensed parameters are displayed continuously on local PC or bed side PC.

If parameters are exceeding the limits which are already specified then an automatic buzzer is generated to concerned physician / Expert. The system must be interactive. The physician is needed to send the suggestion back about the patient to the nurse so that nurse can take immediate action. The device is constructed such that it transmits information periodically say 2 minute.

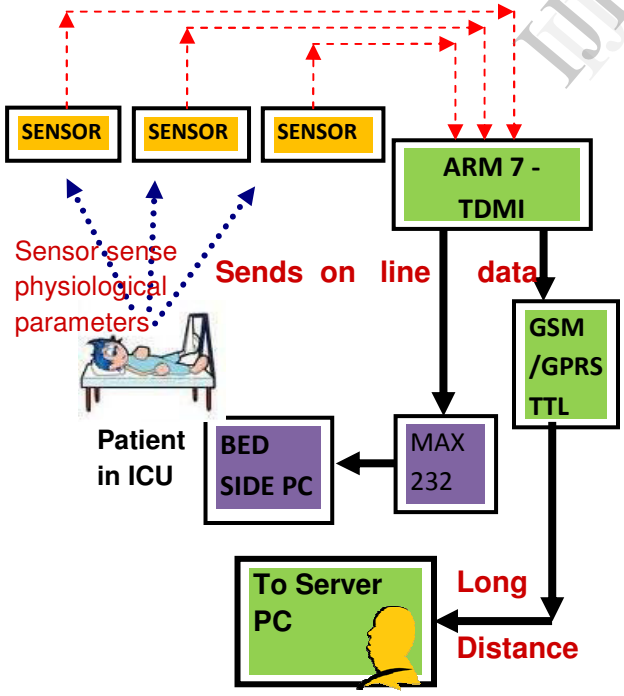


Fig.2. Proposed system

In addition, sending this data in real time to the remote PC or to expert doctor via GSM/GPRS. Thus the remote PC or local PC physician / Expert can prescribe necessary medicine or action towards saving the patient life in I.C.U. Sensors are connected to patient. Measured parameters of patients are interfaced with the system at the patient end. The patient end system is connected with server. Server end system stores the central database of the patients. The status of the parameter is decided at patient end system. The parameters are transmitted via GSM/GPRS modem to remote server. This data is stored in database of the server. If the status is abnormal, then buzzer or alarm is generated at patient end and flag is set to indicate this at remote PC

IV. HARDWARE

The architecture includes sensors, ARM 7 controller, GSM Module., RS 232 (optional)

4.1. Different sensors like temperature, heart rate, electrocardiograph (ECG).

a. Heart beat sensor:

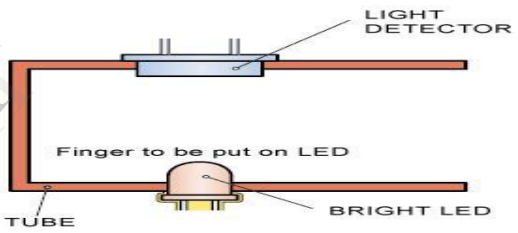
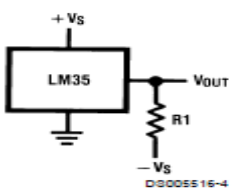


Fig.3 Heart beat sensor

It consists of a super bright red LED and light detector. The LED needs to be super bright as the light must pass through finger and detected at other end. When the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse.

b. Temperature Sensor LM35 :

The LM35 is precision integrated-circuit temp sensors, whose output voltage is linearly proportional to Celsius (Centigrade)
temperature. This is 3 leg IC that directly
gives analog output. LM35 does not require
any external calibration or trimming to provide typical accuracies.



Choose $R_1 = -V_S/50\ \mu A$
V_{OUT}=+1,500 mV at +150°C
= +250 mV at +25°C
= −550 mV at −55°C

Fig.4 Temperature sensor

c. ECG: electrocardiograph:

For ECG we are using instrumentation amplifier & high precision OP-AMP. Filter
for ECG should be a notch filter. Most commonly used electrode placement scheme is shown in Fig.5 Differential potential is measured between right &left arm, between right arm and left leg and between left arm and left leg. These 3 measurements are referred to as leads I, II, III respectively. This is the most basic form of ECG lead placement.

