Health care and Smart Home for Elderly Care, Based on Wireless Sensor Network and Lab VIEW

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Abstract— **The population of elder people is growing rapidly and these days many of them have to stay alone, independently instead of old age homes. With increasing age, people tend to forget things which may create safety problems for them. In this paper, it is proposed to develop a Health care and Wireless Sensor Network based smart home system for such elder people to help them ease their work and provide them safe, sound and secure living. A Health care network is comprised mainly two sensors ECG sensor and pressure sensors are proposed to detect ECG detection, bed pressure detection respectively. A Wireless Sensor Network (WSN) is comprised of a large number of sensor nodes that are deployed in an unattended and remote environment to measure a few physiological parameters. The recent development in WSNs is the concept of Smart Homes. Smart homes integrate many devices that can sense the required parameters and control the characteristics of the home. The great progress in the industry standards and installation of lightweight wireless networking hardware over a period of time has proved ZigBee to be well suited for Smart homes and automation systems. ZigBee is a low cost, low power, less complex wireless standard. In this paper, sensors like temperature sensor, LPG sensor, Contact sensor, flow sensor, water level sensor, and motion sensor are proposed to be deployed for fire detection, gas leakage detection and determination of whether any door is closed or open, water flow detection, water level detection, movement detection, respectively. LabVIEW is used as a graphical user interface. In case of any emergency, a warning message will be generated, and played through a loudspeaker for the user to take notice of the same and an SMS will be sent to the caregiver using GSM modem to take preventive action.**

Index Terms— **ECG, GSM Modem, LabVIEW, Smart Home, Wireless Sensor Networks, ZigBee.**

I. INTRODUCTION

Nowadays, WSNs has become an attractive field for research as well as scientific and technological developments. WSNs are different from traditional wireless networks and hence, pose more challenges like limited energy, restricted life time, limited security, etc. with the benefit of easy installation, low maintenance, etc. Wireless Sensor Networks (WSNs) comprise of a large number of tiny devices equipped with one or more sensors, some processing circuits, and a wireless transceiver. Such devices are called sensor nodes or motes. These *sensor nodes* are densely deployed either inside the phenomenon to be sensed or very close to it. Pressure, humidity, light, flow, level, motion, heart beat and chemical activity are constantly reported by these motes which are deployed and left unattended in the field [1].

As age of people increase, they tend to forget basic things like switching off lights/fans, stop water pump. They may forget to switch off cylinder gas causing LPG gas leakage, or closing the doors leading to thefts in home. Also heart attack is main problem of elder people. Hence, we propose a Smart Home system for safety of such people.

In a Smart home [2], sensors are used for monitoring general parameters like temperature, humidity, LPG leakage, water flow, water level, motion of person, heartbeat of person etc. Thus, with the development of wireless network technology, we prefer low data rate, long battery life, less complex protocols, for such applications as an alternative to wasting bandwidth of high data rate protocols. Short distance wireless communication technologies mainly include Bluetooth, Wi-Fi, and ZigBee.

For the system proposed in this paper, to monitor various parameters defined in above section, ZigBee technology is employed. ZigBee is a worldwide open standard for wireless radio networks in the monitoring and control fields. The development of ZigBee technology was done by the IEEE 802.15.4 committee and ZigBee Alliance, to meet the following principal needs [3]: (1) low cost, (2) ultra-low power consumption, (3) use of unlicensed radio bands, (4) cheap and easy installation, (5) flexible and extendable networks.

The main objective of ZigBee is for battery-powered applications where lower data rate, lower cost, and longer battery life are the key requirements. The lower data rate of the ZigBee devices allows for better sensitivity and range, but of course offers fewer throughputs. In several ZigBee applications, the total time for which the wireless device is engaged in any type of activity is very limited; most of its time is spent by the device in a power-saving mode, also known as sleep mode. Hence, ZigBee enabled devices are able to operate for several years before their batteries are required to be replaced.

