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XBEE BASED HEART RATE MONITORING IN SPORTS TRAINING

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ABSTRACT

At present heart rate monitors are widely used in many places. But death due to cardiac abnormalities has increased day by day especially during sports activities. Thus in order to overcome this problem, a new Xbee based heart rate monitoring system is designed for sportsperson. Using this system heart rate of a person in sports training is determined and the heart rate is monitored continuously by the health care center. Here PIC16F877 microcontroller is used for heart beat measurement and Xbee module is used for communication between user and health care center.

Index term—**Heart rate monitor, PIC16F877 microcontroller, Xbee module.**

1.INTRODUCTION

In recent days many athletes are affected by cardiac diseases during training. Currently heart rate monitoring system is employed only in health care centers to monitor patient .This heart rate monitoring can be extended to sports area. Implementation of heart rate monitoring system in sports field can avoid sudden death of athletes in training session.

Therefore, this paper deals with heart rate monitoring system for sports person. The simple and reliable heart rate monitoring system will monitor the heart rate of athletes and players continuously to check whether the intensity of pulse count is within the prescribed zone.

2.SYSTEM METHODOLOGY

By using optical sensing method heart rate of person is determined. To sense the heart rate, clip like fingertip heart beat sensor is used since it is flexible to use during sports activities. The Xbee module which operates at a frequency of 2.4GHZ is used for communication purpose. For continuous monitoring of heart rate, database is created using visual basics in the PC at the health care center.

3.BASIC REQUIREMENTS

This system requires low cost, less power consumption, low size hardware and software components. The basic components are listed below.

A. *Hardware Requirements*
1. Heartbeat Sensor
2. PIC16F877 Microcontroller
3. Xbee Module
4. LCD Display
5. Alarm

B. *Software Requirements*
1. MP Lab
2. Visual Basic

I. HARDWARE INTERFACE

The heart beat sensor is connected to PIC16F877 microcontroller. This controller is further connected to Xbee module, LCD display and alarm. The hardware design consists of three modules namely Heart rate measurement module, Communication module and Monitoring module.

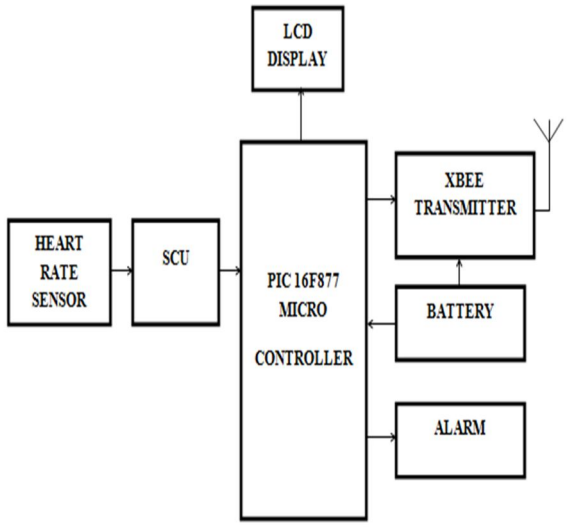

Fig1. *Transmitter Section*

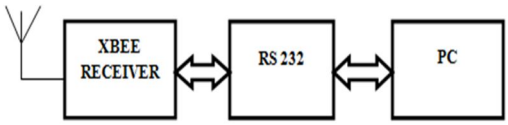

Fig2. *Receiver Section*

A. Heart Rate Measurement Module

Heart rate measurement module consists of following components:

1. Heart beat sensor
2. Signal conditioning unit
3. PIC 16F877 microcontroller
4. LCD display
5. Alarm

1. Heart beat sensor

Heart beat sensor used here is HRM 2103.Optical sensing method is used for sensing the heart rate. While the heart is beating, it is actually pumping blood throughout the body and that makes the blood volume inside the finger artery to change too. This fluctuation of blood can be detected through an optical sensing mechanism placed around the fingertip. The sensor unit consists of an infrared light-emitting-diode (IR LED) and a photo diode placed side by side and the fingertip is placed over the sensor assembly. The IR LED transmits an infrared light into the fingertip, a part of which is reflected back from the blood inside the finger arteries. The photo diode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. So, every time the heart beats the amount of reflected infrared light changes which can be detected by the photo diode.

2. Signal conditioning unit

The reflected IR signal detected by the photo diode is fed to a signal conditioning circuit that filters the unwanted signals and boost the desired pulse signal. Signal conditioning unit consists of two stage operational amplifiers that are configured as active low pass filters. The cut-off frequencies of both the filters are set to about 2.5 Hz, and so it can measure the pulse rate up to 2.5*60 = 150 bpm. The gain of each filter is about 100, which gives the total 2-stage amplification of 10000.

