

Intelligent Patient Monitoring System Based On PLC with Microcontroller

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ABSTRACT: Power line communication (PLC) is considered as adequate communication technology. PLC communication technology enables communication over a power line and it does not require additional communication lines. Power line communication based patient monitoring is an efficient non-invasive vital parameters monitoring system. The objective of patient remote monitoring is to have a quantitative assessment of the important physiological parameters of the patient during the critical periods of their biological functions from a distance. An Intensive Care Unit (ICU) for example a neuro medical ICU would care patients with acute condition involving the nervous system and would require equipments for monitoring and assessing the brain and spinal cord functioning. This paper proposes, in detail monitoring system it has developed with PLC modem, AT89C52 microcontroller and various sensors. The proposed system monitors physiological Parameters, such as temperature, heart rate and respiration of a human subject. The system detects if a person is medically distressed and sends a message to a doctor through GSM module that is connected to a controller. This system is more efficient, flexible and low cost as compare with traditional system. The proposed system can be realized within a hospital and more specific from ICU room to centralized monitoring room.

KEYWORDS: PLC, Biosignals, Sensors, Microcontroller.

I. INTRODUCTION

In olden days, patient's physiological parameters are measured by nurses, who manually record the parameters and later handover to the physician for analysis. Patient's safety depends on how fast the information is exchanged inside the hospital during emergency situation. Due to loss of medical reports, monitoring errors few hospitals in developed countries pay compensation to their clients. Hence intelligent monitoring systems are designed to reduce and avoid such problems. Heart Rate (HR), Temperature and other vital parameters are monitored from the patient's and transferred using PLC and wireless technologies.

Power Line communication (PLC) is a technology that enables data communication using existing PL which provides electricity. Recently power line communication has been used in many applications such as Automated Meter Reading, home automation and high-speed internet service etc. PLC is based on certain parameters such as electrical signal, information to be carried, number of nodes, electrical loads, distance etc [1],[2],[3].

Blood consists of many components like water, red blood cell, white blood cells, haemoglobin, hormones and minerals. Haemoglobin is made up of protein consisting of iron molecules and responsible for oxygen binding and release. Haemoglobin allows wavelengths in the range of 660nm (red) - 910nm (infrared) to pass them and based on the light absorption coefficients HR is calculated. Pulse Oximetry (PO) technique is adapted to measure HR non-invasively. It is based on the Beer-Lambert's law which states that "when any incident light is passed through a uniform medium, a part of the light is absorbed by medium and the rest is transmitted through the medium" [4], [5].

Thermoregulation is the process of maintaining the core body temperature by heat transfer mechanisms such as conduction, convection and radiation coupled with physiological phenomenon such as blood circulation, urine excretion, sweating and metabolic activities. Normally human body parts vary in temperature. Commonly accepted

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average core body temperature is 37.0oC (98.6F). The typical oral measurement is $36.8\pm 0.7\text{oC}$ or $98.2\pm 1.3\text{F}$. [6], [7]. Respiration can be recorded via measurement of bioimpedance *i.e.*, by injecting a small current across the thorax and then sense the corresponding voltage drop. During inhalation, thorax expands, and as air fills the lungs the bioimpedance increases as the conductive surface for the current increases. During exhalation the bioimpedance decreases again[8].

The intention of this work is to design an open-source, flexible and affordable system for safe biosignal measurement. In our paper monitoring system using power line Communication (PLC) is proposed. HR, Temperature and respiration were measured, transmitted and received using low voltage single phase PL inside the hospital building. A Power Line Channel (PLCh) has been simulated using the Keil software PL channel is modeled based on its time-varying, frequency dependent, signal to noise ratio properties. Echo channel model is considered, as it offers reliable way of data transfer with minimum bit error rate (BER). The data is transmitted using the Orthogonal Frequency Division Multiplexing (OFDM) technique in the channel as it offers resistance against multipath, burst noise, frequency interference, dispersion, fading and distortion. From the experimental and simulated results it was found that the Power Line Channel (PLCh) was a cost effective way for transferring the medical data inside a hospital building. Biosignal was transferred at a Considerable speed and accuracy.

II. RELATED WORK

Ximin et al. designed and implemented an Internet home automation system. The design uses an embedded controller based on C8051F005 microcontroller which is connected to a PC-based home Web server via RS232 serial port. The home appliances are connected to the input/output ports and the sensors are connected to the analog/digital converter channels of the embedded controller. The software of the system is based on the combination of Keil C, Java Server Pages, and JavaBeans. Rasid and Woodward developed a system to transmit a patient's biomedical signals directly to a hospital for monitoring or diagnosis, using mobile telephone. The system consists of mobile telemedicine processor, which samples signals from sensors on the patient. It then transmits digital data over a Bluetooth link to a mobile telephone that uses the General Packet Radio Service. Chen Peijiang and Jiang Xuehua described a remote monitoring system based on SMS of GSM. The system includes two parts which are the monitoring center and the remote monitoring station. The monitoring center consists of a computer and a TC35 GSM communication module. The computer and TC35 are connected by RS232. The remote monitoring station includes a TC35 GSM communication module, a MSP430F149 MCU, a display unit, various sensors, data gathering and processing unit.

