



ZIGBEE AND GSM BASED PATIENT HEALTH MONITORING SYSTEM

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ABSTRACT: Care of critically ill patient, requires spontaneous & accurate decisions so that life-protecting & lifesaving therapy can be properly applied. Statistics reveal that every minute a human is losing his/her life across the globe. More close in India, everyday many lives are affected by heart attacks and more importantly because the patients did not get timely and proper help. This paper is based on monitoring of patients. We have designed and developed a reliable, energy efficient patient monitoring system. It is able to send parameters of patient in real time. It enables the doctors to monitor patient's health parameters (temp, heartbeat, ECG, position) in real time. Here the parameters of patient are measured continuously (temp, heartbeat, ECG) and wirelessly transmitted using Zigbee. This project provides a solution for enhancing the reliability and flexibility by improving the performance and power management of the patient monitoring system. In the current proposed system the patient health is continuously monitored and the acquired data is analyzed at a centralized ARM microcontroller. If a particular patient's health parameter falls below the threshold value, an automated SMS is sent to the pre-configured Doctor's mobile number using a standard GSM module interfaced to the ARM microcontroller. Here, we are using Zigbee for wireless transmission. The Doctor can get a record of a particular patient's information by just accessing the database of the patient on his PC which is continuously updated through Zigbee receiver module.

Keywords: Sensor, GSM module, Zigbee.

I. INTRODUCTION

In recently, wireless sensor networks are used to structure home-care system in many researches. Wireless sensor networks application for physiological signals communication transmission has many technologies. Such as the Infrared, Bluetooth and ZigBee, etc. Because the angle limit problem of the infrared transmission, and the infrared have not been used for physiological signal transmission. Although Bluetooth is better than ZigBee for transmission rate, but ZigBee has lower power consumption. Hence, ZigBee is generally used for 24 hours monitor of communication transmission systems. Compared to Bluetooth, ZigBee provides higher network flexibility and a larger number of nodes, and a better transmission range with low power consumption. Large number of nodes enables the expansion of such systems. Recently, ZigBee-based wireless networks were tested in various applications.

The proposed patient monitoring system would be beneficial for medical practitioners to do proper and better treatment; also it would be useful for health care providers to improve disease management. The patient is monitored from ICU and the data transferred to the PC is wired. Recent work [1,2] includes using Bluetooth technology coupled with the GSM technology to report signs to PDAs held by the patient or his doctor. Monitoring based on ultra wideband-based personal area networks was reported in [3]. Sneha and others [4] presented an architectural framework for a system that utilizes mobile techniques to wirelessly monitor the ECG of cardiac patients. The work reported in [5] discusses the implementation issues, and describes the overall system architecture of a Bluetooth sensor network for patient monitoring in [6], the authors investigate the use of ZigBee and mobile phones in monitoring elderly patients with diabetes mellitus or heart diseases.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

In the proposed system, patient's parameters such as ECG, Temperature and Heart Beat will be continuously transmitted and monitored through wireless technology Zigbee [7]. This system does not require the patient to be confined to his bed and allows him to move around freely in his room within a specific distance from the doctor's monitor.

Depending on the size of the hospital, several such nodes might be required resulting in a much higher system infrastructure cost. A ZigBee node is connected to every patient monitor system that consumes very low power and is extremely small in size. These slave nodes are specifically designed for low power consumption, with minimal circuit components [8]. Moreover, such protocols are meant for moderate to high bandwidth applications where relatively large packets of data need to be transmitted and received. In the case of patient vital sign monitoring, the data packet size is much smaller and could be in tens of hundreds of bytes, which seems to suggest that networks using such protocols might seem impractical and it's obvious that we need a low power, low cost network nodes for such applications.

To improve the accuracy and to increase the efficiency of the above processes a real time patient monitoring system based on Wireless Sensor Networks (using IEEE 802.15a) and a central ARM microcontroller is used. The data exchanged between the patient monitoring system and the microcontroller will be of a string format containing individual vital patient parameters like heart beat etc. separated by a delimiter. The response includes the complete patient record of the requested patient. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth.

II. SYSTEM MODEL AND ASSUMPTIONS

The implementation of the system has been described using block diagram and flow chart as follows:

