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PATIENT MONITORING SYSTEM USING DEDICATED ZIGBEE SENSOR NETWORK

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ABSTRACT

A lot of research has been carried out in the field of health care monitoring. In the recent years, development of wireless health care monitoring system has emerged as an area of research. The presented work falls under the health care monitoring system. Here the system monitors the patient continuously while simultaneously transmitting the physiological data to the doctors and other medical staff. The presented system is based on a dedicated communication protocol for sensor networks, ZigBee. The system has low cost, low power requirements and compact. The performance of the system is analysed for indoor and outdoor environment, under various conditions. It is observed that the system provides reliable monitoring and secure wireless transmission of the monitored data. Further it is observed that the current consumption of the system is 64.1 mA and 71.2 mA at the sensing node and coordinator respectively, when transmitted power is set at -18 dBm. The range of the system varies from 10m (indoor environment) to 30m (line of sight range in outdoor environment) at -18 dBm transmitted power, which is suitable for hospital environment.

KEYWORDS

ZigBee, Microcontroller, sensor, Health monitoring

INTRODUCTION

Modern times have seen a lot of development in health care domain. With the advances in medicine the cost of health care has rose many folds on one hand and a rapid increase of the aged population due to the newer and better medicines on the other. The key to saving lives and improving the overall safety of a patient's care still remains in providing timely access to complete patient information, ofcourse need not to mention the medical supervision. As the number of patients increase the need to monitor and record for use by experts later becomes more and more important. Several works have already been done to improve the recording and reporting systems have been developed to provide a wealth of healthcare data [1], still the information remains fragmented and largely inaccessible. With the recent developments in wireless systems [2]-[10] there has been renewed interest for medical applications [11]-[19]. Significant inputs are being directed towards development of novel low power circuits and systems. Wireless systems hold a number of advantages over wired alternatives, including: ease of use, reduced risk of infection, reduced risk of failure, reduced patient discomfort, enhanced mobility, quick & easy setup of the wireless sensor networks make them the only choice in case of disaster response to setup immediate temporary health care center, and lower cost of care delivery [20],[21]. Applications demand expertise in multiple disciplines, suggesting opportunity for System-on-Chip (SoC) or System-in-Package (SiP) integration. The demand for wireless connections increases with as more and more biomedical sensors emerging. The medicare centers like hospital, nursing homes, clinics etc. impose their own specific requirements for wireless data transmission, for example the selected technology has to be extremely reliable, to make a more humane environment for the physical and physiological heath care more feasible for patients especially the aged ones, frequent monitoring and recording of their physiological status becomes very important [22],[23],[24], the stringent regulations relating to patient treatment and monitoring set strict specifications for possible solutions. In addition, and thesensors' power consumption must be low etc. To prevent accidents from happening and prevent sudden situations that cause accidents, the role of the wireless sensor networks comes in very handy, specially for

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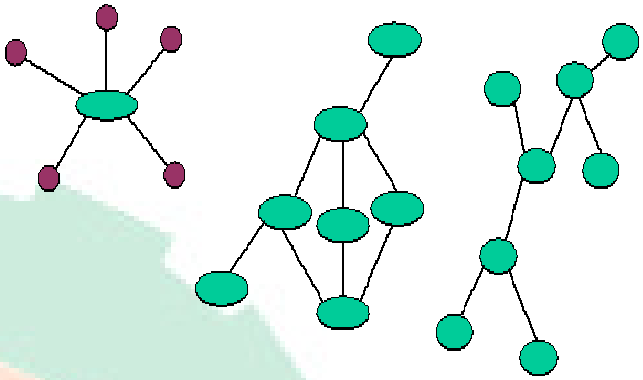
ICU (Intensive Care Unit), ICCU (Intensive Cardiac Care Unit), Burn Wards or Gynae wards where the admission is very restricted due to the reasons of getting further infections from the visiting human personals that would include the hospital staff. It has been often observed that during surgical operations and during their stay in these wards patients monitoring is done by attaching to them monitoring equipment by cables. Cabling, however, offer many hindrances in many ways to the treatment process; for instance, cables obstruct nursing procedures and complicate patient transfers, as they have to be attached and detached. Detaching the sensor would mean loss of monitoring information which could be vital in some cases. Ideally, sensors should be attached to patients on their arrival at the hospital, and detached upon their discharge. In countries like ours were the mass population is still thriving for one square meal the increasing cost of medicine becomes difficult, also the hospitals and nursing centers are overloaded by patients due to lack of widely available services. It is mandatory to reduce not only the cost of treatment but also the load on the institutions offering such facilities. A wireless sensor is best suited for such situations. Many a measurements can be performed.

