

## The Real-Time Monitoring System for In-Patient Based on Biomedical Data Acquisition System

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**Abstract.** Many wearable ECG system have been proposed to date virtually all of them used some form of electrodes that must make electrical contact with the subject's skin surface. This necessitates the used of sticky pads, paste/gel. While this method works for stationary patients, its suffer from several problem. First, the material used to construct the electrode or the paste could cause skin irritation and discomfort, especially if the subject is performing rigorous physical exercise and may be sweating. Another problem is that, during motion the electrodes may become loose, breaking electrical contact and causing high noise spikes in the data. Paste/gel – free resistive contact ECG sensors have been developed. Many of them still suffer from similar noise levels to “wet” electrodes, and the contact can still cause irritation problem as well as being more sensitive to motion.

Several wireless ECG monitoring systems have been proposed [3],[4],[5],[6],[7]. All of them used conventional “wet” ECG sensors. For data sampling and wireless transmission, they used either existing standard wireless interfaces or general- purpose wireless sensor nodes. This combination results in many system – level drawbacks such as big form factor, low transmission speed. A novel wireless data collection for health monitoring of patients based on PIC controller and wireless sensors is proposed and developed in this paper. The unique characteristics of this system such as low power, low cost, and high flexibility make them ideal for this application.

**Keywords:** physiological parameters, data acquisition hardware, remote monitoring station, embedded system design, real-time analysis, PIC controllers.

### 1. Introduction

Measurement in the medical field can be classified into two types: *in vivo* and *in vitro*. *In vivo* measurement is made on or with the living organism itself, such as measurement of pressure in the chambers of the heart. On the other hand, *in vitro* measurement is performed outside the body. For example: the measurement of blood glucose level in a sample of blood drawn from the patient represent *in vitro* measurement. Information obtained from a sensor / transducer is often in terms of current intensity, voltage level, frequency or signal phase relative to standard. Voltage measurements are the easiest to make, as the signal from the transducer can be directly applied to an amplifier having a high impedance.

The system is made up of two sub- systems : patient physical states data acquisition and communication system based on wireless transceiver module and remote monitoring station or graphical LCD display for signals. The patient physical states data acquisition and communication module monitors the main physical parameters and movement status continuously. The information from data acquisition system is sent to PIC controller and monitored on graphical LCD display for signals also simultaneously on wireless communication transceiver module. At the remote monitoring station it receives the information from each subject and then judges the states of Subject. The data from Subject can be displayed as graph or numeric on graphical LCD display and then the examiner can diagnose the Subject according to the recorded continuous data. To obtain higher accuracy in diagnostic and prognostic for the health condition of a patient, efficient

and comprehensive data collecting, monitoring and control play an important role to improve the system more reliable and effective.

## 2. Working Methodology

Methodology is important to achieve a major goal with reliability, predictability. Accordingly a new system is to be developed. So as to design such system with predictable results in a predictable time embedded system software is used to make most effective & wide variety system. Hence we may opt to use PIC( peripheral interface controller) controller for the implementation purpose. The PIC would be programmed using embedded C software developed by Kiel microvision-3. The real time signals would be transmitted / received by RF transceiver modules. Real time location of the event is very important and valuable piece of information so as to make real time decisions. It is beneficial for fault tolerant, routing, aggregation, event detection, & so on.

## 3. The Structure of the Hardware

The system is mainly made up of two sub- systems : patient physical states data acquisition and communication system based on wireless transceiver module and remote monitoring station ,it is shown in fig.1 The main function of the system include : On the basis of keeping the patient movement intact, the main physical states and movement parameters of patient can be continuously monitored and recorded real – time with wireless sensors and the examiner can analyze the trend of the patient with the physical parameters. The doctor can watch the parameter’s change as graph or numeric on graphical LCD display and analyze these data to get more information about the patient , thus the examiner can know the physical states or movement parameters of patient, and then it is helpful to get the correct diagnosis result of examiner. The system can collect sensitive health information remotely and has a good applied prospect in remote healthy hare field.