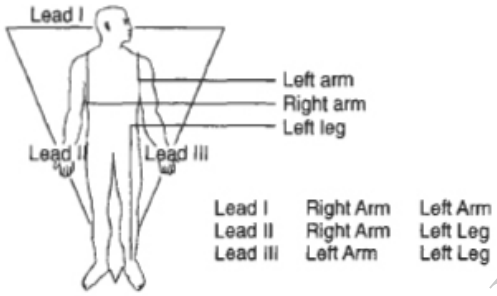


Fig. 5 ECG lead placement

The ECG waveform shows waveforms associated with the contraction of the atria and ventricles. From an ECG a clinician may determine relative timing of contractions of atria & ventricles & assess relative amplitude of atrial & ventricular depolarization & repolarisation. This information may allow identification of
mild heart block

4.2. ARM7 TDMI controller:

The system platform is designed using 16/32 - bit ARM 7 microcontroller, which is single chip with ISP/IAP Flash of 32/64/128/ 256/ 512 kB with 10-bit ADC and DAC. Thumb mode reduces code by more than 30 %.Due to their tiny size and low power consumption, these are ideal for applications where miniaturization is a key requirement. Various 32-bit timers, single or dual 10-bit 8 channel ADC(s), 10-bit DAC, PWM channels and 47 GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems. For ARM7 we are using Embedded C programming language. (Keil Software)

4.3 GSM/GPRS Modem:

Fig. 6 GSM/GPRS Modem

A GSM/GPRS module is used for remote data sending to server. The module is SIM 900B.This module connects to specific application and air interface. Its a quad band engine that works on frequencies GSM 850MHz,EGSM 900 MHz, DCS 1800 MHz, PCS 1900 MHz.
SIM can search 4 frequency bands automatically. Frequency band can be set by AT commands. SIM can meet almost all space requirements in applications such as
M2M,PDA, smart phone and other mobile
devices. It is also designed with power saving techniques so that current consumption is as low as 1.2 mA in SLEEP mode .It is integrated with TCP/IP protocol. TCP/IP, AT commands are developed to use TCP/IP protocol easily which will be very useful for those data transfer applications.

V. PROPOSED SYSTEM OPERATIONAL FLOW:

1. The sensors continuously sense physical parameters of the patients.
2. Values of parameters are checked before processing is done, it mean digital data of ADC is compared with critical / higher/lower values. If the limit is get exceeded the it is indicated by buzzer.
3. Then in ARM7 processor, we design a string of collected data. The size of the string is depend on values of temp, heartbeat, ECG, battery supply
4. This string is then send to GSM module (for remote PC) and RS 232 (for local PC) We send this string , using GPRS using TCP/IP protocol to the remote server.
5. At server end data is collected, then that
data is read by the software application , and it is displayed on server PC.

VI. DESIGNING OF GUI: GRAPHICAL USER INTERFACE :

This is required for displaying different

parameters on PC.For GUI, we are using VB .NET, for database designing SQL, for connectivity between these two is done by using VB.NET

VII. PROGRAMMING:

It includes programming languages used and flow of programming which is designed for ARM7 microprocessor, modem and graphical user interface on server side.

7.1 Programming for ARM 7 processor:

For ARM7 µVision4 Keil software is used. The language used for programming is Embedded C. The Figure 7 shows the flow chart of ARM7 program. Différent files are included with respect to the processor operation and are needed for the perfect operation of the hardware circuit as per designed flow.The included files are Serial.C. , IO. C , ADC.C, Delay.C

7.2 Programming for modem:

This coding includes AT commands for HTTP. The steps to be followed for communication are
Step 1: Configure the profile 1 for bearer
Step 2: Open GPRS context
Step 3: Initiate HTTP service
Step4: Set different parameters for HTTP communication
Step 5: POST the data
Step 6: POST session start
Step 7: POST successfully

7.3Flowchart for programming:

Following flowchart describes the details of programming which is done for microprocessor.