There are three frequency bands in the version of IEEE 802.15.4, which was released in September 2006 [4]: (1)868–868.6 MHz (868 MHz band) with data rate 20kbps used in Europe, (2) 902–928 MHz (915 MHz band) with data rate 40kbps used mainly in North America, (3) 2 400–2483.5 MHz (2.4 GHz band) with data rate 250kbps is used worldwide. There are two types of devices in an IEEE 802.15.4 wireless network [4], *full-function devices* (FFDs) and *reduced-function devices* (RFDs). An FFD is capable of performing all the duties described in the IEEE 802.15.4 standard and can accept any role in the network. An RFD, on the other hand, has limited capabilities. For example, an FFD can communicate with any other device in a network, but an RFD can talk only with an FFD device. RFD devices are intended for very simple applications such as turning on or off

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a switch. The processing power and memory size of RFD devices are normally less than those of FFD devices.

ZigBee network has three device types [3]:

(1) *ZigBee Coordinator:* It is the central or the top- most node in the network. The function of a coordinator is to select the frequency channel used by the network, start a network and allow devices to join the network.

2) *ZigBee End Device*: It is located at the extremities of the network. The main task of an End Device at the network level is to send and receive messages.

3) *ZigBee Router*: The main task of an r outer is to relay messages from one node to another and allow child nodes to connect to it.

In this paper, mesh topology [4] is employed for communication between devices wherein, each device can communicate directly with any other device by establishing a successful communication link.

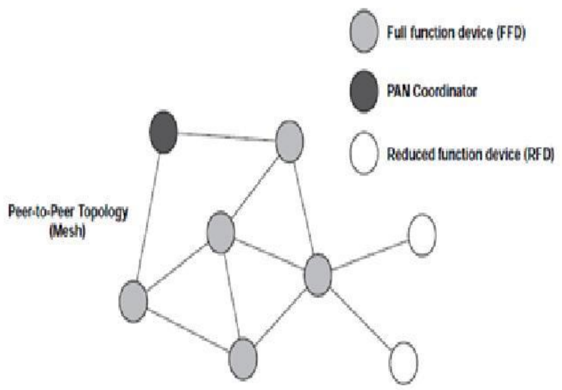

Fig. 1. ZigBee Mesh Topology [4].

In Section II, we present the complete system overview. The hardware details are mentioned in Section III and the software details are described in Section IV. The results and discussions are mentioned in Section V followed by future scope in Section VI and the conclusion in Section VII.

II. SYSTEM OVERVI EW

Figure 2 shows the functional block diagram of the sensor section that consists of a temperature sense or for sensing the temperature of the environment, LPG leakage sensor for sensing LPG concentration and Contact sensor to sense whether any door is left open. The sensors generate analog voltage which is fed to the ADC (Analog-to-Digital) inputs of the microcontroller. The digital value is then given to XBee

Module to transmit wirelessly. At the coordinator shown in Fig. 3, another XBee module receives the data and forwards it to a host computer where the data is processed in LabVIEW. LabVIEW displays the value received from each sensor. Each received value is compared t o a respective threshold. If the measured value is greater than the threshold, a warning alarm is played through a loudspeaker for user to take notice of the critical condition. Also, a warning SMS is sent to a caregiver via GSM modem to take preventive measures. The hardware blocks are explained in full details in the later section.

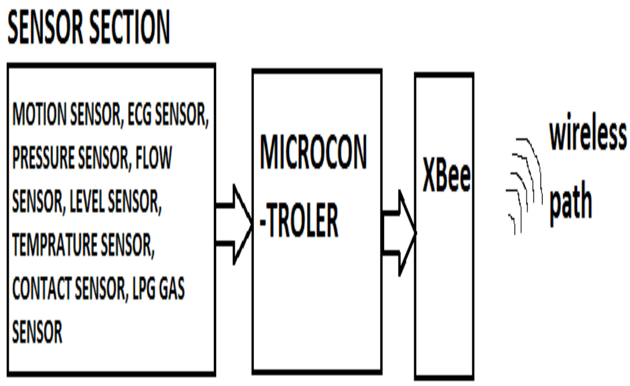

Fig. 2. Block Diagram of Sensor section.

