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Fault Tolerant and Scalable IoT Based Architecture for Health Monitoring

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Abstract- **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. Even there are situations that the patients should be monitored continuously for certain parameters. With the increasing in the aging population, the health of the elderly caused widespread concern. The recently developed body sensor networks (BSN) have been confirmed to be a low cost and efficient way for elderly health monitoring. We mainly introduced the design of a ZigBee based personal health device monitoring system which consisted an embedded system with sensors transmitting the details of the person and at another end the reception of the data is done which also displays the health status of same person.**

The Internet of Things (IoT) is one of the major technological trends which is utilized to monitor natural and human made resources to help in predicting and detecting exigency events like flood, fire, gas and water leak that can pose an intimidation to human life. This system describe a novel wireless health weather monitoring station that uploads person's health information received from the array of sensors to cloud database from a remote location which can be monitored from anywhere.

Index Terms- BSN, ZigBee, IoT, Sensors.

INTRODUCTION

This is an IoT based Health monitoring system designed to know anyone's health conditions any time. The system is developed using AT89S52 microcontroller that allows connecting any analog or digital sensors. In this paper the sensors like Temperature sensor and Heart beat sensor are used through which a person's body temperature and pulse rate can be sensed. The temperature sensor is analog in nature which means that it gives the analog output. The readings from LM35 sensor is converted to its digital form and sent to the Microcontroller which would process it further.

The Microcontroller has the temperature sensor (LM35) connected via the ADC - PCF8591 which works on I2C protocol. The Heart beat sensor is directly connected to the controller through its external interrupt pin 0. The controller monitors the sensor data and displays it on a 16x2 LCD module. Whenever a person wishes to know his health status he can connect the sensor inputs to himself and have a look into his health status. In case of patients, the health status can be updated to his family doctor by sending this status through the Zigbee with the help of webpage.

The sensor data is given to the controller. The controller sends this data through Zigbee with the help of transmit pin. The receiving end has another Zigbee which would receive the sensor data and tries to display it on the webpage using Web application. This requires software languages like .NET or C#.`

LITERATURE SURVEY

Recently there have been many proposals and research on patient health monitoring systems. The health monitoring systems are being made using different devices and technologies which are aimed to provide immediate help to the patient who is not present at the medical care and even to prevent the increase in chronic disease in elderly people. Some health monitoring systems have been successful in providing communication between the patient and the doctor but are not efficient enough. They fail in cases where there might be loss of data or disturbance in the communication system.

In the near future, healthcare applications will have important roles in hospital environments and also in everyday life. Healthcare applications based on wireless sensor networks are used by doctors/caregivers for real-time remote monitoring of health related bio-signals such as body temperature, peripheral capillary oxygen saturation (SpO2), blood pressure, respiration, glucose and contextual data. In addition to that, other requirements of reliability, connectivity, user interaction and moderate costs must also be accomplished. Furthermore, when the number of old people and patients increases over the years, healthcare applications require expandability to serve all patients.

Our aim is to provide an efficient health monitoring system which is also fault tolerant to make sure that there is an uninterrupted communication between the patient and the hospital even in the cases of power cut or system error.
The scope of this paper is to design a health monitoring system. The system is designed to be a robust and efficient system compared to the older health monitoring systems. It is a fault tolerant and a portable system which can be easily used

to monitor a patient's health. The basic block diagram of the project is shown in the figure 1.

