Design and Implementation of Wireless Healthcare Monitoring System

Kalpesh Patel
M.E (Embedded System)
Electronics & Communication Dept
G.H.Patel College of Engineering & Technology
Anand, India

Rahul Kher, Ph.D
Associate Professor,
Electronics & Communication Dept
G.H.Patel college of engineering & Technology
Anand, India

ABSTRACT

Healthcare monitoring is now becoming part of everyday life. Today's healthcare industry aims to provide better healthcare to people anywhere, anytime in the world in economical and patient friendly manner. In this paper the physiological parameters like heart rate, body temperature, SpO_2 and ECG signal are obtained and displayed using PIC18F45K22 Microcontroller. Body temperature, SpO_2 and heart rate are displayed on LCD display and ECG signal is monitored on PC through Labview. If the abnormalities in the recorded parameters are detected, then an SMS alert will be sent to the physician. The system comprises of low cost ECG, SpO_2 and temperature sensors along with the GSM modem.

Keywords
ECG sensor, Temperature sensor, PIC microcontroller, GSM module

1. INTRODUCTION

The embedded system (electronics technology) has entered almost in all aspects of today's life and medical area is not exception for that. The need for well-equipped hospitals and healthcare centers is increasing day by day as the people are becoming more aware about their health problems. In some hospitals special units are used for biomedical field, as for example such as intensive care unit or coronary care unit. All of these units are designed, so that the advantage of the low nurse-patient ratio, concentration of the equipment and their resources needed, to take care of critically ill or seriously injured units. Today medical field faces two basic problems when it comes to patient monitoring. First one, the presence of healthcare provider beside the patient and second, the patient is restricted to bed and wired to large machines.[2] With the technological advancement, it has become possible to design low-cost, home based healthcare monitoring system in which the system records and displays the signals from human body and transmits to any other location. This paper discusses the acquisition of physiological parameters such as ECG & heart rate, body temperature, SpO_2 (pulse oximetry) and displaying them on LCD display/PC.

2. DETAILED DESCRIPTION OF SYSTEM
This section includes:

- Block diagram of the system
- Flowchart
- Algorithm

2.1 Block diagram
The blocks in the diagram represent the major components of the system and interconnection between them.
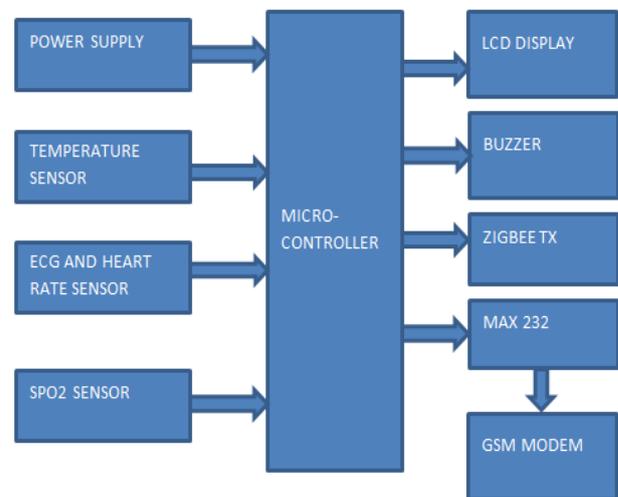

Fig.1 Block diagram of system

- Sensors: Sensors like temperature sensor, SpO_2 sensor, ECG sensor are placed on the patient's body.

- PIC microcontroller: It receives the outputs of the sensors and analyzes them. Then send them through zigbee transmitter to physician PC. It also sends an SMS alert to physician mobile through GSM. [5]

- ZIGBEE module: zigbee module is used for wireless data transmission between microcontroller and PC.[6]

- GSM module: It sends a message or call to doctor's mobile.

2.2 Flowchart
Flowchart describes the flow of control in the system.

2.3 Algorithm
This describes the flow of system operation

Various sensors are placed on human's body to collect the real time data about his health.

This collected data are then compared with the threshold data to check the abnormality of the patient.

Database of the patients are continuously updated in doctor's PC.

Whenever abnormal condition is detected, an alarm is also sent to the doctor's mobile from of a SMS alert, through GSM modem [7].
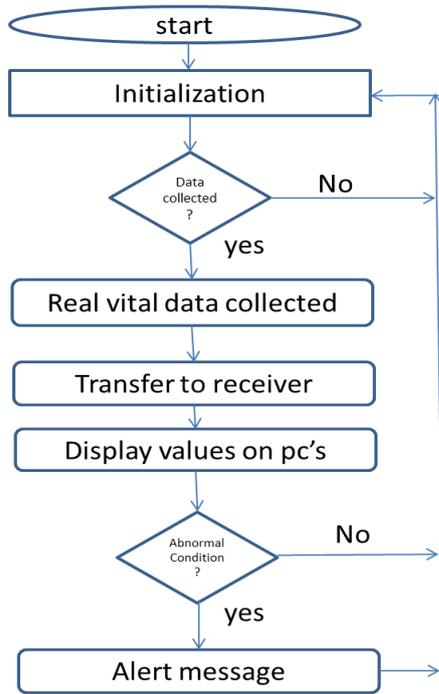