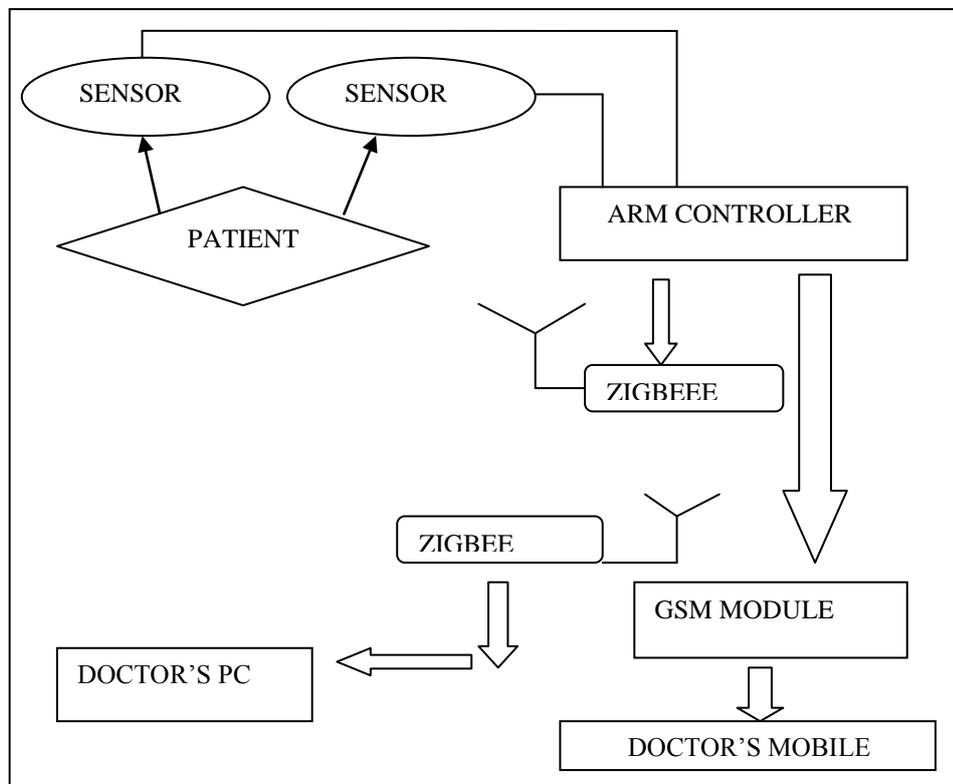


Fig 1. Block Diagram

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 3, Issue 1, January 2014

Algorithm:

- Different sensors are connected to the patient's body at appropriate positions to collect real time data about his health.
- These data are then compared to standard threshold values to check if the patient is in normal condition.
- Accordingly, the information about the patient is updated in the database on doctor's PC.
- Continuous monitoring of health parameters of the patient is being achieved by wireless transmission of sensors output through Zigbee technology.
- In case of any emergency condition, an alarm is also sent to the doctor's mobile in the form of a SMS alert, through GSM modem describing that immediate visit is required by the doctor.

III.IMPLEMENTATION METHODOLOGY

A. Hardware to be Use

- *ARM processor:* ARM is a general purpose 32-bit microprocessor. The parameters to be monitored are sensed using respective sensor and data is feed to ARM. Traditionally, embedded devices include two types of processors: a Microcontroller and a DSP to process signals. However, with the development of ARM processors, last two can be replaced by one single processor.This unit is the heart of the complete system. It will monitor & control all the peripheral devices or components connected in the system. In short, we can say that the complete intelligence of the project resides in the software code embedded in the ARM 7. The code is written in Embedded Linux and is burned or programmed into the code memory using a programmer.
- *ECG Sensor:*ECG is primarily a tool for examination of cardiac diseases. An ECG sensing device commonly consists of a group of electrodes to detect electrical events of a heart. The ECG is the electrical manifestation of the contractile activity of the heart, and can be recorded fairly easily with surface electrodes on the limbs orchest. The rhythm of the heart in terms of beats per minute (BPM) may be easily estimated by counting the readily identifiable waves. The amplifier takes the input from 3 electrodes which are connected to the patient.

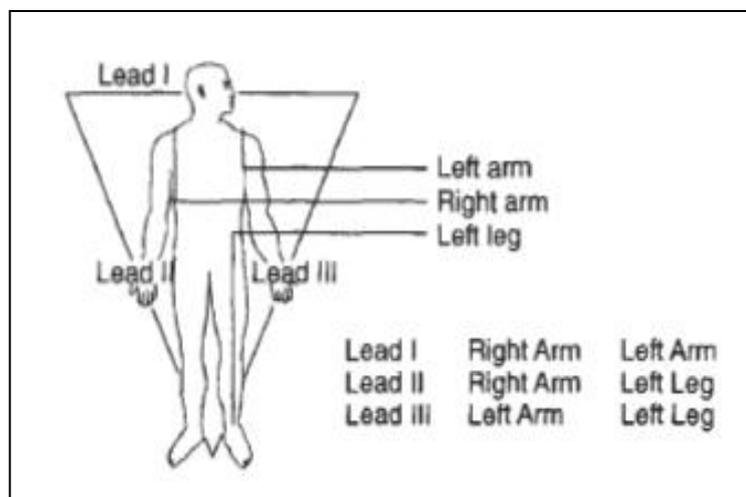


Fig 2. ECG Sensor

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 3, Issue 1, January 2014

- *Heart sensor:* Heart beat sensor is designed to give digital output of heart beat when a finger is placed inside it. This digital output can be connected to ARM directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger each pulse. ICLM358 is used for this sensor. Its dual low power operational amplifier consists of a super bright red LED and light detector. One will act as amplifiers and another will be used as comparator. LED needs to be super bright as the light must pass through finger and detected at other end. When heart pumps a pulse of blood through blood vessels, finger becomes slightly more opaque so less light reach at the detector. With each heart pulse, the detector signal varies which is converted to electrical pulse.