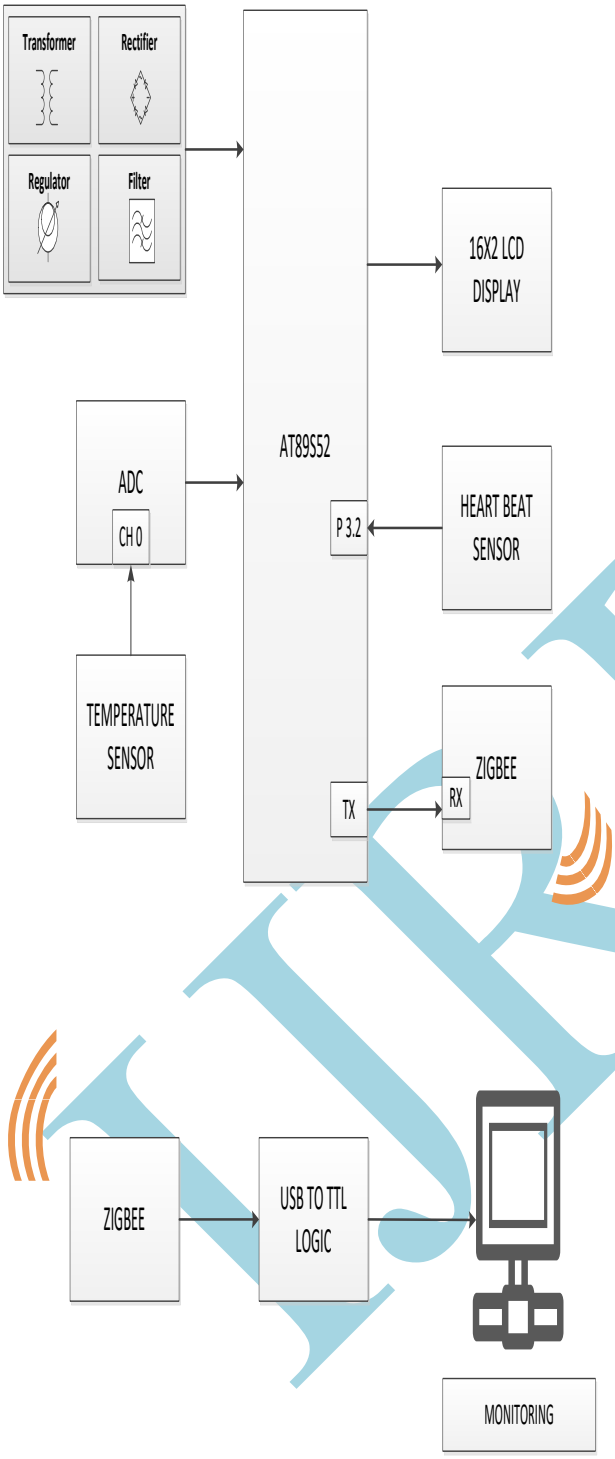

Figure 1: Block Diagram

In this paper we have used an AT89S52 controller. The controller acts as the master which synchronizes and controls the slave devices on the hardware. The microcontroller has its own flash memory which makes it scalable and reliable to use. It has low power and high performance.

COMPONENTS OF BLOCK DIAGRAM

Microcontroller AT89S52

The microcontroller is the heart of this paper. It is the main component which does all the necessary processing of the data before giving the result. Its timers and oscillator are used for calculating the heart rate of the patient from the received heart pulses from the patient. The data from the heartbeat sensor is received through the interrupt and further conversion is done to display the result in ASCII. The data from the temperature sensor is received through the sda input and processed to be displayed. It takes care of the conversion needed to display the result on the LCD. The transmitter and receiver on the microcontroller is used for ZigBee connection.

Temperature Sensor

The temperature sensor senses the patient's body temperature and transfer the signal in voltage. This voltage is then converted to noiseless analog temperature by the sensor. The result from the sensor is sent to ADC for analog to digital conversion. The output of the ADC is then given to the microcontroller which coverts it into ASCII and is displayed on the LCD display.

Heartbeat Sensor

The heartbeat sensor uses an LDR to detect the pulses. The blood flow through the finger is used to detect the pulses. Depending on the amount of blood in finger tip the LDR transmits very low signal which might have noise. The sensor passes the signal through filter, amplifier and a comparator to get a noiseless amplified signal which is sent to the microcontroller and then displayed on the LCD.

Analog to Digital Converter (ADC)

Since the output from the temperature sensor is in analog form, it needs to be converted into digital signals before sending it to the microcontroller for further processing. This conversion is done using the ADC. The ADC receives the analog signals from the temperature sensor as input and converts these signals to digital signal and then send it to the microcontroller. The I2C (Inter Integrated Circuit) protocol is used for serial communication between the devices. This protocol is used to synchronize and to communicate with other devices in the circuit faster. The microcontroller acts as the master controls the ADC to send and receive information. The data is transmitted serially through the system through two buses: the clock and the data bus.

LCD

A 16x2 LCD display is used on the hardware device to display the values of heartbeat and body temperature simultaneously when they are measured. The LCD is connected through the microcontroller; this paper requires only one row of the LCD for displaying the results. The results are in ASCII characters.

ZigBee

ZigBee protocol is used for wireless communication between the device and the other devices like laptop or a desktop computer. It uses IEEE 802.15.4 protocol for the data transmission. It is connected to the devices with the help of USB modules through TTL connections.

Monitoring

The output from the system is also sent to different devices using ZigBee and local hosting. MySQL is used to collect and store all the data in form of database which can be used when needed to display the values collected from the hardware. A web form is created in Visual Studio using C# web programming language. When the web form is opened the form fetches the data in real time from the database and displays it. For remote monitoring a website is hosted and an SMS gateway is created so that the patient's health can be monitored from anywhere. The website is locally hosted using IIS8 provided by Windows. The website is secured through a username and password. Anyone authorized to use it can access it using the host IP address.

