Wireless Sensor Networks for Monitoring Physiological Signals of Multiple Patients

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Abstract: ***Recently, in many cases, the reason for a patient staying in the hospital is not that he or she actually needs active medical care. Often, the principal reason for a lengthy stay in the hospital is simply continual observation. Therefore, efforts have been made to avoid acute admissions and long lengths of stay in the hospital. In recent years, emergency admissions and long lengths of stay have become extremely costly. So the focus of health policy has shifted away from the provision of reactive, acute care toward preventive care outside the hospital. As models of care are redesigned, health economies are seeking to provide more care outside large acute centers. The drivers for this shift are two-fold; first, there is a quality-of-care issue and second, there is a resource allocation issue. Being cared for in a patient's own home is a key aim of current U.K. government health policy and that is driven by an imperative to provide better quality care to people without the need to disrupt their lives. Investment in technologies that enable remote monitoring would lead to long-term gains in terms of hospital finances and patient care.***

Keywords: wireless, patients, monitoring, observation, emergency, sensors.

1. Introduction

In this paper, we present a wireless sensor network where a group of sensors monitor and transmit medical signals. Sensors are tailored to a specific condition. In this case, we observe a patient who has suffered a heart attack and is considered at risk for having another attack. This patient would be fitted with electrocardiogram (ECG) sensor, heartbeat, blood-pressure, temperature sensors that monitor the heart activity, and all the parameters so on.

Further, patients are considered as nodes of the network, and the hospital is considered as the central node or sink. These nodes are then connected to a central node which is installed in the hospital. Clinicians are then able to monitor their patients' conditions, detect any abnormalities, and take appropriate action (e.g., contact the patient to give some advice or send an ambulance to their home). This system has particular benefits for patients who want to live their normal lives and for providers who are keen to closely monitor patients but have limited resources or space. In this system, there is no need for a PC to transmit data via an Internet connection. The quality of service (QoS) is largely the same without the PC but with a dramatic reduction in cost and improvement in ease of use.

2. Existing System and Proposed System

The system described in this project is one of these examples which would significantly reduce the lengths of stay among those patients who have had an acute episode but whose only medical requirements are for continual monitoring.

Currently, some wireless monitoring systems have been designed which commonly use a PC, a personal digital assistant (PDA), or a mobile phone at the patient's side. In these systems, the vital signals are transmitted to the hospital via internet or mobile networks. The main drawbacks of these systems are the costs of a PC or PDA, accessibility, and possible delay that occur in sending data if the PC is off and the difficulty of using PCs for elderly people. Meanwhile, some of the existing systems transmit signals via an analog radio link to the base station, which leaves the signal vulnerable to degradation/hacking during analog radio. In this paper, we present a wireless sensor network where a group of sensors monitor and transmit medical signals. Sensors are tailored to a specific condition.

3. Project Overview

It consists of two main sections in the system. The first section is the patient home which consists of two modules wireless patient portable unit (WPPU), where the ECG signals, temperature pressure values, heartbeat values are detected, amplified, and send it to the wireless access point unit (WAPU) which is located near to the patient and then by using Ethernet module sending the data to the internet such that which can be seen in the hospital by the doctors.