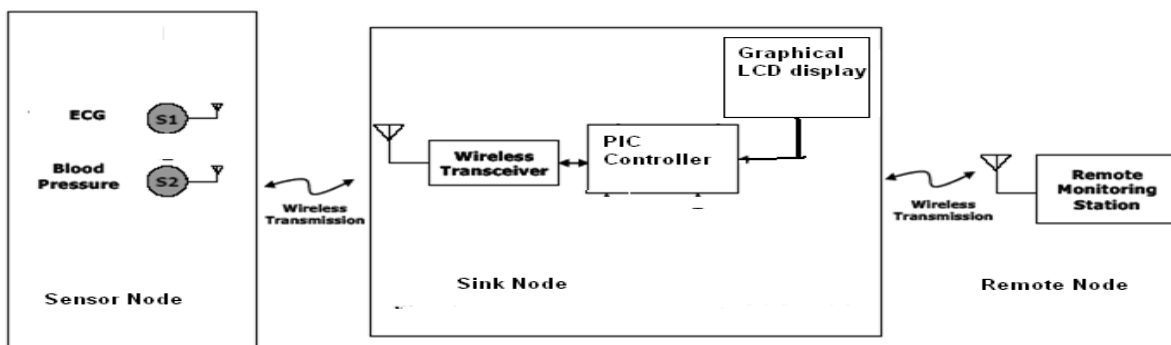


Figure 1 Overall architecture of embedded biomedical data acquisition system consisting of Sensor node, sink node and remote mode.

### 3.1. Physical States Acquisition System for Patient

To keep the moment of the patient intact with the sensors on his body, the wireless sensors are required to be minimized and portable. Base on wireless transceiver module communication technology the patient physical states data acquisition system is made up of sensors, signal conditioning unit, A/D converter, embedded PIC controller unit and transceiver communication module. According to the state of an illness of the patient, the sensors which are fixed on patient body may be of some of these sensors ECG sensors, blood pressure sensors. Each sensor is fasted on corresponding position of the patients body[8] ,[9].

The hardware structure of this system is shown in figure2. The physical states and movement parameters are acquired with sensor’s at first and then the signal is been transferred to signal conditioning unit to be amplified and filtered, A/D converter transforms the analogue signal to digital signal the main function of PIC controller is to integrate the data with the definition frame format, at last, the transceiver communication module sends it to remote monitoring system or display. . IEEE 802.15.4 is selected as the wireless transmission standard because of its short-range, low-cost, and low-power characteristics.

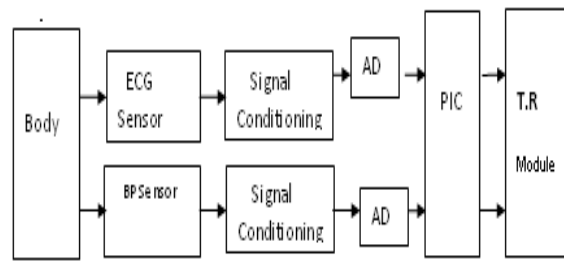


Figure 2. The hardware structure of Embedded biomedical data acquisition system .

### 3.2. The Sensor in the System

#### (a) ECG Sensor

In order to achieve the design goals we are developing new ECG monitoring system that takes advantage of QUASAR's ECG sensors [7]. The QUASAR sensor is a wearable, tiny, low power ECG sensing device. QUASAR's sensor (Figure 3) is a compact ECG sensor that does not require skin preparation, gels or adhesive. It includes not only a sensing device but also signal conditioning circuitry such as low noise amplifier and voltage reference chips. its output signal range is adjustable from differential (-4.5v to 4.5 v) to a single ended (0 v to 4.5 v). It measures only 15mm ( in diameter)  $\times$  3.8 mm ( in height) and weights 5 g. Also it consumes only 1mW active power on average. These features enable our monitoring system to be truly wearable. This sensor measures ECG signals using capacitive coupled electrodes that do not require ohmic contact. QUASAR sensors have at least equivalent and often superior signal quality and artifact rejection compared to the standard wet/resistive ECG sensors.



Fig.3(a) Top View of QUASAR ECG Sensors



Fig.3 (b) Sensors attached on a T-shirts and Worn on a human body

### 3.3. Signal Conditioning

Signal conditioner converts the output of the sensor /transducer into an electrical quantity suitable for operation of the display or recording system. Signal conditioner may vary in complexity from a simple resistance network or impedance matching device to multi-stage amplifiers and other complex electronic circuits. Signal Conditioning usually include functions such as amplification, filtering ( analog or digital ) , analog to digital and digital to analog conversion or signal transmission circuitry. They help in increasing the sensitivity of instruments by amplification of the original signal or its transduced form. The buffer amplifier, which is usually an instrumentation amplifier is proposed in this paper which provides impedance buffering , signal gain and common mode rejection. It has a high input impedance, 100 Mohms or more to reduce the effects of any signal distortion. The high input impedance also minimizes errors due to the finite on – resistance of the A / D convertor or channel switches. The use of programmable gain amplifiers removes the necessity to standardize on the analog input ranges.

