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A Review on Remote Patient Monitoring System using Zigbee and GSM Technology

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ABSTRACT: In hospitals, considering the huge campus, it is very difficult for the doctors to reach every patient for their daily updates and its very time consuming to monitor all the patients on daily basis. Home care services are growing up in the past years. Contemplating the patient-family pair, it represents a solution to the medical problems of the modern life. Also, in critical situations, it is very important to report the live health status of the patient to the doctor and provide immediate medical help to the patient during the critical hour. Statistics reveal that everyday many lives are affected because the patients did not get timely and proper help. This paper shows design and development of a reliable, energy efficient patient monitoring system. It can send parameters of patient in real time. It enables the doctors to monitor patient's health parameters (temperature, heartbeat etc.) in real time. The paper presents the design and implementation of a Remote Patient Monitoring system (RPMS) based on wireless technology. 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. The proposed system combines two commonly used technologies namely, Global System for Mobile (GSM) and ZigBee Technology.

KEYWORDS: Patient Monitoring, Wireless Sensor Network, ZigBee, GSM, Remote Patient Monitoring system (RPMS).

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.

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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.

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. 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 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. RELATED WORK

The design and implementation of a telemetry system for measurement and monitoring of bioelectric signals such as EEG, ECG or EMG is discussed in [9]. The proposed system consists of two parts, a portable part and a stationary part. The transmitter uses a pair of 2.8v lithium D cell batteries and can operate for 1.5 months before replacement. The stationary part consists of a commercial radio receiver. The signals can be plotted (using x-y plotter), displayed (using a conventional analogue CRT), or sent to PC system for further processing and interpretation. This system utilizes conventional radio transmitter which consumes very high power.

AMON is a project financed by the EU FP5 IST program [10]. It consists of on-body sensors integrated in the form of a wrist worn device capable of measuring blood pressure, skin temperature, blood oxygen saturation and a one lead ECG. It also incorporates a two-axis accelerometer for correlating user activity with the measured vital signs. The authors designed a GSM based communication link and also the software for telemedicine centre. To measure the ECG and blood pressure the subject attention is needed. The physiological parameters are not continuously transferred. The inconsistencies of the observed results are also reported by the authors. Though it has varying degrees of accuracy on all the measurements, the tests have provided a clear indication of the feasibility of the concepts and validity of the solutions adapted by the project. An unobtrusive and wearable, multi-parameter ambulatory physiological monitoring system for space and terrestrial application, termed Lifeguard [10] has been developed. The system uses the conventional electrodes to acquire ECG and interfaces a separate non-invasive cuff-based blood pressure monitor and

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wires from the sensors to the data acquisition hardware are routed around the subject. The system uses the conventional electrodes to acquire ECG and interfaces a separate non-invasive cuff-based blood pressure monitor. The different sensors are connected through wires from the crew physiologic observation device (CPOD) and are routed around the subject.

In SmartVest, Pandian et al [11] describe a wearable multi parameter monitoring system which uses an array of on-body sensors connected to a central processing unit for continuously monitoring of physiological monitoring system. The parameters measured are ECG, photoplethysmography (PPG), heart rate, body temperature, blood pressure, and galvanic skin response (GSR). An instrumented wearable belt for wireless health monitoring is presented in [12]. The instrumented wearable belt device is composed of the electronics and sensors for the monitoring of electrocardiogram (ECG), heart rate (HR) derived from ECG signals by determining the R-R intervals, body temperature, respiratory rate, and three axis movement (acceleration and position) of the subject measured using an accelerometer. The experimental results showed that the cardiorespiratory signals, the heartbeats, the respiratory cycles and the patient movements can be obtained clearly by the device. The instrumented wearable belt makes possible physiological parameter measurements for telemedicine diagnosis, especially for home health care management of aged people.

The above all are some developments in the period of 2000-2013 in the field of sensor-based systems for health care application. They were trying to develop successful wireless health monitoring devices. But successful commercial models are yet to reach in medical fields for regular use. Now it is high time to develop wireless monitoring systems for telemedicine applications using latest devices and technology available. It must be made available to local population for their health monitoring to bring the technological developments for the benefit of common man.

In this proposed method of patient monitoring, the ZigBee wireless technology is used for transmission which consumes very low power, so the system can be run months or years without replacement of battery.

III. PROPOSED WORK

Working Of the system:

There are mainly two parts of the system one is transmitter and other is receiver.

In the transmitter part, heartbeat sensor, temperature sensor, ECG and lungs capacity sensor, respiration sensor are used as shown in figure 1.

All the sensors are connected to the patient body, and the output of the sensor is given as an input to the Arduino board.

The Arduino monitors the all the system in the transmitter and sends the signal so that the receiver will capture the signal and will work according to that. In this system there are two receivers one is ZigBee connected to the doctor's pc and other is doctor's mobile.