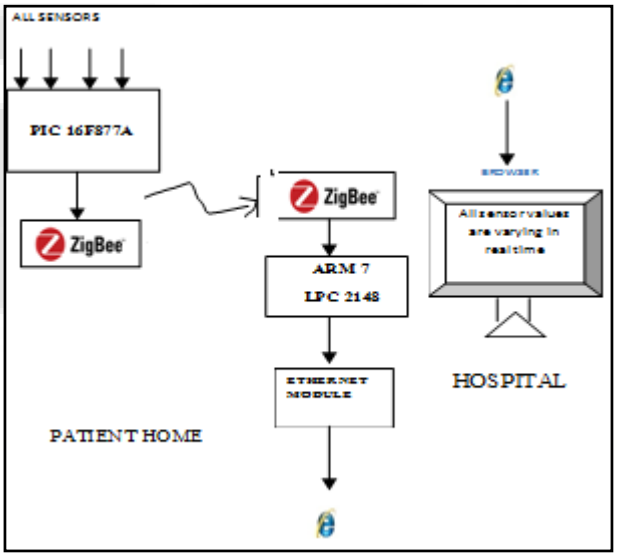

Figure 1: whole scenario of the project

3.1 Patient Home

The modules at the patient's home are wireless patient portable unit (WPPU) and wireless-access point unit (WAPU). wireless patient portable unit (WPPU) consists of ECG sensor, temperature sensor, blood pressure sensor, heartbeat sensor, PIC microcontroller, LCD(Liquid crystal display), UART (Universal Asynchronous Receiver Transmitter) and zigbee module.WAPU consists of ARM7 processor, zigbee module,UART, MAX 232, Ethernet module. The WPPU is held with the patient and the WAPU is attached to an Internet router.

As can be seen, all these sensors are connected to the patient via a very light set of cables and all the ECG sensor, temperature sensor, blood pressure sensor, heart beat sensor values are taken and give it to the PIC microcontroller and then we are giving it to LCD and zigbee module by using UART.The WPPU then wirelessly transmits the collected signals to the WAPU through a zigbee network connection based on the Tarang F4 zigbe module.

3.1.1Transmitter Section

WPPU (Wireless Patient Portable Unit): Wireless Patient Portable Unit (WPPU) consists of ECG sensor, temperature sensor, blood pressure sensor, heartbeat sensor, PIC microcontroller, LCD (Liquid crystal display), UART (Universal Asynchronous Receiver Transmitter) and zigbee module. All the sensor values are taken and sends to the PIC microcontroller and by serial communication sends the data to LCD and zigbee module ie zigbee transmitter.

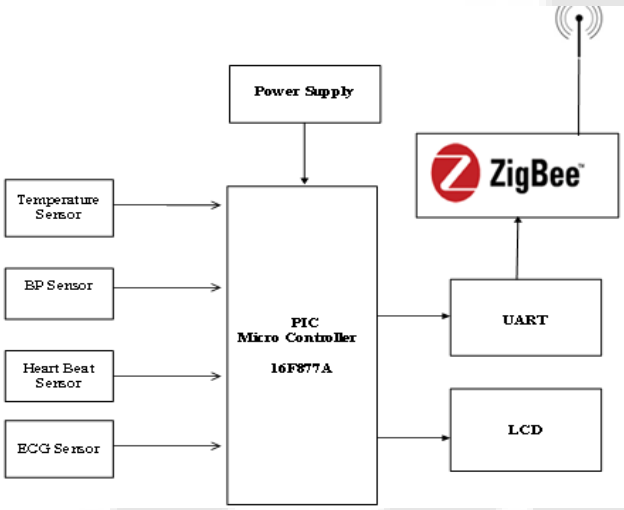

Figure 2: Wireless Patient Portable Unit

3.1.2 Receiver Section

WAPU (Wireless Access Point Unit): It consists of ARM7 processor, Zigbee module, UART, MAX 232, Ethernet module. When all the values of sensors are reached through zigbee module from the WPPU, it receives through the zigbee receiver and by using UART, sending the data to the ARM7 and from then we writing the code for the Ethernet module such that all the patient data are entered and show the output in any internet browser such that in the hospital section doctors can view the details of all the patients and observe all the sensor values and give the suggestions or aid details if required and send an ambulance if any emergency case occurs.