Fig.2 Flowchart of system

Normal range for various parameters:

The body temperature lies in the range 36.5 degrees C to 37.2 degrees C for a healthy person. The heart rate of a normal adult ranges from 60 to 100 beats per minute. Form ECG waveform many cardiac abnormalities can be predicted through its various intervals, shapes and morphologies. ECG is the most common test for heart conditions. It is a simple painless test that takes few minutes. An ECG machine records heart's rhythm onto paper through sticky electrodes which are placed on human chest, arms and legs.[3] The recording will show if the heart muscle is damaged or short of oxygen.

3. METHODOLOGY

Designing part consists basically two sections.

3.1 Hardware

PIC microcontroller: The blocks in the diagram represent the major components of the system and interconnection between them

Fig.3 PIC microcontroller PIC18F45K22

Temperature sensor: LM335 sensor is used for temperature measurement, whose output voltage is linearly proportional to the Celsius (centigrade) temperature.

Fig.4 Temperature sensor

ECG sensor: For ECG measurement electrodes are placed on human body as shown in fig. 5 to obtain small electrical voltage produced through contracting muscles because of each heart rate. The ECG signal captured by the electrodes is in the voltage range of 1mv to 5mv. Because of this weak voltage level, the signal is fed in to an instrumentation amplifier to amplify the acquired signal. The amplified signal is then fed in to the PIC18F45K22 having inbuilt A/D converter. Digital output of the ADC can be seen on the labView software via serial port transmission.
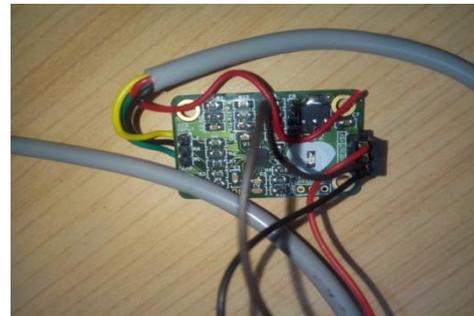

Fig.5 ECG sensor

3.2 Software

Coding of PIC microcontroller is done in MPLAB IDE software. MPLAB IDE is a software program that is used to develop application for microcontrollers and digital signal controllers.

Following are the steps for creating a new project file in MPLAB:

- Project > Project Wizard then Click Next

- Select Device from Drop down Menu then Click Next

- Active Tool suit > Microchip C18 Tool suit

- Once you select C18 Tool suit, check if it shows Red Alert.

- Then Tick and select "Store tool locations in project"

- Finally it will show summary page. Click Finish.

- Now you will see a window with source files and header files etc.

- Now click on Project > Add New File to Project.

- Save file with .c extension

- Finally write code for system in this .c extension file.

3.3 System Design Parameters

The AD8232 is an integrated signal conditioning block. AD8232 used in ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter signal in the presence of noisy conditions, like as remote electrode placement. By using AD8232, one can implement a two-pole high-pass filter for removing motion artifacts and the electrode half-cell potential. This filter is strongly joined with the instrumentation architecture of the amplifier to allow both large gain and high-pass filtering in a single stage, thereby saving space and cost. An operational amplifier turns on the AD8232 to create a three-pole low-pass filter to remove additional noise. Thus the user can select the cutoff frequency of all filters to suit different types of applications.

In instrumentation amplifier CMRR value (80-86 dB), PSRR (76-90 dB), gain 100, bandwidth 2 kHz, RFI filter cutoff (each input) 1MHz and in operational amplifier CMRR and PSRR both 100dB. large signal voltage gain 110dB. In AD8232 two-pole high pass filter at 7Hz and two-pole low pass filter at 24Hz have been used. The two pole low pass filter follows the two pole high pass filters to eliminate any other artifacts and line noise.

LabVIEW is a short form of laboratory Virtual instrument Engineering Workbench. LabVIEW support interfacing to devices, such as cameras, and other devices. LabVIEW is a platform and development environment for visual programming language from NI (National Instruments) and uses graphical programming language. In the system implemented in this paper, LabVIEW is interfaced with microcontroller through serial port - a virtual port for communication between microcontroller and PC. Real time ECG signal is continuously monitored using LabVIEW software.

4. RESULTS

Figure 6 shows the body temperature and heart rate (37 degree celcius and 60 beats/minute, respectively) of the subject displayed on LCD. Figure 7 shows the captured ECG signal of the subject with lead I configuration on DSO. The same is being monitored on PC as well using Labview.