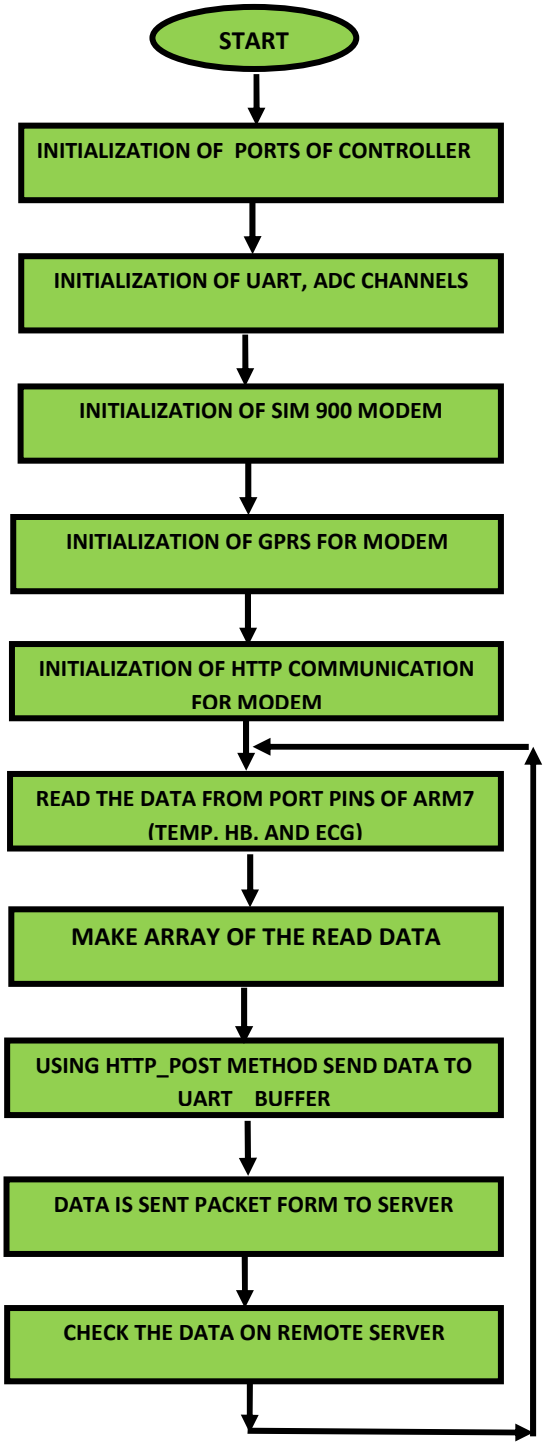


Fig. 7 Flowchart of ARM7

VIII. RESULTS:

The hardware includes two boards. One board includes sensors placed to bed side of patient while other board contains GSM/GPRS modem positioned away from ICU to avoid high frequency effects /

interference on sensor circuits. Complete hardware is shown in Figure 8. Figure 9 shows complete hardware when power is turned on.