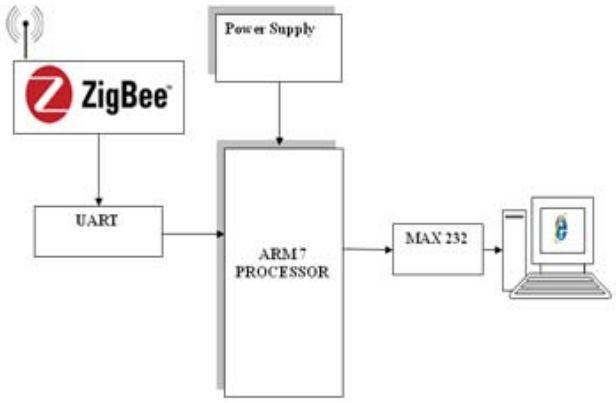

Figure 3: Wireless Access Point Unit

3.2 Hospital

The signals are transmitted constantly from patients' homes to the hospital by using Ethernet module connected to the router via to the Internet in real time. Hence, there is no appreciable time lag between a signal being detected by the sensors and it being received at the hospital. In the internet browser all the real time varying data can be seen and doctors can view the details of all the patients and observe all the sensor values and give the suggestions or aid details if required and send an ambulance if any emergency case occurs. At the hospital, special software can be written and installed on a computer server if server is maintained, which shows the temperature blood pressure, heart beat, ECG values of the patients in the digital format.

Internet connected to Router Personal computer

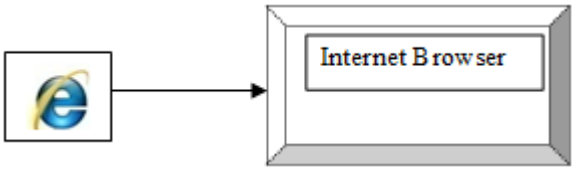

Figure 4: hospital section

4. Hardware Description

4.1 Introduction

In this chapter it deals with all hardware components used to make the project successful. And all individual modules which can interface with the controllers and to get exact output are explained in detailed.

4.2 LPC 2148 MICROCONTROLLER (ARM 7)

General description: The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

Features

a. 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
b. 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory.
c. 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
d. In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software.
e. Single flash sector or full chip erase in 400 ms and programming of 256 B in 1ms.
f. EmbeddedICE RT and Embedded Trace interfaces offer real-time debugging with the on-chip RealMonitor software and high-speed tracing of instruction execution.
g. USB 2.0 Full-speed compliant device controller with 2 KB of endpoint RAM.

4.3 PIC MICROCONTROLLER (PIC16F877A)

Introduction: Manufactured by Microchip, the PIC ("Programmable Intelligent Computer" or "Peripheral Interface Controller") microcontroller is popular among engineers and hobbyists alike. PIC microcontrollers come in a variety of "flavors", each with different components and capabilities. Many types of electronic projects can be constructed easily with the PIC family of microprocessors, among them clocks, very simple video games, robots, servo controllers, and many more. The PIC is a very general purpose microcontroller that can come with many different options, for very reasonable prices.

4.4 Temperature sensor

LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. . The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

4.5 Heart Beat Sensor

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat.

4.6 Integrated Silicon Pressure Sensor

Description: The MP3V5050 series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

4.7 ECG Sensor

General description: The heart functions as a pump for circulating blood to the bod y by repetition of contraction and enlargement. The cardiac electric potenti al is produced in the body during heart contraction. Electrocardiogram can be measure ed by leading this electrical signals to other body position and amplify. Inventory of Items Included with the EKG Sensor, Electrocardiogram sensor (EKG sensor).

4.8 Zigbee Technology

Introduction to Zigbee: Zigbee is an IEEE 802.15.4 standard for data communications with business and consumer devices. It is designed around low-power consumption allowing batteries to essentially last forever. The Zigbee standard provides network, security and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard. It employs a suite of technologies to enable scalable, self-organizing, self-healing networks that can manage various data traffic patterns. Zigbee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications,

4.9 ENC 28J60 Ethernet Module

The ENC28J60 is a stand-alone Ethernet controller with an industry standard Serial Peripheral Interface (SPI). It is designed to serve as an Ethernet network interface for any controller equipped with SPI. The ENC28J60 meets all of the IEEE 802.3 specifications. It incorporates a number of packet filtering schemes to limit incoming packets. It also provides an internal DMA module for fast data throughput and hardware assisted checksum calculation, which is used in various network protocols. Communication with the host controller is implemented via an interrupt pin and the SPI, with clock rates of up to 20 MHz.

