An Embedded System for Patient Heartbeat Monitoring

K.Y. Roode  
S.S. Shende  
S.M. Ghatole  
P.B. Dahikar

Abstract- A Health care is one of the fast emerging fields today. With the average age of general population increasing each year the credit goes to cutting edge of medical research. New methods are developed almost every month to as a solution to numerous health problems for which accurate diagnosis is the need of the day. The Biomedical equipment provides accurate reproduction of body signals and automated diagnosis and patient monitoring systems. The field of biomedical instrumentation is an integral part of medical research. Sometimes it becomes necessary to monitor physiological events from a distance like monitoring a patient in an ambulance and in other applications away from the hospital, collection of medical data from a home or office and use of telephone links for transmission of medical data. When the patient is in critical condition and is admitted in intensive care unit (ICU) or is being operated upon in the operation theatre (OT), it is crucial to monitor the patient for his physiological parameters such as heart beat, pressure, temperature, respiration rate etc. This monitoring is necessitated on account of the immediate response required for support of patients. The monitor provides the healthcare team with the information that is used to make decisions about the patient’s treatment.

In this research work it is to study the embedded system for heart beat monitoring of patients using wireless technology which has the low cost, reliable, and portable and it is used in many medical laboratories and industries. In present development, the monitoring is done from a central location using a wireless technology based control and graphical LCD based system. This system makes use of RF transceivers modules to establish communication between the patients systems and remote central monitoring unit.

Key Word - Embedded Heart Rate, Monitoring patients, Wireless etc.

I. INTRODUCTION

“Health is Wealth”, is true not only for an individual, but is perhaps equally important for society in large. A Health care is one of the fast emerging fields today. With the average age of general population increasing each year the credit goes to cutting edge of medical research. New methods are developed almost every month to as a solution to numerous health problems for which accurate diagnosis is the need of the day. The Biomedical equipments provide accurate reproduction of body signals and automated diagnosis and patient monitoring systems. The field of biomedical instrumentation is an integral part of medical research.

An embedded system is an applied computer system "embedded system", it constantly evolves with advances in technology and dramatic decreases in the cost of implementing various hardware and software components. It is nearly any computing system other than a desktop, laptop, or mainframe computer system that has embedded software and computer hardware which makes it a system dedicated for an application or specific part of an application or product or a part a larger system. Embedded systems are found in variety of common electronic devices, such as, consumer electronics, cell phone, pagers, digital cameras, camcorders, videocassette recorders, portable video games, calculators, and personal digital assistants. An embedded system has three main components embedded into it.

1. It embedded hardware interfacing similar to computer
2. It embedded application of software
3. It embeds a real time operating system supervises the application software
4. Working with hardware to control the resource of the task in the system.

II. METHODOLOGY

The functioning of this work is based on the fact that blood circulation occurs for every heart beat which can be sensed by using a circuit formed by the combination of an LDR and LED. Depending upon the rate of circulation of blood per second the heart beat rate per minute is calculated. This device consists of a microcontroller which takes the input from the heart beat sensor and calculates the heart rate of the patients.

III. EXPERIMENTAL WORK

For designing of an embedded system for heart beat monitoring of patients using wireless technology, the three microcontrollers are to be selected. Two controllers at two patients and one at central monitoring system. This system consists of a microcontroller which takes the input from the heart beat sensor and calculates the different parameters of the patients. The system design with Microcontroller, power supply, heart beat sensor, LCD, touch screen sensor, crystal oscillator, LED and LDR etc. In addition to this, some more resources are required like RF transceiver modules, crystal oscillator etc. which will provide additional capability use for the complete system design.

The software aspect requires controlling & observing the different parameters of the patients. The controllers used in the research are programmed using Embedded C language and some assembly language programming.
A. Regulated Power Supply
Requirements of power supply is the main task, power supply of +5V and +12V is required for the circuit. The supply of +12V needed for the relay connections and 7805 IC which has given +5V to the circuit.

![Power Supply Diagram](image)

Fig. d. Power Supply

B. MICROCONTROLLER (PIC18F252)

PIC18F252 is the 28 pin IC, having 10 bit inbuilt A/D converter with five input channels. Operating frequency is DC-40MHz, 32k bytes program memory and data memory is of 1536 bytes. In this work PortA is used for the analog inputs, port B is used as output port for the LCD Display and on PortC there are 4 pins used for push-button and other 4 pins are used for the LED indication. The Relay is connected to the PortB and 5MHz crystal has been used in the oscillator.

C. Heart beat sensor

Heart rate measurement indicates the soundness of the human cardiovascular system. The heartbeat sensor is based on the principle of photo phlethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

D. LCD (Liquid Crystal Display) with driver
A liquid crystal display is a type of display used in digital watches and many portable computers. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light. Monochrome LCD images usually appear as blue or dark gray images on top of a grayish-white background. Color LCD displays use two basic techniques for producing color: Passive matrix is the less expensive of the two technologies.

**E. Touch screen with driver**

Usually a resistive touch screen consists of at least three layers: A flexible membrane made from PET film is suspended over a rigid substrate made from glass or acryl. Both surfaces are coated with a transparent conductive film like ITO (Indium tin oxide). The conductive ITO layers are kept apart by an insulting spacer along the edges, and by spacer dots on the inner surface of the two ITO layers. In this way there will be no electrical connection unless pressure is applied to the top sheet (PET film).