SENSOR NETWOK DESIGN

The mission of the ZigBee Working Group is to bring about the existence of a broad range of interoperable consumer devices by establishing open industry specifications for unlicensed, untethered peripheral, control and entertainment devices requiring the lowest cost and lowest power consumption communications between compliant devices anywhere in and around the home.

The ZigBee specification is a combination of Home RF Lite and the 802.15.4 specification. The spec operates in the 2.4GHz (ISM) radio band - the same band as 802.11b standard, Bluetooth, microwaves and some other devices. It is capable of connecting 255 devices per network. The specification supports data transmission rates of up to 250 Kbps at a range of up to 30 meters. ZigBee's technology is slower than 802.11b (11 Mbps) and Bluetooth (1 Mbps) but it consumes significantly less power



ZigBee/ addresses three typical traffic types. MAC can accommodate all the types.

1. Data is periodic. The application dictates the rate, and the sensor activates checks for data and deactivates.

2. Data is intermittent. The application, or other stimulus, determines the rate, as in the case of say smoke detectors. The device needs to connect to the network only when communication is necessitated. This type enables optimum saving on energy.

3. Data is repetitive, and the rate is fixed a priori. Depending on allotted time slots, called GTS (guaranteed time slot), devices operate for fixed durations.

ZigBee employs either of two modes, beacon or non-beacon to enable the to-and-fro data traffic. Beacon mode is used when the coordinator runs on batteries and thus offers maximum power savings, whereas the non-beacon mode finds favour when the coordinator is mains-powered.

In the beacon mode, a device watches out for the coordinator's beacon that gets transmitted at periodically, locks on and looks for messages addressed to it. If message transmission is complete, the coordinator dictates a schedule for the next beacon so that the device 'goes to sleep'; in fact, the coordinator itself switches to sleep mode.

While using the beacon mode, all the devices in a mesh network know when to communicate with each other. In this mode, necessarily, the timing circuits have to be quite accurate, or wake up sooner to be sure not to miss the beacon. This in turn means an increase in power consumption by the coordinator's receiver, entailing an optimal increase in costs.

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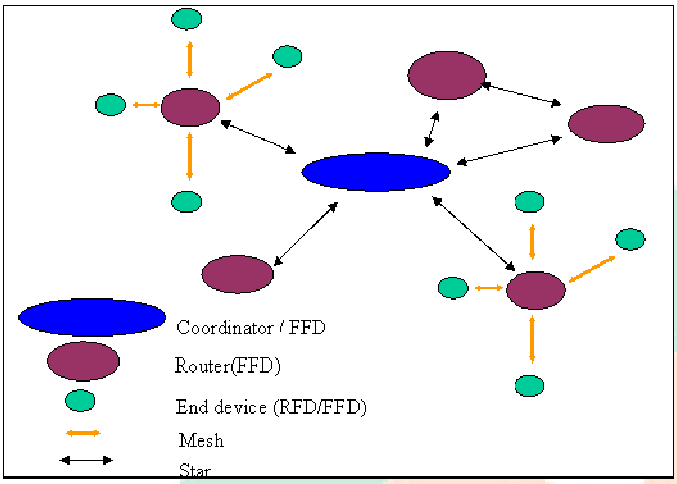
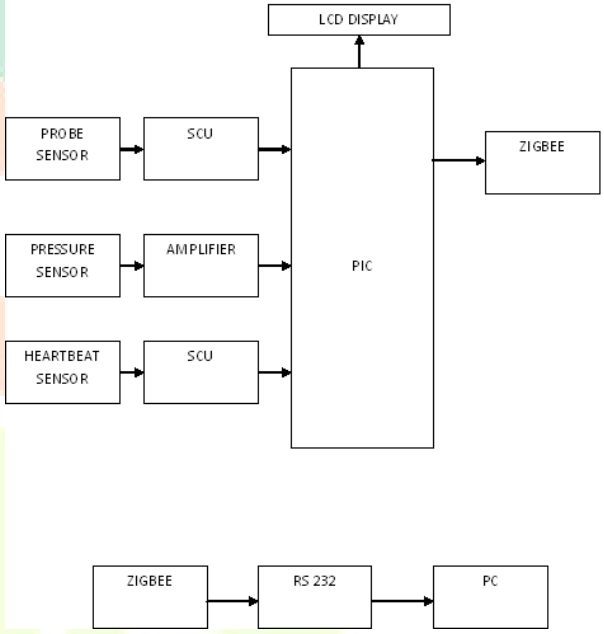


For the sake of simplicity without jeopardizing robustness, this particular IEEE standard defines a quartet frame structure and a super-frame structure used optionally only by the coordinator.