Fig.6 Tempearture and heart rate diplayed on LCD

Fig.7 ECG waveform display on oscilloscope

5. CONCLUSION AND FUTURE WORK

In this paper, the physiological parameters such as body temperature, ECG and heart rate of the subject are monitored and displayed. Whenever the parameters such as body temperature or heart rate goes below or above from the normal range then an alert message or call to the physician will be generate by using GSM module. In future, the pulse oximetory (SpO2) sensor which measures the percentage of oxygen in blood of the subject will be interfaced with the microcontroller. A web page will be created, where these physiological data of the subject(s) will be continuously transferred by incorporating the zigbee based wireless communication. Thus, a physician at distant location can access the physiological data of the subjects.

6. REFERENCES

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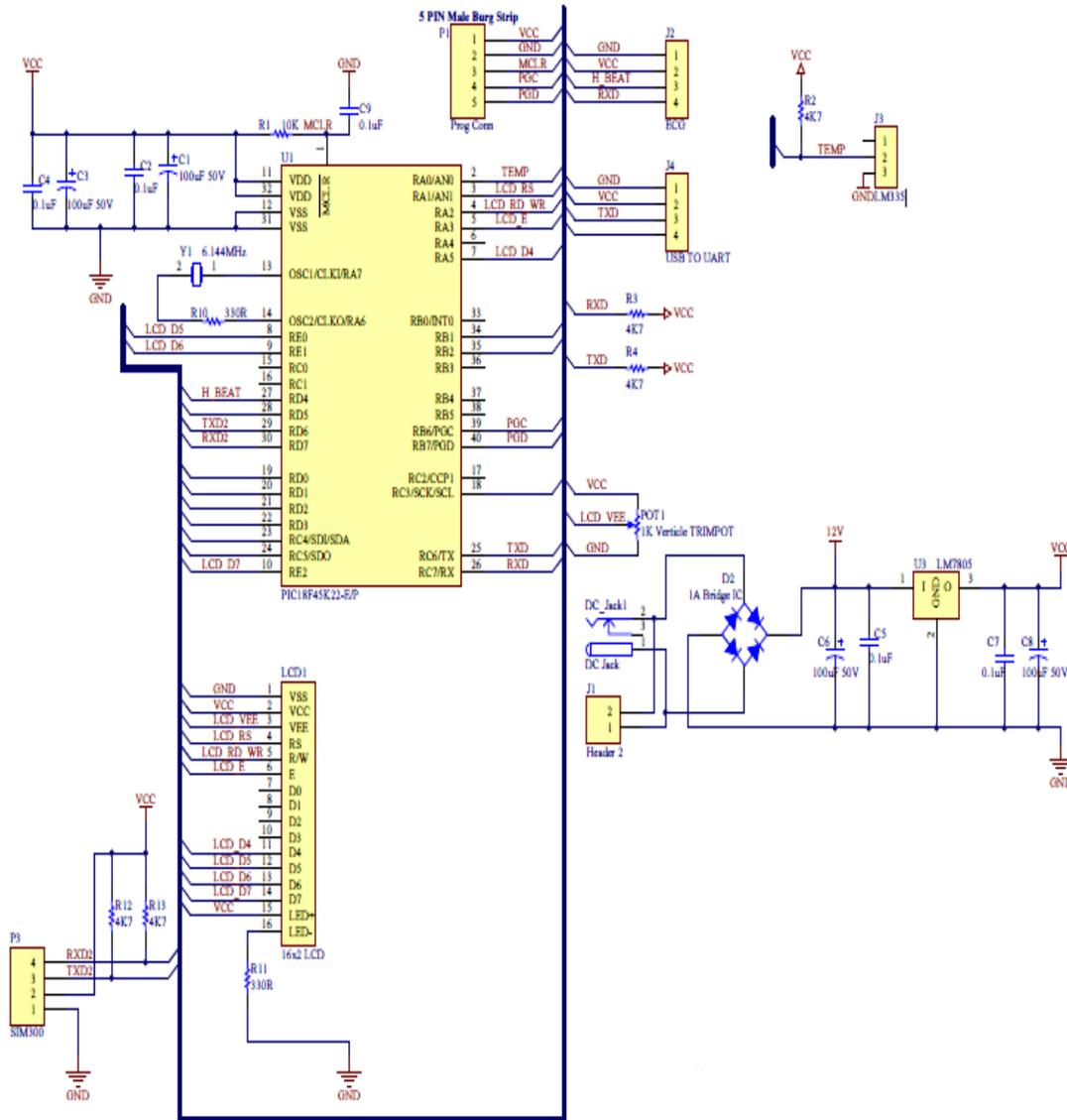
Fig.8 Schematic diagram of system