(Scanail et al. developed a tele-monitoring system, based on short message service (SMS), to remotely monitor the long-term mobility levels of elderly people in their natural environment. Mobility is measured by an accelerometer-based portable unit, worn by each monitored subject. The portable unit houses the Analog Devices ADuC812S microcontroller board, Falcon A2D-1 GSM modem, and a battery-based power supply. Two integrated accelerometers are connected to the portable unit through the analog inputs of the microcontroller. Mobility level summaries are transmitted hourly, as an SMS message, directly from the portable unit to a remote server for long-term analysis. Each subject's mobility levels are monitored using custom-designed mobility alert software, and the appropriate medical personnel are alerted by SMS if the subject's mobility levels decrease. Xu Meihua et al. described a remote medical monitoring system based on GSM (Global System for Mobile communications) network. This system takes advantage of the powerful GSM network to implement remote communication in the form of short messages and uses FPGA as the control center to realize the family medical monitoring network. The system is made up of user terminal equipments, GSM network and hospital terminal equipments. Hospital terminal equipments can be a personal computer (connected with GSM modules) or other receiving equipments such as the mobile phone of the related doctor.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Issue 6, June 2016

III. METHODOLOGY

The proposed system consists of hardware and software modules. The hardware module is implemented using various sensors, ADC0808 chip, AT89S52 Microcontroller and power line Modem etc. Figure.1 depicts the simple outline of the system hardware. The proposed work intended to accept few inputs to measure physiological parameters of human such as body temperature, HR and Respiration.

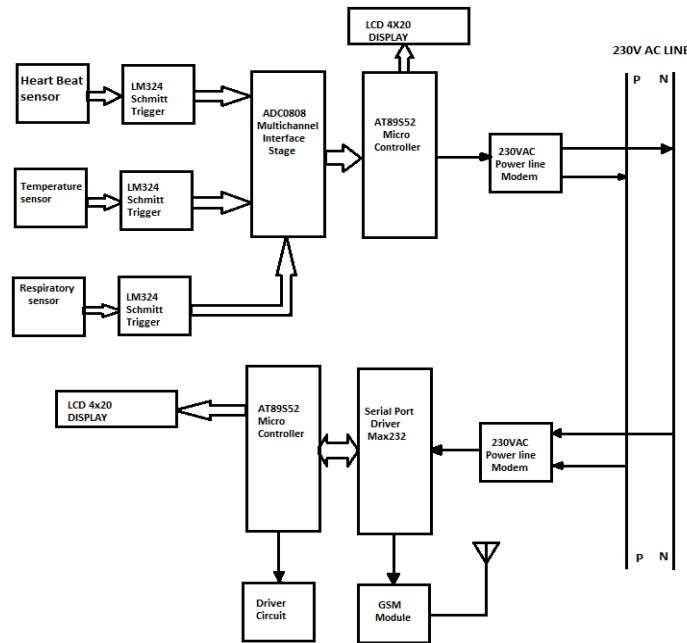


Fig. 1 Block Diagram of Proposed System

The inputs from the sensors are given to microcontroller which stores the information. Once the user has connected to the receiver unit, information is consequently upgraded on the screen. Temperature, HR and respiration are displayed on the LCD screen. GSM module is used for sending SMS to doctor's mobile.

IV. HARDWARE MODULE

A. Biosignals measurement using Sensors

The heart rate is measured through heart beat sensor. The sensor used in this work is MODEL: 1157. More advanced models will offer measurements of heart rate variability, activity, and breathing rate to assess parameters relating to a subject's fitness. Figure 2 depicts heart rate measurement. The amount of light that was detected by the phototransistor varied with the patient's heart pulse, as the amount of absorbed IR light changed with the flow of blood, which is directly linked to the heart rate. This signal was then amplified, filtered, and sent to the microcontroller to be analyzed. To get the best and most accurate results with the heart rate sensor we chose to measure the pulse at the finger tip like commercial device do.