HEALTH MAINTENANCE SYSTEM DESIGN

A device for holding a heartbeat sensor in a relatively fixed relationship with respect to the end of a user's fingertip. More particularly, a device is disclosed wherein a single sheet of resilient material is formed into a base portion for holding the heartbeat sensor and three resilient bands that extend upwardly therefrom. The bands are adapted to grip the user's fingertip. In one embodiment of the invention, the bands and base portion define a U-shaped channel of constant cross-sectional area. In this embodiment a holding structure for the heartbeat sensor is wedge-shaped, the wedge-shaped holding structure being adapted to be held by the base portion so that the cross-sectional area defined by each band and the wedge-shaped holding structure decreases along the longitudinal length of the base portion. In another embodiment of the invention, each band defines a smaller cross-sectional area with respect to the base portion. Thus both embodiments result in more pressure being applied to the sensor at the portion of the user's fingertip closest to the end.

The invention provides a device for holding a heartbeat sensor in a relatively fixed relationship with respect to a user's fingertip. The device includes a base portion for holding the heartbeat sensor, and a pressure producing means connected to the base portion for holding the user's fingertip against the heartbeat sensor, the pressure producing means including means for causing pressure between the heartbeat sensor and the user's fingertip to be greater at the portion of the user's fingertip closest to the end than at the portion of the user's fingertip furthest from the end.



In telecommunications, **RS-232** is a standard for serial binary data interconnection between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports.

The standard does not define such elements as character encoding (for example, ASCII, Baudot or EBCDIC), or the framing of characters in the data stream (bits per character, start/stop bits, parity). The standard does not define protocols for error detection or algorithms for data compression.

The standard does not define bit rates for transmission, although the standard says it is intended for bit rates lower than 20,000 bits per second. Many modern devices can exceed this speed (38,400 and 57,600 bit/s being common, and 115,200 and 230,400 bit/s making occasional appearances) while still using RS-232 compatible signal levels.

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Details of character format and transmission bit rate are controlled by the serial port hardware, often a single integrated circuit called a UART that converts data from parallel to serial form. A typical serial port includes specialized driver and receiver integrated circuits to convert between internal logic levels and RS-232 compatible signal levels.

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complimentary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877. The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The picstart plus development system includes PIC start plus development programmer and mplab ide.

The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under mplab provides for full interactive control over the programmer.

An ELECTRONIC AMPLIFIER is a device for increasing the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with a larger amplitude. In this sense, an amplifier may be considered as modulating the output of the power supply.

Here we use inverting amplifier as a gain amplifier. We can change the gain by adjusting the value of feedback resistance value.

TESTING

The ZigBee Alliance targets applications across consumer, commercial, industrial and government markets worldwide.Unwired applications are highly sought after in many networks that are characterized by numerous nodes consuming minimum power and enjoying long battery lives. ZigBee technology is designed to best suit these applications, for the reason that it enables reduced costs of development, very fast market adoption, and rapid ROI.

Air bee Wireless Inc. has tied up with Radio crafts AS to deliver "out-of-the-box" ZigBee-ready solutions; the former supplying the software and the latter making the module platforms. With even light controls and thermostat producers joining the ZigBee Alliance, the list is growing healthily and includes big OEM names like HP, Philips, Motorola and Intel.

The health maintenance system has been installed to the testing flat of health maintenance system which we have built in cooperation of Ostrava University. Other devices are were tested in laboratory condition.

CONCLUSION

The developed system is low cost, autonomous, and light weight. It consists of sensing nodes. These nodes can be strategically placed on the human body and capable of creating a wireless body area network (WBAN) to monitor various physiological parameter. These parameters can be monitored for a long period of time and provide real-time feedback to the user and medical staff. The system is also capable of providing reliable and secure communication. The system further promises to revolutionize the health care monitoring. In this work temperature sensors are used to collect physiological data from patients. The data is then transmitted to the coordinator using ZigBee standard, where it can be observed by the doctors and other medical staff. The developed system is also capable of improving the battery life by reducing power consumption during the transmission.

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