WORKING PRINCIPLE

The goal of the paper is to develop a system that can provide the health status of a person anytime. The system is designed using AT89S52 Microcontroller, sensors like temperature and a heartbeat sensor, to observe the temperature and pulse rate of the person. This also makes use of a wireless Zigbee module that works at the frequency of 2.4GHz. A 16x2 LCD display is used to display the sensor readings.

The temperature is interfaced to the controller with the help of ADC. The Heart beat sensor takes the input from the person and fed them as external interrupt to the controller through which the controller processes it and gives the heart beat rate or pulse rate of a person. The Zigbee module is connected to controller to send all these sensor readings to the monitoring system through which the sensor data is monitored and displayed. Also the sensor values are displayed on the LCD. This controller has the inbuilt LCD connections and hence we just need to connect the LCD module to the controller.

The language that is used for coding is Embedded C, C# or .NET. The Zigbee module works on UART principle. It has a set of transmit and receive pins through which serial communication can be established. Zigbee uses Transmitter pin of the Microcontroller to get the data from the sensors. The monitoring section has a Zigbee connected to a laptop with the help of USB to TTL module. The data is constantly monitored and displayed in Windows application.

IMPLEMENTATION

The system implementation of the health monitoring system has many phases of implementation that includes both hardware and software components listed in the previous chapter. All these components are made into one system using different protocols and system architectures to get a complete and successfully working health monitoring system. Following are the various implementation made in the project.

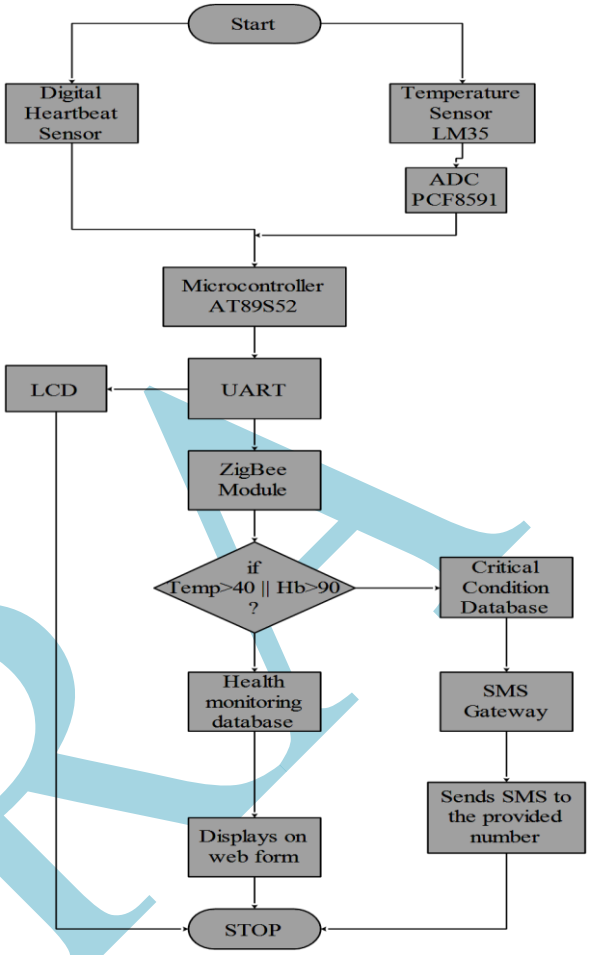

Figure 2: Complete Flow Chart

APPLICATIONS

- Architecture can be expanded to monitor other vital signs like Oxygen saturation or any other interested parameter.
- Can be used for monitoring an elderly or a disabled person.
- Can be used as the most effective way of getting immediate medical need during emergency health situations.

ADVANTAGES

- Reduces the need of caretakers.
- Cuts the cost of extra Health Care Services.
- Reduces the number of data transfer protocol.
- No wired connections required.
- Time saving, continuous and efficient monitoring.
- Cost efficient.

DISADVANTAGES

- If in case of any communication error, it's not possible to get the data.

CONCLUSION

The health monitoring system proposed in this paper is developed to provide much needed patient health history in the real time to the doctors. The primary need of our paper is to monitor the system using wireless sensor system with high accuracy and security. This health monitoring system is highly reliable, efficient and robust. It is a boon for elderly people and patients with critical diseases. The system is cost efficient so it is easily affordable.

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