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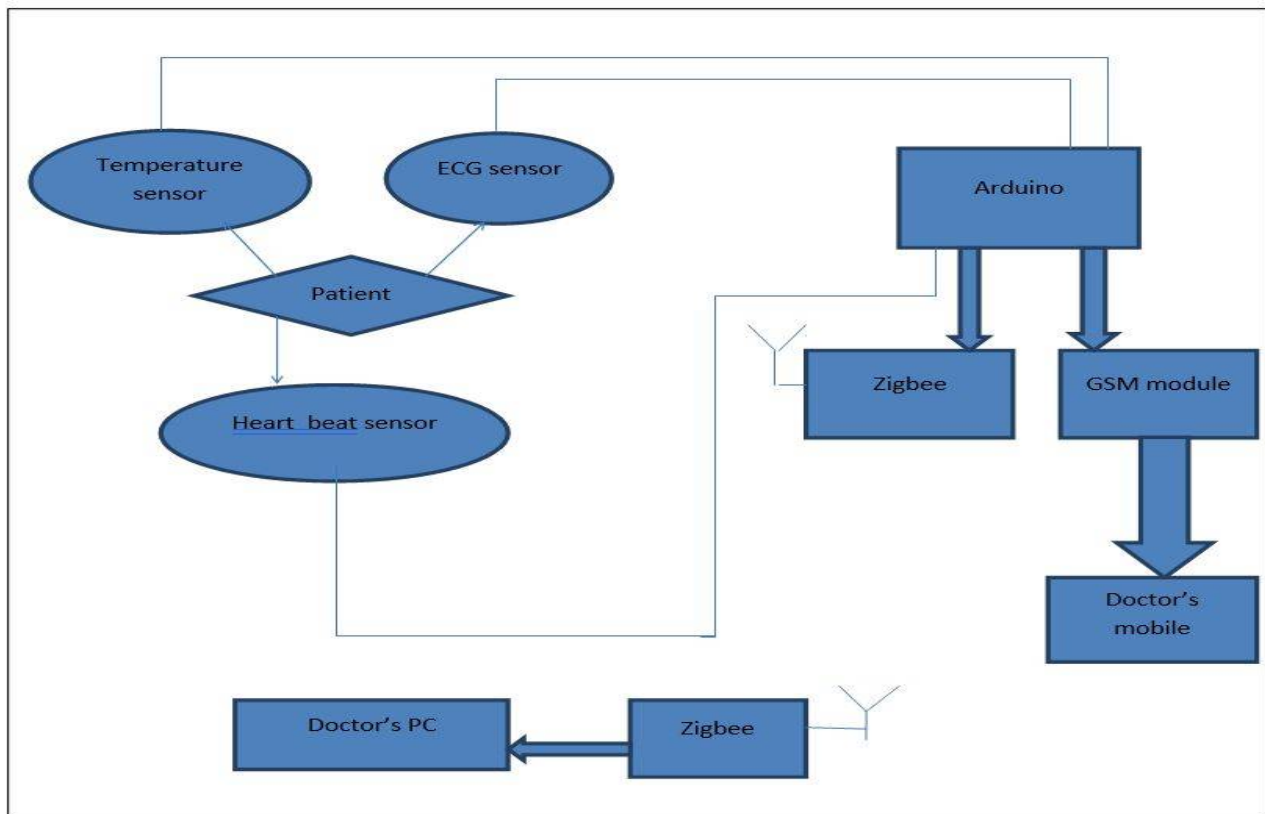


Fig 1. Block Diagram

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.

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IV. IMPLEMENTATION METHODOLOGY

The designing part includes basically two sections as follows:

4.1 Hardware to be use:

a. ARM processor: ARM is a general purpose 32-bit microprocessor, offers high performance and very low power consumption. ARM architecture is based on RISC principles. Instruction set and related decode mechanism are simpler than CISC. ARM Processor supports both 32-bit and 16-bit instructions via the ARM and Thumb instruction sets. 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.

b. 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 easily with surface electrodes on the limbs or chest. 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.

c. 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. IC LM358 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 another end. When heart pumps a pulse of blood through blood vessels, finger becomes slightly opaquer so less light reach at the detector. With each heart pulse, the detector signal varies which is converted to electrical pulse.

d. 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 analogue output. This unit requires +5V DC for its proper operation.

e. Accelerometer sensor: For measuring the patient's activity and guarding against the possibility of falling down, an ADXL213 Accelerometer Sensor is used. It's low cost, $\pm 1.2g$ Dual and measures both static (Gravity) and dynamic acceleration (Vibration). The accelerometer is used to determine whether the patient is stable and is in good position (standing or sitting) or has fallen down (sudden vertical change of the position). This sensor provides a digital output. The Duty cycles of the digital signals are proportional to acceleration and the typical noise floor is 160 g/Hz.

f. 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

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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.

4.2 Software to be use:

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:

- a. 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.
- b. The data from the patient is collected continuously and stored in the database designed using MySQL.
- c. Graphical user interface is prepared on Visual Studio for processing, displaying and storing real time Patient's information and maintaining a log file.

IV. CONCLUSION

The proposed work can be used to transmit the data which is sensed from remote patient to the doctor's PC by using wireless transmission technology, Zigbee. The doctor can get an alert message on his mobile phone in case of any emergency and in case 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 to facilitate immediate action by the doctor to provide proper medication and treatment to the patient in case of any emergency.

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