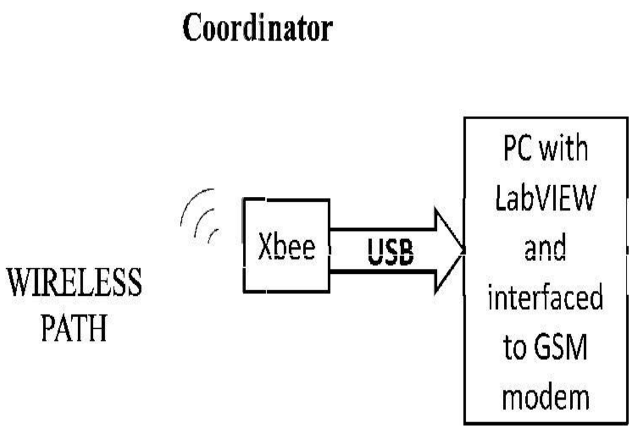

Fig. 3. Block Diagram of Coordinator.

III. HARDWA RE IMPLEMENTATION

The hardware components used for designing the prototype described in this paper are:

A. YF-S201 Water Flow Sensor

Measure liquid/water flow for your solar, water conservation systems, storage tanks, water recycling home applications, irrigation systems and much more. The sensors [13] are solidly constructed and provide a digital pulse each time an amount of water passes through the pipe. The output can easily be connected to a microcontroller for monitoring water usage and calculating the amount of water remaining in a tank etc.

B. LM35 Precision Centigrade Temperature Sensor

LM35 sensor [5] is an accurate integrated-circuit temperature sensor. The output voltage of LM35 is linearly proportional to the Celsius (Centigrade) temperature. External calibration need not be done for LM35. LM35 measures temperature within the range of -55^{o}C to +150^{o}C fire.

C. Magnetic contact switch

This magnetic contact switch or door sensor [7] is used to determine the door position. It is used to detect whether a door is open or closed.

D. ADS1291 ECG sensor

TheADS1291 [14], ADS1292, and ADS1292Rincorporate all features commonly required in portable, low-power medical electrocardiogram (ECG), sports, and fitness applications.

E. MQ-6 Gas Sensor

It is a simple gas sensor [6] which is highly sensitive to LPG, iso-butane and propane. The output of MQ-6 is an analog resistance. MQ-6 can detect LPG gas in concentration of 200-10000ppm.

F. FlexiForce pressure Sensors

This manual describes how to use FlexiForce Sensors [15]. These sensors are ideal for designers, researchers, or anyone who needs to measure forces without disturbing the dynamics
Of their tests. The FlexiForce sensors can be used to measure both static and dynamic forces (up to 1000 lbf.), and are thin enough to enable non-intrusive measurement.

G. PIR Motion Sensor

The objective of this project is to use inexpensive PIR sensor to detect if a human has moved. To build this project I use a microcontroller to detect if the sensor had change state and it will emit a sound from the speaker or piezo, the MCU also detect the voltage of the battery in the startup, the algorithm it´s very simple it use a interrupt on change to detect the change on the PIR sensor[16].

H. Water Level Indicator

The Water Level Indicator employs a simple mechanism to detect and indicate the water level in an overhead tank or any other water container. The sensing is done by using a set of nine probes [17].

I. Arduino MEGA 2560

The ATmega2560 AVR [8] comes with an entire set of program and system development tools including: macro assemblers, C compilers, in-circuit emulators, program debugger/simulators and evaluation kits. The ATmega2560 was chosen for the proposed design due its excellent interfacing capability with XBee modules. The important requirements for the proposed system li key internal 10-bit ADC, in-System Programmable Flash with Read -While-Write capabilities, an SPI serial port, and IE EE® std. 1149.1 compliant JTAG test interface for accessing the On-chip Debug system and programming are satisfied by the Arduino ATmega2560.