4-wire touch screens use a single pair of electrodes (“Busbars”) on each ITO layer. The busbars in the topsheet and substrate are perpendicular to each other. The busbars are connected to the touch screen controller through a 4-wire flex cable. The 4 wires are referred as X+ (left), X- (right), Y+ (top) and Y- (bottom). An advantage of the 4-wire touch screens is that it is possible to determine the touch pressure by measuring the contact resistance (R_{Touch}) between the two ITO layers. R_{Touch} decreases as the touch pressure (or the size of the depressed area) increases. This characteristic can be useful in applications in which it is not only required to detect where the pressure is applied, but also the type of pressure (area and force).

**F. RF TRANSCEIVER MODULES**

An **RF module** (radio frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through Radio Frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and/or receiver.

RF modules are widely used in electronic design owing to the difficulty of designing radio circuitry. Good electronic radio design is notoriously complex because of the sensitivity of radio circuits and the accuracy of components and layouts required to achieve operation on a specific frequency. In addition, reliable RF communication circuit requires careful heart beat monitoring of the patients.

**G. GLCD with driver**

The graphical LCD used in this experiment is based on KS0108B controller, which is a 128x64 pixel monochromatic display. The KS0108B is a dot matrix LCD segment driver with 64 channel output. On the other hand, the KS0107B is a 64-channel common driver which generates the timing signal to control the two KS0108B segment drivers. The KS0108B and KS0107B are very popular controllers and have made their way into many graphical LCDs. The internal block diagram of the GLCD module is shown below.

**H. Crystal oscillator.**

An oscillator is an electronic circuit which generates a repetitive time-varying signal, which in this context is used to clock communication and the execution of instructions in the EFM32 microcontroller. Several ways of generating such a
signal exists, all with different properties that influence cost, size and stability of the clock signal.

**Crystal oscillators** use the mechanical vibration of a crystal to generate the clock signal for the heartbeat monitoring system. Due to the molecular composition of the crystal matter and the angle of which the crystal is cut, this type of oscillator is very precise and stable over a wide temperature range. The most commonly used crystal is the quartz crystal. Producing quartz crystals require very stable temperature and pressure conditions over a few weeks. This makes crystal oscillators more expensive than RC oscillators.

### I. LED indicators

A Light-Emitting-Diode (LED) is a P-N junction device (diode) that gives off light radiation when biased in the forward direction. LED chip materials are combinations of elements from the III and V columns of the periodic chart. The light emitting phenomenon makes use of the recombinations within the P-N junction instead of thermal radiation, therefore, LED’s are free of waste and wear and can be expected to have a long life time. The photodiode and LED are used for the photoplethysmography unit. By controlling the forward current, the radiant flux of the LED can be easily controlled. The response time of an LED is very high (a few hundred nanoseconds) and can be pulsed at greater forward currents, to obtain high intensity radiant peaks. The resin packaging of LED’s allow for superb mechanical integrity and can withstand dropping, vibration and shock. These semiconductor devices can be mounted in any position.

### IV. Future Scope

The Scope of research work intended to design and construct an Embedded System for heartbeat monitoring patients using Wireless Technology which has the low cost, reliable, and portable and it is used in many medical laboratories and industries where we can get better and more accurate result as compared to other devices.

### Conclusion

With this kind of approach and resource simple and very cost effective heartbeat monitoring patients using wireless technology can be designed which will be very useful in medical field, laboratories and industries where we can get better and more accurate result as compared to other devices.

### References


AUTHOR’S PROFILE

Mr. K. Y. Rokde
He has completed M.Sc. (Electronics Science), UGC NET Qualified in June-2011 and pursuing Ph.D. from R.T.M. Nagpur University, Nagpur. He is Assistant Professor in the Department of Electronics, S. M. M. Science College, Nagpur (MS), India. Presently he is working as a research scholar in RTM Nagpur University, Nagpur. His research interest includes Embedded System for Biomedical Instrumentation. He has published several research papers in journals and conferences.
E mail: krokde@yahoo.com

Mr. S. S. Shende
He has completed M.Sc. (Electronics Science), UGC NET Qualified in Dec-2012, SET Dec-2013 and pursuing Ph.D. from R.T.M. Nagpur University, Nagpur. He is Assistant Professor in the Department of Electronics, Shivaji Science College, Nagpur (MS), India. Presently he is working as a research scholar in RTM Nagpur University, Nagpur. His research interest includes Embedded System for Biomedical Instrumentation. He has published several research papers in journals and conferences.
Email: sagarshende2012@gmail.com

Prof. S. M. Ghatole
He has completed M.Sc. (Applied Electronics), and pursuing Ph.D. from R.T.M. Nagpur University, Nagpur. He is working as Associate Professor in Department of Electronics, SSES Amravati’s Shivaji Science College, Nagpur (MS), India. Presently he is working as a research scholar in RTM Nagpur University, Nagpur. His research interest includes Biomedical Instrumentation. He has published several research papers in journals and conferences.
E mail: smghatole@gmail.com

Dr. P.B. Dahikar
He is a Reader in the Department of Electronics, Kamla Nehru Mahavidyalaya, Nagpur (MS) India. He has more than 20 years of experience in teaching and research field. His current area of research includes Embedded System, Electronics Instrumentation and Simulation. He has published more than thirty papers in referred national and international journals. He has also presented more than twenty research articles in national and international conferences. He has written few books related to his research work. He is currently dealing with few projects sponsored by UGC.
E mail: pbdahikarns@rediffmail.com