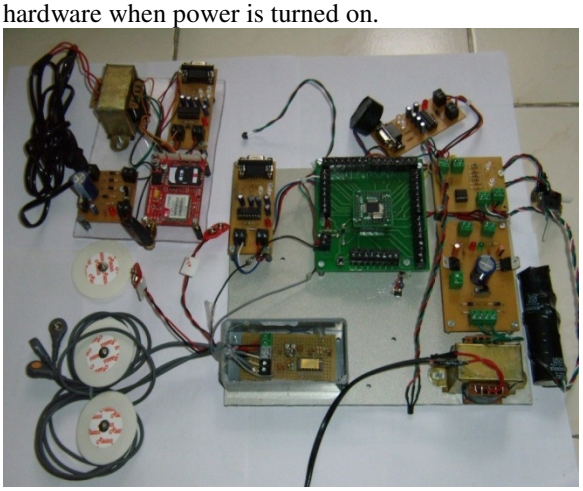


Fig. 8 Complete designed hardware

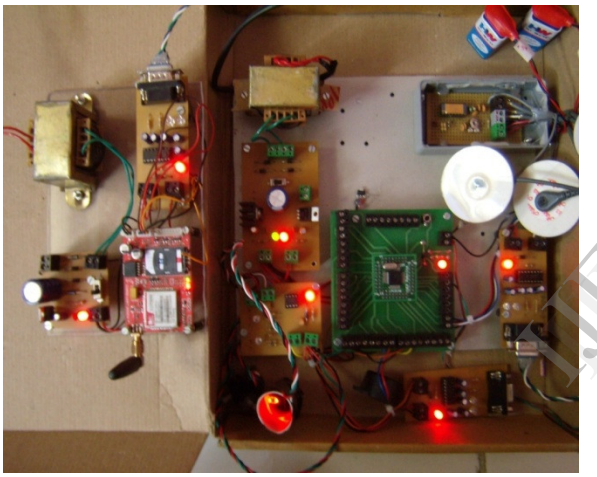


Fig. 9 Hardware system when turned ON

a. Result of temperature and heart beat sensor:

The results of temp and heart beat sensor are shown in Fig.10. Temperature gets changed when the patient's temperature changes and according to that the waveform changes. When there is no heart beat then the graph indicates zero value. The numerical value of temperature and heart beat is indicated at top of screen.

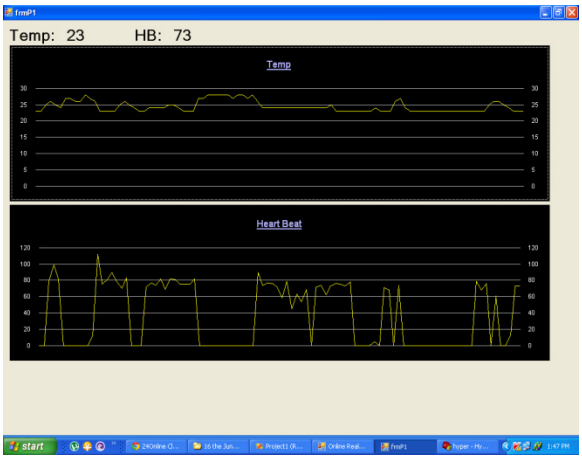


Fig. 10 Waveform of temp and heart beat sensor.

b.Result of ECG sensor

The ECG waveform is called as PQRS waveform. The standard ECG waveform is as shown in Fig 11. From each interval of waveform the expert can detect different disease. Each interval (ST, QT, PQ) defines different diseases.

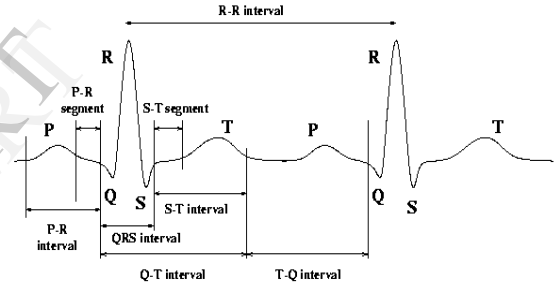


Fig. 11 PQRS waveform

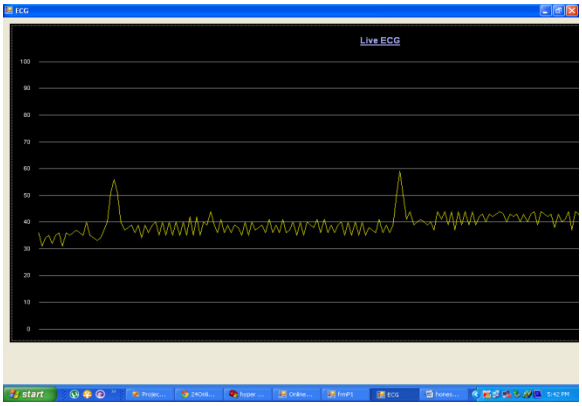


Fig. 12 Waveform of ECG sensor

9.1Merits:

- As information is transmitted in real time, no attendant near the patient is required.
- Continuous monitoring helps expert to cure the patient at high rate.
- Transmitted and received data storage can be possible.