International Journal of Innovative Research in Science, Engineering and Technology

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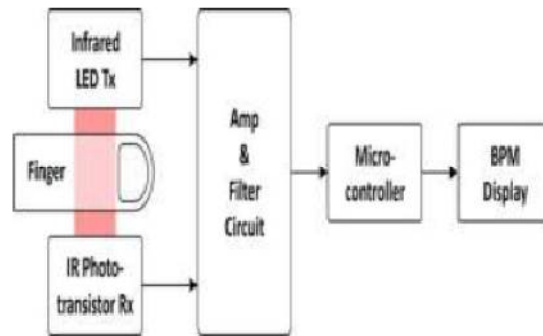


Fig .2 Heart Rate measurement

The body temperature is measured through a temperature sensor, the temperature reading depends on which part of the body is used to measure temperature, usually temperature at arm is used to measure and it is about 36.5 degree Celsius. The temperature sensor used here is LM35.

Respiration measurements are done through thoracic bioimpedance measurements. A strain Gauge chest Transducer is used to measure respiratory activity. A respiration belt that is basically piezoelectric sensor is put around chest to measure respiration.

B. Power line Communication modem (PLC)

PL modems transmits the data in digital from inside the building using the live and neutral cables which are used for distributing power. Carrier frequencies will be ranging from 50 to 500 kHz based on the modulation technique such as ASK (amplitude shift keying), PSK (phase shift keying), FSK (frequency shift keying), BPSK (binary phase shift keying) and DSSS (direct-sequence spread spectrum) PLC uses different frequencies based on the data transmitted over the power lines. Lower baud rate will be used for long distance communication with few hundred bits of data rate. The shorter distances will be covered by high baud rate which operates on millions bits.

Figure 3 shows PLC Modem

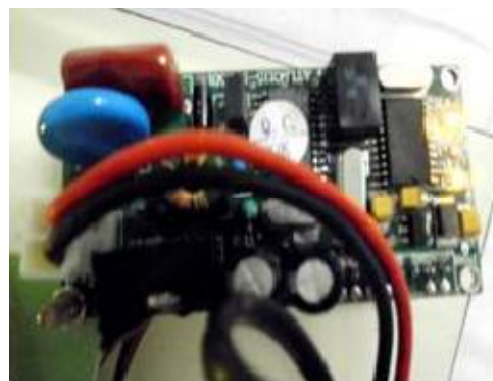


Fig.3 power line communication modem

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

V. SOFTWARE MODULE

In this work keil micrvision3 is used to create software to be run on AT89S52 microcontroller. It allows such software to be written either in assembly or C Language and for that software can be simulated on a computer before being loaded onto microcontroller. The programmer is used for AT89S52 to program ,read and verify code data etc.This programmer has intelligent onboard firmware and connect to the Serial port.

VI. RESULT AND DISCUSSION

Heart rate sensor and LM35 sensor senses the heart rate and temperature of person(normal beat is 60-100bpm and 98.6oF) and the data is transferred to MCU. MCU stores the digital data after converting the analog data from sensor unit through ADC, for some delay unit of time and resets the reading in MCU as well as in LCD also. MAX232 receives the digital data and converts into serial form suitable for GSM communication so that data is received by the user doctor. The doctor advises precautions for the temporary observation of the patient from serious condition. The system will improve the structure of traditional patient monitoring systems. The intelligent patient monitoring systems will posses more flexible architecture. Thus, the fast data monitoring can be achieved through the proposed system. The power line as a communication medium could also be a cost-effective way compared to other systems because it uses an existing infrastructure, wires exists to every household connected to the power-line network. Physiological parameters were measured using prototype model as shown in figure 4 .

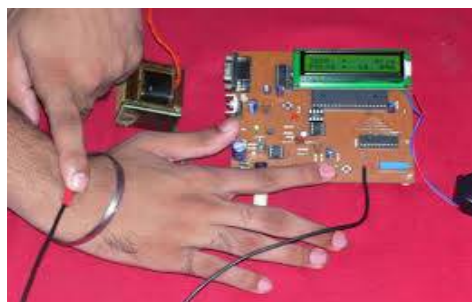


Fig. 4 Prototype Model for measuring Biosignals

After hardware connections and each sensors which are connected to the patient records the vital signals of a person and stores in a controller then it is displayed on LCD display as shown in below figure 5



Fig. 5 Biosignal displayed on LCD display

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VII. CONCLUSION

By using this prototype circuit containing AT89S52 MCU, PLC Modem, sensors and other hardware circuit so that messages can be transferred to the corresponding medical expert to give necessary precautions to take care about the patient. This system has the following features: i. AT89S52 MCU consumes low power with suitable devices for interconnection ii. Continuous monitoring of patients is done which is simple by using PLC modem and GSM network. In future, in addition to these biosignals other physiological parameters will be added to the model; noise and error rate will be reduced using filters and algorithms communication distance will also be increased. Serial output can be attached to the device so that the heart rates can be sent to a PC for further online or offline analysis. Warning or abnormalities (such as very high or very low heart rates) can be displayed on the LCD or indicated by an LED or a buzzer. The Whole health monitoring system, which we have proposed can be integrated into a small compact unit as small as a cell phone or a wrist watch.

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