

ZIGBEE Protocol Based Low Power Health Care Monitoring System

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Abstract— ZigBee based health care system was a health care monitoring system which mainly measures the physical conditions of the patient. It was based on an LR-WPAN ad-hoc network known as ZigBee". It was mainly utilized for the implementation of health care system with less cost and low Power usage. The key feature of this paper is that it less energy consumption, optimum bandwidth maintenance and appreciable compatible to the preexisting and newer technologies. This work is implemented in both hardware and software and it was compiled and simulated using MPLAB and Proteus simulation software.

Key words—Wireless Sensor Networks, Zigbee, MEMS Sensor, Temperature Sensor, Gas Sensor, Body Area Networks.

I. INTRODUCTION

Diversified disciplines started utilizing wireless technology since 20th century after realizing the features and functions that it can offer. One of the areas which were given incredible recognition in recent years was Health Care System. Awareness of the importance of health in recent times stimulated people to take care of their health and physical conditions regularly. Wearable technology became feasible and reliable way of achieving it. Wearable technology mainly involves using of sensors that are tied around body of the person which will keep a continuous monitoring of body parameters and it will be transmitted wirelessly to a remote care taker of that particular person and will be issue suggestions and precautions that suitably fit to the user. As far as the sensors that are suitable to the measurement are excessive power consumption sensors which was a fundamental constraint to implement any health care application. So, the only protocol which overcomes this constraint and implement in very economical way is Zigbee Protocol. It creates Body Area Personal Networks for the continuous regulation of the physical conditions of the user. It is capable of collecting medical data up to 20 meters .This protocol supports almost every network topology having even number of nodes reaching maximum of 60 million and utilizes 2.4 GHz frequency. One more predominant it possess is that it is capable of including any type of sensor node from any sort of vendor. The feature that mainly leads the Zigbee compared to previous protocols is Interoperability which means data from different sensors are gathered and made into a uniform level and can be interpreted there after by any other sensor. Our project provides a flexible and reliable parametric approach to monitor the health parameters.

II. RELATED WORK

One of the early works on Health Care System was proposed in [1]. This paper mainly deals with measuring the body parameters like body temperature, heart pulse rate, ECG signal and muscle power with enough accuracy. The proposed system was based on Zigbee which was less cost and low power. Coming to software implementation side of this project, it was done using LABVIEW software which was quite reconfigurable. It also enabled with storing of patient medical data for any sort of time. It was also enabled and

being made compatible for future enhancements like attaching diabetes and blood pressure measuring sensors.

This paper provides us the scope of successful completion of an e-based health care system with low cost and less power usage. It provides an efficient way for descriptive and predictive analysis.

Next relative work was performed in [2]. This paper was mainly focused on elderly patients who will be alone at households. It was given results with enough accuracy. The distinguished feature of this proposed system was using diversified sensors like Temperature sensor, force sensor, MEMS sensor and gas sensor etc. The developed system was robust, flexible, efficient monitor and regulatory of the elderly activities at the households with appreciable accuracy.

This paper enlightened us with involvement of hardware and software and compatible working of distinguished sensors from various vendors. This paper provides the way of intimating and getting back the responses from the care taker of the elder ones at home.

Similarly, another work which was relevant to the healthcare system was proposed in [3]. This paper primarily concentrated on infirm and impaired people. It creates the wireless sensor network of MicaZ motes fixed with pulse oximeter sensors and environmental sensors, namely temperature and light. It adapts three – tier and SNMP proxy network management organization model. The prominent characteristic of this project is usage of two proprietary network management tools to monitor personal health parameters and provide timely alerts when thresholds are arrived.

This publication was very a significant contribution to the implementation of the concept of Internet of things and inclusion of server for the transfer, storage and download of the medical data. This became crucial in deciding and framing way for the wireless and computer communication part of the project.

Another publication which inculcated the ways to implement the health care system was proposed in [4]. This paper was mainly centered on measuring the internal and

sensitive parameters like blood pressure and diabetes effectively. It was focused on hospitalized patients to handle the immediate urgencies and emergencies. It persistently measures the hereditary parameters and immediately intimates to the corresponding caretaker about the level of emergency, so that he will be treated accordingly.

These publication concepts made us familiar to the measuring of internal sensitive parameters with accuracy and exactness that need to be take care off.

III. ZIGBEE

ZigBee was an IEEE 802.15.4 based wireless communication protocol used to create a low power consumption personal area networks. ZigBee was operates in medical, scientific and industrial bands. It mainly supports star, tree and generic mesh networking. The network consists of mainly a coordinator to control and coordinates the other nodes on the network. It includes four additional key components: network layer, application layer, ZigBee Device objects and manufacturer – defined application objects which allow customization and favor total integration.

ZigBee protocol features include:

- Support for multiple network topologies such as point-to-point, point-to-multipoint and mesh networks.
- Low duty cycle – provides long battery life.
- Low latency
- Direct Sequence Spread Spectrum (DSSS).
- Up to 65,000 nodes per network.
- 128-bit AES encryption for secure data connections.
- Collision avoidance, retries and acknowledgements.

