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A Portable Health Monitoring System based on Wireless Sensor Network

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Abstract-- *Health monitoring system is one of most important and practical applications of wireless sensor network (WSN). Even though various health monitoring devices based on WSN are used, they are still quite limited in the sense of mobility and accuracy. In this project a new wearable health monitoring system is proposed, which consists of vital sensor nodes for multiple patients. Here the accuracy of the measurement of electrocardiogram signal and body temperature is enhanced, and the sensor node is optimized for the use in WSN. The idea was largely imbibed from* [1].
The wearable health monitoring system provides the communication between the wearable sensor nodes and relay nodes in the proximity even during the movement of the user, allowing for real-time monitoring of biometric signals. The overall system is depicted in block diagram and it consists of three components: the wearable vital sensor node, a relay node, and host computer monitoring the user. The wearable vital sensor node measures and processes the ECG signal, removing the noise and transmitting the processed signal. The relay nodes are used to increase the limited communication range of the wearable vital node, and they are installed on the ceiling of the room. Finally, the host PC uses a terminal implemented as a .net application to monitor the measured biometric signal.
In our project we are using ZigBee modem for the transmission of data from remote location to personal computer. ZigBee is one of the most popular wireless network technologies in the world. ZigBee wireless network is a new close range, simple, low power, low data rate and low cost technology. It is based on IEEES02.1S.4 standard. Thousands of tiny sensors coordinate with each other to achieve communication. The sensor requires very little energy to relay the data from one sensor to others using radio waves, so such communication is efficient.

Keywords *– WSN; Sensor Node; Relay Node; ZigBee; ECG Signal;*

1. INTRODUCTION

In recent times, the number of dreadful diseases have increased along with the cost of living while the average life span of humans has gone down drastically. The lifestyle of humans has been changing with the advancement of modernity in life. As a result, Humans tend to ignore their health. Lets consider an example of a person falling prey to the dreadful Diabetes. It is important to note here that his Blood Glucose Level has to be monitored regularly and it should be made sure that he maintains a normal level. But it is evident with the growing work life pressure that he's definitely going to ignore his health. In such a case, it would be very advantageous if there's a device which is portable, easily wearable and also keeps a check on his Blood Glucose Level. How amazing would it be, that the person would never have to overlook his work or personal life and run behind keeping a check on his health. Here, in this paper we employ a microcontroller, a ZigBee Module and a couple of sensors in order to demonstrate how it is affable to use a portable device that keeps a check on your health. We put forward our Research by demonstrating the Pulse and Body Temperature. We make use of Embedded C, Assembly Level Language to code the Device.

2. WORKING PRINCIPLE

Wearable health monitoring systems integrated into a telemedicine system are novel information technology that will be able to support early detection of abnormal conditions and prevention of its serious consequences. Many patients can benefit from continuous ambulatory monitoring as a part of a diagnostic procedure, optimal maintenance of a chronic condition or during supervised recovery from an acute event or surgical procedure.
This system consists of the various smart sensors and advance technologies. In this system the wearable device wore by the patient have various smart sensors such as temperature sensor, heart rate sensor etc that measures the health condition and simultaneously reports the microcontroller.
Important limitations for wider acceptance of the existing systems for continuous monitoring are:

1. Unwieldy wires between sensors and a processing unit,
2. Lack of system integration of individual sensors,
3. Interference on a wireless communication channel shared by multiple devices, and
4. Nonexistent support for massive data collection and knowledge discovery.

The values extracted by the wearable device is been collected by the microcontroller and these values will be transmitted to the remote PC using ZigBee module. At the remote location (PC) a graph will be made and monitored.

2.1. REQUIREMENTS

2.1.1 HARDWARE REQUIREMENTS

1. MICROCONTROLLER : AT89S52
2. POWER SUPPLY : 5V-12V
3. SENSORS: TEMPREATURE SENSOR (LM35), HEART RATE SENSOR, etc.
4. ZigBee Device.

2.1.2 SOFTWARE REQUIREMENTS

1. Embedded C
2. Proload
3. Proteus
4. KEIL IDE
5. .Net

3. PORTABLE HEALTH MONITORING DEVICE

As seen in the Block Diagram, We are employing MICROCONTROLLER : AT89S52 as an interface between the receiving end and the transmitting end. The Temperature sensor LM35, Heart Rate Sensor are connected as inputs to the microcontroller. The LCD Module is the output. To keep it more sophisticated, we can use a Monitor to display the output. The received data is transmitted to the output through the ZigBee Module which was designed by us. We studied the structure and designed the entire module on a Printed Circuit Board. The communication between the microcontroller and the ZigBee module is serial in nature. Hence we make use of MAX 232 for serial communications. The Pins of Port 3.0 serve as inputs and the pins of Port 3.1 serve as outputs to the Microcontroller. The Inputs received from the Temperature Sensor, LM35 are analog in nature and have to be converted to digital since we're displaying the output on a LCD. As a result, we use an Analog to Digital Converted to make this operation successful.
The Device consists of a number of components. A Brief Block Diagram of the Heath Monitoring Device in clearly shown in Figure 1.