4.9 KEIL uVision4

THE uVision IDE from KEIL combines project management, make facilities source code editing, program debugging, and complete simulation in powerful

environment. The uVision development platform is easy to use and helping you quickly creates embedded programs that work. The uVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment.

5. Advantages and Applications

5.1 Advantages and Disadvantages

1. Reduction of costs in the hospital bills since every patient was hospitalized from their homes
2. Digital values are visualized for more than one patient in real time anywhere through the internet.
3. For continuous medical observation.
4. Privacy for the patients.
5. Patient can move from one place to another easily.
6. Patient can also take a walk to feel relief

5.2 Applications

1. Used for Monitoring Physiological Signals of Multiple Patients in hospitals when the patient was in their homes.
2. Used in military applications to know the health conditions time to time.
3. And to check the person is alive or not when war was going on.
4. Used in the hospitals for observing heartbeat, blood pressure, temperature wirelessly.
5. Used For continuous medical observation.

6. Result

A. Final Hardware Setup Implemented

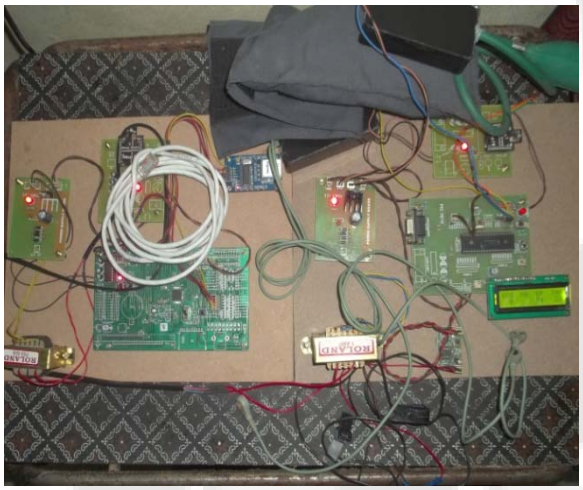

Figure 5: Total hardware setup implemented

B. Output can be seen in the internet browser in any hospital by giving its ipe address http/www.182.168.1.25

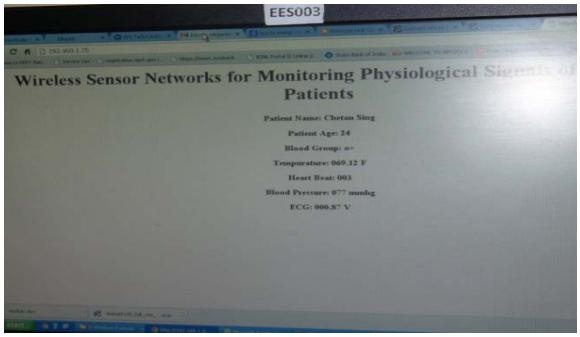

Figure 6: Output screen seen in the hospital

7. Conclusion

Many hospitals and physicians have requirements for an integrated and reliable wireless monitoring system to observe real time physiological signals from patients outside the hospital with high and reliable accuracy. Currently available systems for monitoring physiological signals suffer from technical limitations, resulting in the under exploitation of potentially life-saving data. In this project a wireless sensor network structure to monitor patients with chronic diseases in their own home through a remote monitoring system of physiological signals was presented. Moreover, it was demonstrated how to eliminate the need for a PC. Further, it was shown how to design an easy-to-use and configure access point for these systems.

8. Future Scope

If we maintain server, Patient database: ability to add, delete, and modify patient information online ECG BP, Temperature, Heartbeat values are visualized for more than one patient at any time. latest records of all the ECG, BP, Temperature, Heartbeat values of multiple patients can be stored including date and time.

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