J. XBee Series 2 module

XBee [9] is a microcontroller made by Digi which uses the ZigBee protocol. The RF data rate given by this XBee module is 250kbps since it operates in IS M 2.4GHz band. There exists a simple connectivity between Arduino and XBee modules. Arduino TX directly connects to X Bee RX (Data in) while Arduino RX directly connects to XBee TX (Data out).

K. GSM SIM 300 modem

This GSM Modem [10] can recognize any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem is that you can use its RS232 port for communication. The modem can either be connected to PC serial port directly. It can be used to send and receive SMS or m ake/receive voice calls.

IV. Software Implementation

A. Arduino Programming

The Arduino environment [11] is an open-source. Thus, it is easier to write code and upload it to the I/O board. It runs on operating systems like Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing.

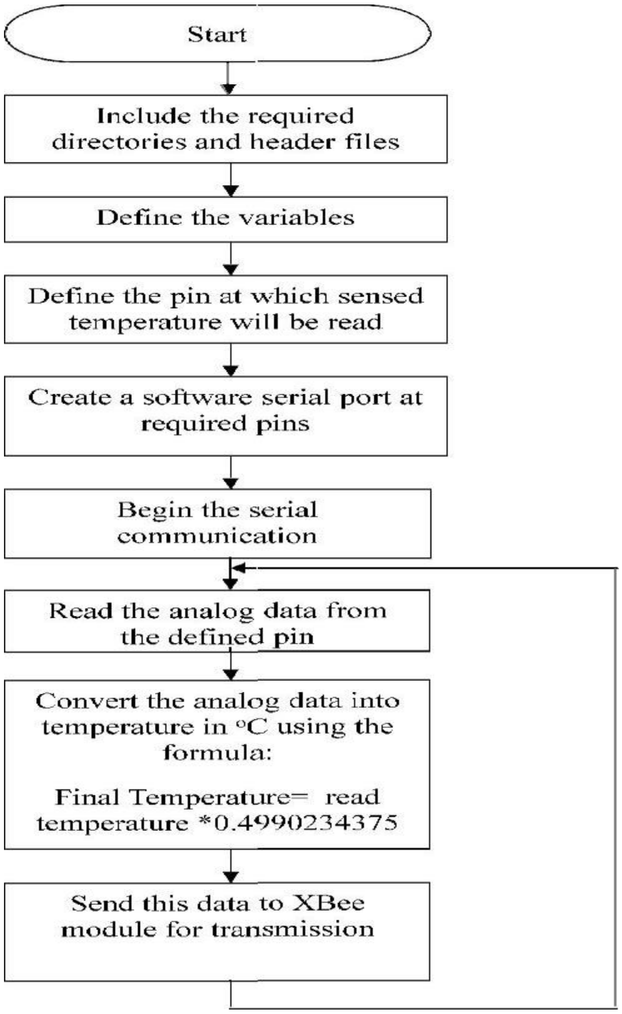

Fig. 4. Algorithm for programming Arduino ATmega256C.

B. LabVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a highly productive development environment for a visual programming language.

Test point, Measurement Studio, LabVIEW is most widely used due to advantages like parallel programming, code re-use, large available libraries, etc. The algorithm for data processing in LabVIEW is as follows:

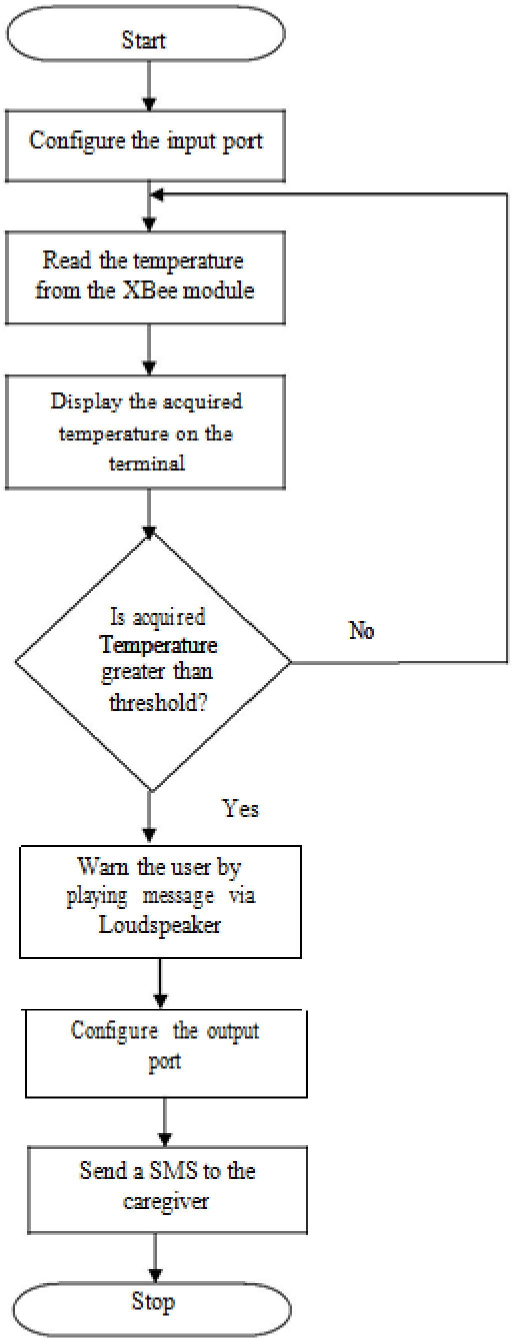

Fig 5. Algorithm for data processing in LabVIEW

IV. RESULTS AND DISCUSSIONS

The temperature monitoring section is implemented successfully. Figure 6 shows the configuration of both the XBee modules used.

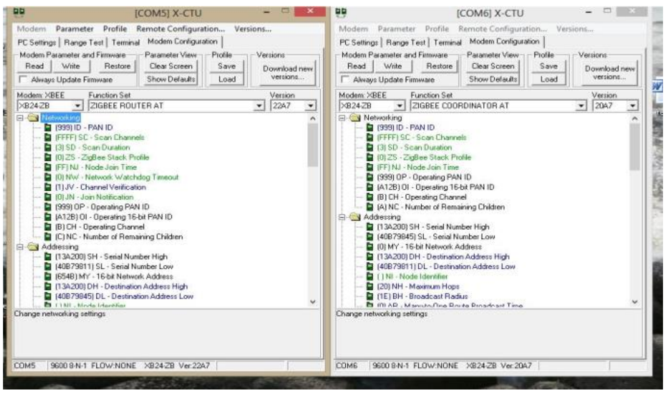

Fig. 6. Configuration of XBee modules in X-CTU.

Figure 7 shows the acquired temperature in the X-CTU terminal.

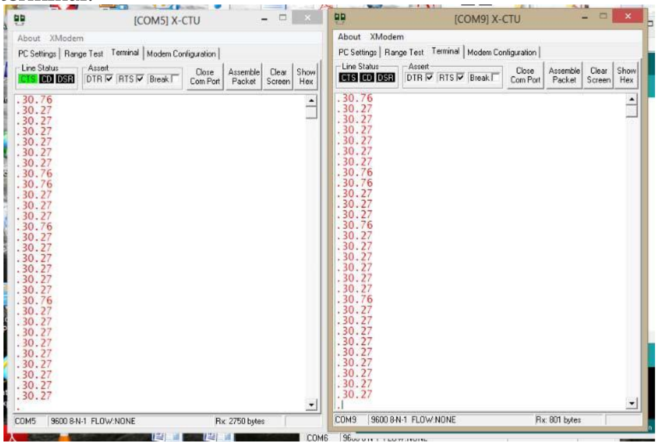

Fig. 7. Acquired temperature displayed in X-CTU.