3. PIC 16F877 Microcontroller

A microcontroller is a single chip that contains the processor, nonvolatile memory for the program, volatile memory for input and output, clock and I/O control unit. The microcontroller PIC 16F877 is here used to develop heart rate monitoring system. Technology that is used in PIC 16F877 is flash technology, so that data is retained even when the power is switched off. The main purpose of using PIC microcontroller is for analog to digital conversion. PIC has five I/O ports in which port A perform analog to digital conversion. PIC is programmed to count the pulse from signal conditioning unit and also programmed to compare the measured heart rate with predefined threshold value stored in the memory.

4. LCD Display

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals. It is an electronically-modulated optical device made up of any number of pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. LCD is more compact, lightweight, portable, less expensive and more reliable. The heart rate measured by PIC microcontroller is displayed using LCD display.

5. Alarm

An alarm gives an audible or visual warning about a problem or condition. PIC microcontroller compares the measured heart rate with predefined threshold value stored in the memory, if the measured heart rate is above or below normal heart rate an alarm is activated.

B. Communication Module

The communication module consists of Xbee transmitter and Xbee receiver.Xbee modem is a point to point or point to multipoint protocol. The Xbee module works at a frequency of 2.4GHZ.The data rate of Xbee module is 250kbps. The heart rate detected by sensor is stored in PIC microcontroller and transferred to Xbee transmitter. This data is transmitted over the Xbee wireless link. At the receiving end, we have another Xbee module receiving data and passing it onto another RS-232 serial port to which PC is connected.

C. Monitoring Module

The monitoring module consists of Personal computer. The personal computer may be desktop or laptop. The data regarding heart rate is continuously displayed in PC. A database is created using Visual Basic. The database includes name, heart beat range, time and date. Visual Basic (VB) is a third-generationevent-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model first released in 1991. Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, ActiveX Data Objects and creation of ActiveX controls and objects. When the heart rate reaches abnormal condition a buzzer is activated at the receiver end.

4. SOFTWARE INTERFACE

MPLAB software is used to program PIC microcontroller. MPLAB is a software program that runs on a PC to develop applications for Microchip microcontrollers and digital signal controllers. The program embedded on microcontroller is written on Embedded C. The program includes analog to digital conversion and analysis of heart rate. The programming process is given below

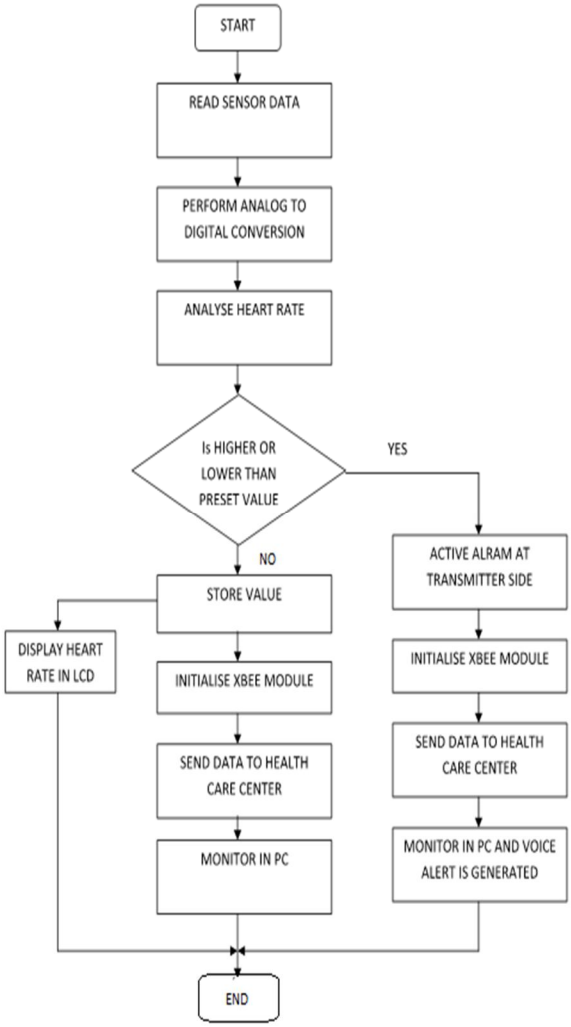

Fig3. *Flow Chart*

5.FUTURE SCOPE

The system can be improved further by introducing the concept of wireless sensor networks .Heart rate of group of athletes can be monitored simultaneously by implementing wireless sensor nodes within required zone.

6.CONCLUSION

Excessive training for athletes may result in excessive fatigue, injury or overtraining. But less training was not good for long term because it may cause in stagnation or degradation of athletic ability. Therefore, effective training sessions for athlete's improvement need to be planed. Athlete's performance and training intensity may be observed from their heart rate. Thus the Xbee based heart rate monitoring system facilitates continuous monitoring of athletes heart rate by health

care center. This design is of strong practicality and extensibility, it can transmit the heart rate data to PC in order to carry on the analysis statistics, and it is very convenient for the doctors to give immediate treatment.

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