IV. SENSOR NODES

Sensors in the current project are Gas sensor, Temperature sensor, MEMS sensor since the parameters that need to measurement are measured perfectly by these sensors.

Gas Sensor: It was primarily utilized for the measurement of harmful or toxic content in the person inhalation. It was calibrated with the threshold values such that when there is an excessive level of any gas substance then it will raises an alarm warning the person and the care taker. It mainly has 3 connections, they are VCC ground and V out pin connected to 5V supply, ground and pin 6 in port A of microcontroller.

Temperature Sensor: This was mainly used for the measure of body temperature of the user. When he come into contact with the person it will automatically measures the body temperature and reflect the value of temperature in their LCD display. Similar to gas sensor, it also has 3 connections, they are VCC, ground and V out pin

connected to 5V supply, ground and pin 5 in port A of microcontroller.

MEMS Sensor: This was mainly used for the detection of epilepsy, convulsions, vibrations etc. Currently only one axis in the MEMS was kept enabled. When there is an abnormal change in the physical state of the user then it will raises an alarm warning the user and caretaker. It posses 5 connections, they are VCC, ground, Vout (X), Vout (Y) and Vout (Z).

PULSE SENSOR: This sensor was mainly used for the measure of pulse or heartbeat of the person. It will count the ticks of heart beat for a minute. If this was deviate from standard normal value then it will intimates the caretaker of the user about the anomaly of the pulse rate. It also posses similar connections like Gas sensor.

V. CONSTRUCTION AND WORKING

Initially, the project was implemented in hardware by assembling the PIC Microcontroller and other resistor and of diodes. The input A.C. voltage was step down to 5V by use of step down transformer and inputs of Port A was connected to the appropriate sensors. The outputs of these sensors will be digitized and fed to the microcontroller, and then microcontroller will process these raw inputs and drives the LCD display accordingly to reflect the readings and intimates the user and care taker about the health condition.

The processing of the raw inputs will be done by software program embedded into it. The program was written in Embedded C and it was compiled in MPLAB and then it was dumped into PIC microcontroller using PICKIT 2. So when the inputs from these sensors were arrived at the Port A, then it will automatically process these inputs as per the program. All the hardware material will be integrated on a single breadboard, such that the user will attach the breadboard with him for continuous monitoring or regulation.

As a precaution, first of all the code was tested on the Proteus simulator and then it was implemented in hardware. The most preeminent part of the project was transmitter and receiver module synch that transmitter module was implemented in a microchip intend with PCB. The data will be sent from the microcontroller to module through UART. It mainly works on the Zigbee protocol. It will be communicated with receiver module through Personal Area Network which was created by Zigbee protocol. The receiver module which was within the distance limit will be connected to a remote PC of the care taker of the user such when it receives the data from the transmitter then it will automatically store sit in server using the concept of Internet of Things. When the caretaker downloaded it from the server, he will decrypt the data then a proper analysis will be made. The caretaker will be responded with precautions and suggestions after a descriptive and predictive analysis. This was entire over view of the project in terms of its construction and

working. Additional software TightVNC was used to extend the application i.e. to make it suitable to handle the situations where the caretaker was far away from the user.

The following shows the block diagrams of transmitter and receiver and the hardware design structure using heartbeat sensors, MEMS, gas sensors, temperature sensors.

Transmitter Side:

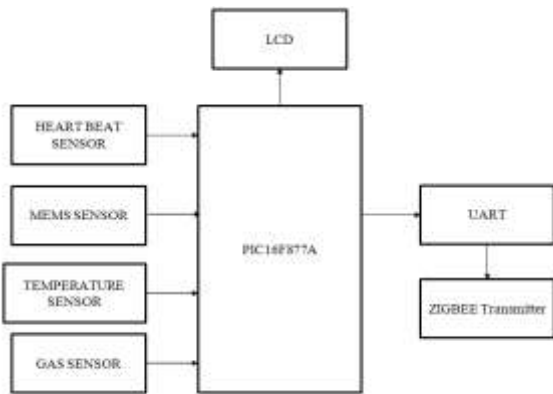


Figure 1: Transmitter Block Diagram

Receiver Side:

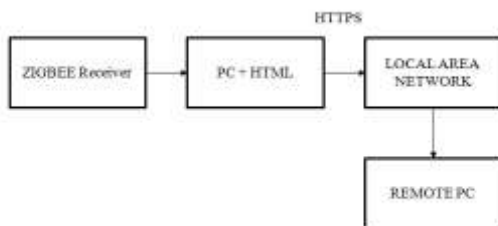


Figure 2: Receiver Block Diagram

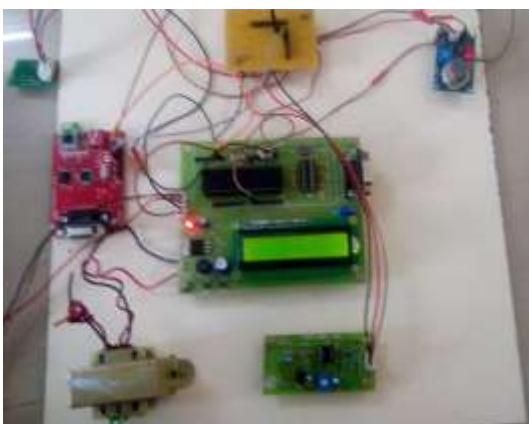


Figure 3: Hardware design

VI. RESULTS

The analog circuitry and the sensors temperature, gas, MEMS were assembled on the PCBs which were placed as shown in the figure. The prototype works well over a range of 30m without any obstructions. The output figure.4 shown below is the photocopy of values that are read on the pc through ZigBee protocol usage. We can also include a large number of sensors for flexibility. For USB programming the software on which it is done is PICKIT2 with the help of MPLAB code.