Figure 8 is the user interface screen designed in LabVIEW. The input temperature from microcontroller is read and then compared with a threshold to take further action in case of the read temperature exceeds the set threshold

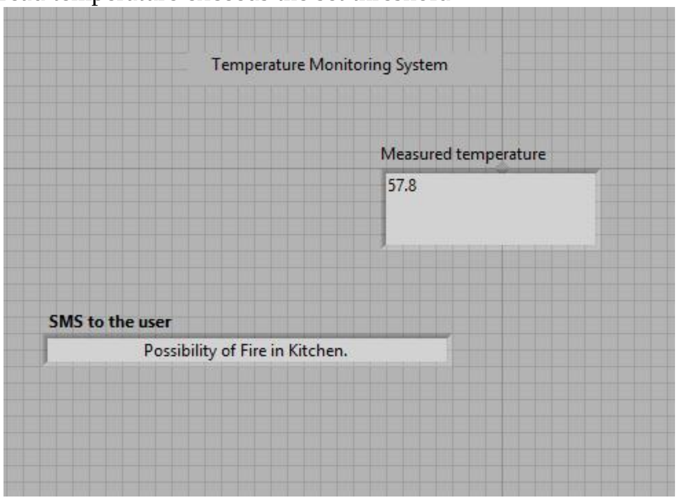

Fig. 8. LabVIEW user interface screen for warning the user in case of fire.

The water level monitoring section is implemented successfully. Figure 9 is the user interface screen designed in, LabVIEW.

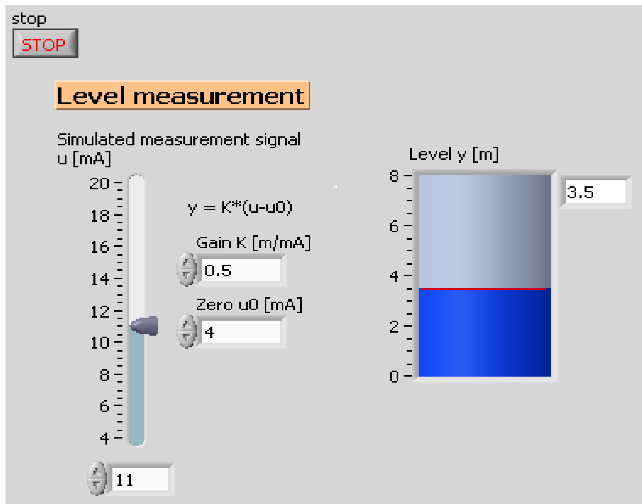

Fig9. LabVIEW user interface screen for warning the user in case of water level increases.

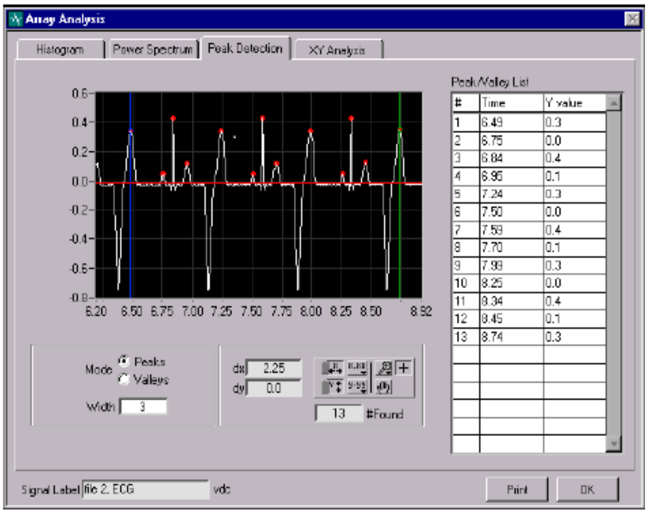

Fig10. LabVIEW user interface screen for monitoring ECG.

The ECG monitoring section is implemented successfully. Figure 10 is the user interface screen designed in, LabVIEW.

The motion detection system is implemented successfully. Figure 11 is the user interface screen designed in, LabVIEW.

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