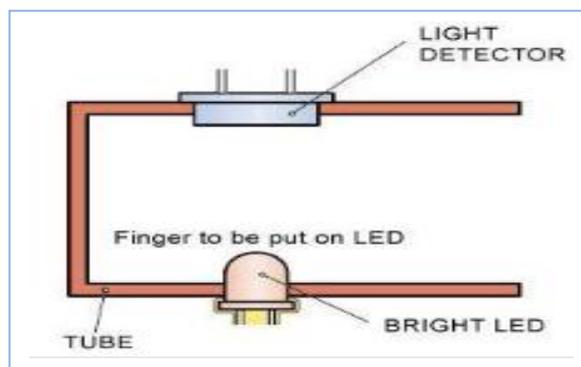


Fig 4. Heart Beat Sensor

- *Temperature Sensor:* LM35 series are precision integration-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 does not require any external calibration or trimming to provide typical accuracies. This is three legs IC that directly gives analog output. This unit requires +5VDC for its proper operation.
- *Zigbee:* ZigBee is 'Wireless Networking Technology' and is an established set of specifications for wireless personal area networking (WPAN), i.e., digital radio connections between computers and related devices. This kind of network eliminates use of physical data buses like USB and Ethernet cables. Transmitter section of the monitoring health care system consists of a Zigbee network which is made up of sensor nodes. The information sent by the Zigbee Module is received wirelessly by the other Zigbee Module at the receiver section. ARM microcontroller will match the limit predefined in the code of the microcontroller. If a mismatch occurs, that is if the collected data is more than the limit defined then alert signals are issued. Alert signals are issued in the form of SMS on doctor's mobile to alert him so that he can provide cure on time. If the collected data is within the limits then the value of the sensed data will simply be displayed on PC Display.

B. Software to be use

- C. This includes individual coding for ARM 7 in Embedded Linux, for database in MySQL, and for the GUI (Graphical User Interface) on doctor's PC.

The basic application software architecture of the system is split into four major modules:

- Coding of ARM 7 is done in Embedded Linux. It is required for interacting with both GSM and Zigbee module. GSM module is required for interaction of the ARM microcontroller with the doctor's mobile while Zigbee module is used for the transfer of sensor outputs corresponding to health parameters over required distance.
- The data from the patient is collected continuously and stored in the database designed using MySQL.
- Graphical user interface is prepared on Visual Studio for processing, displaying and storing real time Patient's information and maintaining a log file.



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 3, Issue 1, January 2014

IV.APPLICATION

This technique presents a system to upgrade existing health monitoring systems in the hospitals by providing monitoring capability and a thus a better cure. This system is based upon wireless technology i.e. Zigbee IEEE 801.15.4 providing low cost effective solution. As it is wireless device, the cost of cables is reduced here. It provides continuous monitoring of the vital signs of the patient over long periods of time until an abnormal condition is captured and hence critical situations can be overcome. This intelligent monitoring system provides long term monitoring capability useful for the staff in the hospitals and reduces their workload. Future work may include more number of sensors in a single system to provide flexibility. Hence the main goal of this paper is to develop a patient health monitoring system to alert the staff in the hospitals so that immediate care is provided to patients.

V. RESULT AND DISCUSSION

This technique presents a system to upgrade existing health monitoring systems in the hospitals by providing monitoring capability and a thus a better cure. This system is based upon wireless technology i.e. Zigbee IEEE 801.15.4 providing low cost effective solution. As it is wireless device, the cost of cables is reduced here. It provides continuous monitoring of the vital signs of the patient over long periods of time until an abnormal condition is captured and hence critical situations can be overcome. This intelligent monitoring system provides long term monitoring capability useful for the staff in the hospitals and reduces their workload. Future work may include more number of sensors in a single system to provide flexibility. Hence the main goal of this paper is to develop a patient health monitoring system to alert the staff in the hospitals so that immediate care is provided to patients.

The proposed technique has the following advantages

- *Easy and Reliable for Doctors:* In a hospital, either the nurse or the doctor has to move physically from one person to another for health check, which may not be possible to monitor their conditions continuously. Thus any critical situations cannot be found easily unless the nurse or doctor checks the person's health at that moment. This may be a strain for the doctors who have to take care of a lot number of people in the hospital.
- *Increase efficiency:* The number of nurses required for keeping a check on patients in ICU can be reduced to a large extent.
- *More Accurate:* Chances of human error in checking different health parameters is also reduced, also the database can be updated time to time.

VI.CONCLUSION

From the above designed project we can conclude that we are able to transmit the data which is sensed from remote patient to the doctor's PC by using wireless transmission technology, Zigbee. Using Zigbee at receiver the data is received and displayed on the PC. Also, if doctor is not present in campus, he will receive a SMS on his mobile phone in case any of the parameter goes beyond the normal range. The leads of the ECG sensor must be stick properly to the patient, which is nearest to the chest side of patient. So that we get more and more correct ECG. All other sensors should also be calibrated properly for precise measurement of parameters and in order to facilitate immediate action by the doctor to provide proper medication and treatment to the patient in case of any emergency situation.

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ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

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