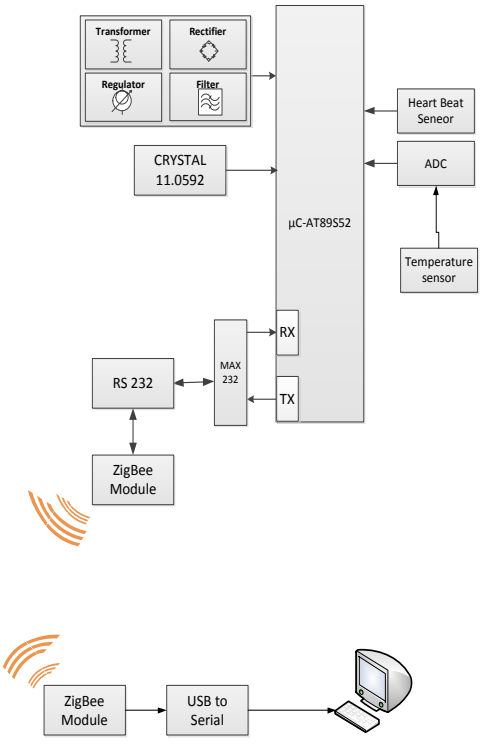

Figure 1.A Brief Block Diagram of a Portable Health Monitoring Device

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. This sensor monitors the flow of blood through ear lobe. As the heart forces blood through the blood vessels in the ear lobe, the amount of blood in the ear changes with time. The sensor shines a

light lobe (small incandescent lamp) through the ear and measures the light that is transmitted. The operating voltage of this sensor is 5V Dc. The demonstration of the Heart Sensor is shown in the image given below, i.e, Figure 2.

Figure 2. Pictorial demonstration of Heart Sensor Usage

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The device is used with single power supplies, or with plus and minus supplies. As the LM35 draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 is rated to operate over a −55°C to +150°C temperature range, while the LM35C is rated for a −40°C to +110°C range (−10° with improved accuracy). A Plastic Package of the LM35 Temperature Sensor is shown for understanding of the nodes in Figure 3. All Hardware related help was largely available from [3]

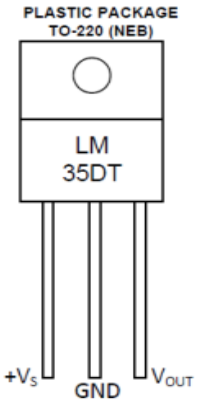

Figure 3. Plastic Package of LM35

In this paper, we intend to demonstrate the usage of this device and the advantages of employing it in the field of Bio-medicine. Here, we've designed a ZigBee Module which captures the parameters from RS 232 and transmits them to the display. During the implementation of the ZigBee Design we referred to [4] for any kind of assistance. In case of an emergency, that is if the body parameters cross the normal range, an alert signal is created in order to inform the Doctor to immediately take care of the patient. The parameters into consideration are monitored constantly. Since we have taken into consideration, the measurement of Heart Beat and the body Temperature, the range of desirable values are shown in Table 1.

	Measured Parameter	
State	Pulse[Heart Beat]	Body Temperature
Low	<60	<37 Degree C
Normal	60-100	37 Degree C
High	>100	>37 Degree C

Table1. Measurement of Body Parameters

In an age where life has become expensive, it would be highly helpful if such a device is commercialised and made available at relatively less prices. Saving the Human Life would be a lot more easier and the value for life would definitely increase. The Programming part of this Device was done majorly using Embedded C. Large amelioration from [2].

4. CONCLUSIONS

Here we have studied and implemented a complete working model of "A Robust Multiple Patient Monitoring System based on WSN". The wearable health monitoring system provides the communication between the wearable sensor nodes

and relay nodes in the proximity even during the movement of the user, allowing for real-time monitoring of biometric signals. The overall system is depicted in block diagram and it consists of three components: the wearable vital sensor node, a relay node, and host computer monitoring the user.

The wearable vital sensor node measures and processes the ECG signal, removing the noise and transmitting the processed signal. The relay nodes are used to increase the limited communication range of the wearable vital node, and they are installed on the ceiling of the room. Finally, the host PC uses a terminal implemented as a .net application to monitor the measured biometric signal.

4.1 LIMITATIONS OF THE STUDY

There are two major limitations that can be acknowledged from our research. The same have been mentioned below:
Battery consumption is more due to simultaneous data transfer. Here we have employed the usage of three Microcontroller nodes which need three separate power sources. As a result of this the consumption of power is abnormally high. This is a major setback.
Delay in measuring the parameters. In recording the parameters of the patients the sensors demand a particular period of time i.e., a few seconds. This is another limitation recorded in our study.

4.2 FUTURE ENHANCEMENTS

1. This project can be enhanced in future by modifying in the program to increase the threshold and measure accurate values of each and every parameter.
2. Apart from measuring the Heart count i.e., the Pulse Rate(PR), we can extend the application to measuring various other parameters such as Blood Glucose Level, Presence of stones and various other infections in Human body.
3. This can be implemented for Veterinary purposes too.

4. The measured parameters could be directly sent to a PC display or a Smart Phone. This would be a major future enhancement of this research. The whole project could be implemented as an Application in Smart Phones.

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