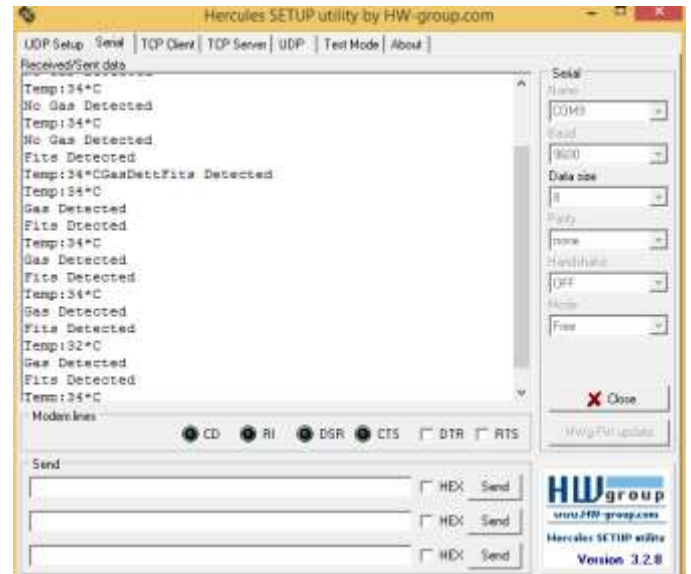


Figure 4: Hardware output readings on PC

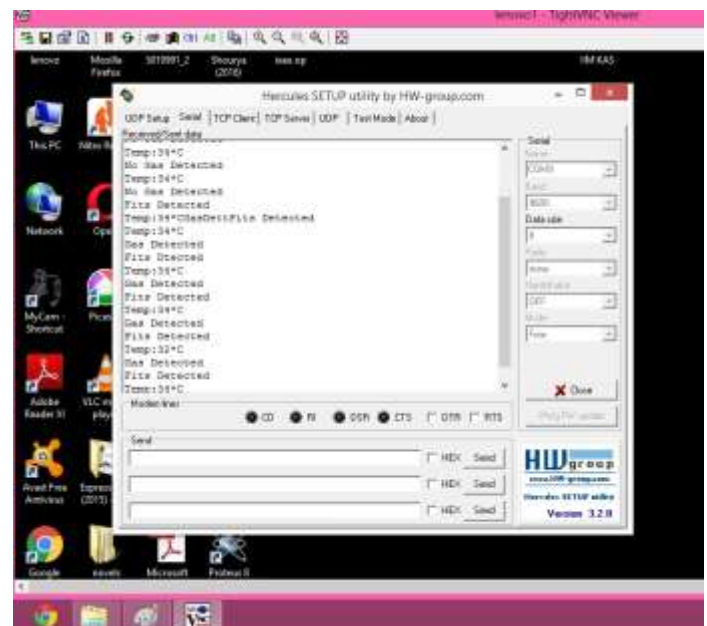


Figure 5: Hardware output readings on Remote PC

VII. CONCLUSION

Improving the quality of life for people with health care issues is one of essential one now a day. This paper discusses the implementation of a monitoring system targeting patients with typical health problems. The end system contains a module that collects the sensed data and transmits to a coordination

unit in our case it is personal computer /laptop. This is implemented using ZigBee network. The proposed system will monitor temperature, heartbeat, excess gas and fits if detected. The readings obtained from the ZigBee wireless network were compared against readings received from regular static devices. Since the proposed system is on ZigBee protocol, we can say that it is a low power and low cost system. In order to facilitate the patient doctor immediately if an abnormality is detected we transfer the data on to the doctor servers. The system can also be extended to add more sensors to the system if necessary since it is easily compatible.

VIII. FUTURE WORK

In future, this project can be taken to a next level of by implementing this health care system using ANT+ protocol. In previous era, wireless communication applications do not require high data rates generally. The pitfall of ZigBee was it can't be properly used for the applications in which there was a demand for high data rates. Besides that ANT+ protocol was better in battery life time comparatively ZigBee. Also ZigBee has a dominant constraint that it can't be extended more than 20 meters of distance from the PC. This application was not suitable for the applications to treat the people in rural areas especially nomadic people. ANT+ is best option in this regard and also ANT+ was more vibrant, robust, viable and

compatible with pre and post technologies than zigbee. Moreover, ANT+ protocol emerged as proprietary protocol especially for health care systems as it has advanced features even to measure the very sensitive and internal parameters like blood pressure, diabetes etc.

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