### 3.4. A/ D Convertor

The A/ D convertor carries out the process of analog to digital conversion. An A/ D convertor is a single chip integrated circuit having a single input connection for the analog signal and multiple pins for digital output. It may have 8, 12, 16, or even more output pins, each representing an output bits. The higher the number of bits the higher the precision of conversion. Each step represents a change in the analog signal: 8-bits gives 256 steps, 12-bits provides 4096 steps and we get 32768 steps with 16 output bits. Speed of an A/D convertor is generally expressed as its conversion time, i. e. the time elapsed between application of a convert command and the availability of data at its output. The speed of A/ D Convertor is measured by its settling time for a full scale digital input change.

### 3.5. PIC Controller

PIC 18F4450 is a 16/ 32 –bits microcontroller based on supporting real- time simulation, which is attached with 32kB embedded high-speed Flash memory, 128-bit wide memory interface and a unique acceleration structure, it can make the 32-bit code run at maximum Clock speed. Smaller packages and lower power consumption makes the PIC 18F 4450 suitable for access to controllers and POS machines and other small-scale application systems. Due to provided with a wide range of inset serial communication interface (2 UART, SPI, SSP, and two I2C) and 8KB chip SRAM, PIC 18F4450 is also suitable for use in communications gateways and protocol converters. 32/16 bit timer, enhanced 10-bit ADC, timer PWM output matching characteristics, up to 13 edges, level-triggered external interrupts, 32 high-speed GPIO, make PIC 18F4450 microcontrollers particularly suitable for industrial control and medical system.

Table 1. Features of PIC 18F4450

Features	PIC18F4550
Operating Frequency	DC – 48 MHz
Program Memory (Bytes)	32768
Program Memory (Instructions)	16384
Data Memory (Bytes)	2048
Data EEPROM Memory (Bytes)	256
Interrupt Sources	20
I/O Ports	Ports A, B, C, D, E
Timers	4
Serial Communications	MSSP, Enhanced USART
(USB) Module	1
Streaming Parallel Port (SPP)	Yes
Instruction Set	75 Instructions; 83 with Extended Instruction Set enabled
Packages	40-pin PDIP 44-pin QFN 44-pin TQFP

## 4. Wireless Monitoring of the Subject

Monitoring and control is the core of the real- time monitoring system for patient physical states, and it can dispose, display, save, query and analyze the data from each patient. To know the physical states of in-patient, the physical parameters need to be monitored real –time. With the increase in the number senior citizens and chronic diseases, the number of elderly patients who need constant assistance has increased. One key point of all critical care for elderly patient is the continuous monitoring of their vital signs. The results prove that the mobility, usability and performance of our proposed system have impacts on the user’s attitude, and there is a significant positive relation between the user’s attitude and the intent to use our proposed system. This proposed system is expected to monitor the electrical activity of heart of the patient under critical care more conveniently and accurately for diagnosing which can be interfaced with PIC 18F4450 to bring it under a network system widely for the doctor to monitor the patients condition sitting in his own office without being physically present near to the patients bed. Wireless – networked embedded device includes signal conditioning circuitry, sensors and a PIC controller with a wireless Transceiver module( CC2500). To measure or monitor human movements or activities, a graphical LCD display is

selected for its low price, small size, capability of continuous measurement, and ease of integration. IEEE 802.15.4 is selected as the wireless transmission standard because of its short-range, low-cost, and low-power characteristics. This system can not only realize accurate measurement of indicators, but also save the patients travel between home and the hospital.

## 5. Conclusion:

The research and design of embedded pulse monitoring instrument overcome the shortcoming of traditional pulse diagnosis system. The instrument has simple structure stable and reliable operation, high accuracy, low power consumption, good portability full featured function, and extensive application occasion. The real time monitoring system for cardiac patient physical state is based on wireless transceiver module technology. It can be taken by patient and keep the patient moment intact because it is miniature and portable. The system can monitor and record the physical states and moment parameters real time, and provide auxiliary means for the correct diagnosis of doctor. With intelligent transceiver module, the sign of acute disease for patient can be found early, and then the patient can be helped in time, the sudden death of patient can be avoided. The wireless transceiver module technology can be suited for short distance communication, and the transmission distance is limited only about 10 meters, and then it can be suitable for in-patient monitoring. The system is important to be applied to patient care.

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