- With online recording of parameters, the workload of the case providers and the nursing staff is reduced.
- The information database contains all data regarding the patients in an electronic form.

9.2 De-Merits:

- The heart beat sensor is highly temperature dependent and the dynamic characteristics changes with different level of ambient light and temperature level.
- The dual operational amplifier needs a high CMRR and additional narrowband filters are necessary to attenuate effects of the noise and interference.
- The modem should be kept 3-5 meters away from sensor circuit otherwise it causes high frequency effect, which changes the operation of sensor circuit.

X. CONCLUSION:

In this project highest priority is given to the information which is sent in real time to remote server using internet.

It is basically used for ICU patients. It monitors the parameters of patient continuously. This system ensures that the expert will get all information of parameters.

Continuous monitoring of patient gives more assurance of life. By observing the parameters of patient on server, expert doctor can advice at any time for improvement of patient's health.

This project represents an integrated real time and on line health monitoring platform for ICU patient. It demonstrates an automated patient monitoring system. Continuous monitoring: Patients parameters are continuously monitored so if any threat is detected, it will be treated immediately. So no delay in treatment of patient occurs. The staying of assistant / specialist is eliminated: As the parameters are transmitted in real time to remote server there is no need of assistance. Easy to operate. It is very easy to use and connect the sensors also it does not cause any harm to the patient. In comparison with the compact sensor it gives better performance. Modern technologies have developed that promotes comfortable and better life which is disease free.

REFERENCES:

[1] Arun E, Marimuthu,Pradeep,Karthikeyan. Remote patient monitoring "An implementation in ICU ward", International conference on information and network technology IPCSIT vol 4 Singapore. 2011

[2] Md Faizul Bari, Rifatshahriyar, Gourab Kundu, Sheikh Iqbal nd Md Mostofa Akbar, Balgladesh university of Engg and tech. " Intelligent Mobile Health Monitoring System", International journal of control and automation vol 2 No. 3 Sept 09

[3]Preliminary data sheet of LPC by Philips

[4] SIM900-RS232GSM/GPRS user manual,

[5] Abou Bekr Belkaid University "Bluetooth Portable Device for ECG and Patient Motion Monitoring by Noureddine" BELGACEM, Fethi BEREKSI-REGUIG Biomedical Engineering Laboratory, Algeria 23 November 2010.

[6] Xiao yu Zhang, Hanjun Jiang,Member, IEEE, Lingwei Zhang, Chun Zhang, Zhihua Wang, Senior Member,IEEE, and Xinkai Chen, "An Energy-Efficient ASIC for Wireless Body SensorNetworks in Medical Applications" IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS, VOL. 4, NO. 1, FEB 2010 11

[7] "Wireless health care monitoring system for home", world academy of science, Engg and tech 2008.

[8] 7 Solutions Brief, Institute OfMedicine, July 2006 from Motorola.com/wimax [9] Michael Eves Georgia Institute of Tech., Jin Yao Georgia Institute of Tech ACRIB: Advanced Critical Response Intensive-care Bed CHI 2009, April 4–9, 2009, and Boston, Massachusetts,

[10] C. Rodriguez, S. Borromeo, R.dela Prieta and N. Mapica."Wireless ECG based Bluetooth protocol design and amplifier "

[11] Nor hafeezah binti kamarudi,"Future extraction and classification of ECG signal to detect arrhythmia and ischemia disease "university of Malaya, may 2010.

[12] Soumya Mishra and K. Goutham "Real time classification of ECG waveforms for diagnosis of diseases", NIT Rourkel,09-10.

[13] Johor, Nor Syahidatul Nadiah Ismail, Sharifah H. S. Ariffin and Mohd Rozaini Abd Rahim, Norsheila Fisal Telematic Research Group (TRG), Faculty of Electrical Engineering, University Technology Malaysia Skudai "TRGWireless ECG Sensor for Medical Healthcare Application" in Proceedings of 2008 Student Conference on Research and Development 26-27 Nov. 2008, , 81310 UTM Skudai.