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ZigBee and Bluetooth Network based Sensory Data Acquisition System  

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Abstract  

In this era of modernization, lots of systems have been introduced by which the human effort has been limited to a certain level. In this Paper a data acquisition system has been proposed for factories and industries or environment monitoring, which will measure the certain parameters like temperature, humidity, the level of gases present in atmosphere, motion of any person near the restricted areas at a time and transmit these parameters to the control room wirelessly as well as to the concerned person of the area by the latest smartphone/ tablets. Through the smartphone, the person can give command to the control room in case of any parameter crosses a certain level. The data is collected from sensor nodes to the control room node using ZigBee network and then retransmit the desired data to smart phones, tabs and PCs using Bluetooth network. Sensor node contains analog output sensors like temperature, gas and Digital output sensors like sound and metal. The LCD is used to display the sensor parameters. The RF modem is used to transmit the values to the control room node using star and mesh network topologies. The control room node contains ZigBee transceiver module to receive the information and Bluetooth modem to make available the desired data to the smart phones, tabs and PCs. The ZigBee and Bluetooth network are working at 9600 baud rate and 2.4GHz frequency in ISM band. The ZigBee nodes are capable to transmit the information upto 100 meteres and for long distance communication, multi-hopping is used. Bluetooth modem is capable to transmit the information upto 30 feet distance.  

Keywords: Bluetooth; Smart phone; wireless sensor network; ZigBee
1. Introduction

Papers on systems used for monitoring the environmental parameters for different purposes like disaster management, greenhouse monitoring, animal monitoring etc. have been studied and from the literature it can be inferred that ZigBee based monitoring systems are low cost, low power reliable systems and can be used for data collecting and monitoring. Further optimizing techniques are studied to find out the algorithm for data optimization. The wearable computing devices are the latest technology used for monitoring purposes in order to cater for the rural peasants who as end user need not be aware of the complexity of the computing devices.

From the literature available it is found that systems have been proposed which monitored the factory zone temperatures, humidity and air quality using smart phones and also the electric load. The system also detects the vibrations of operating machinery. For the intelligent monitoring ZigBee and Wi-Fi protocols are used. The integrated system is fabricated by 32 bit ARM core Arduino-Duo module. The Android APP and web-based platform are used to show measurement results. The system will transfer results to a specified cloud device using the TCP/IP protocol and Fast Fourier Transform (FFT) approach is used to analyse the power loads in the factory zones [1]. Michael Friedewald et al describes the technical, legal and social challenges that have to be addressed. Ubiquitous computing is considered as a technological path of innovation. The article concludes about efforts necessary to make ubiquitous computing applications economically sustainable and socially compatible in order to tap its full potential[2]. Kulkarni, R.V. et. al have narrated about Wireless sensor networks (WSNs) challenges, failures, and computational constraints [3]. Gyou-tae Park et. Al describes an intelligent gas safety management system to monitor the flow and pressure of gas, earthquake, temperature, smoke and leak of methane. The system communicates with a wall-pad including a gateway by zigbee network in buildings and report to server [4]. V.Vanitha et al narrates an extended service oriented architecture (ESOA) which provides customizable sensor network and manages application to overcome the limitation of sensing systems like robustness, complexity etc. The system is offering improvement in service oriented architecture of embedded systems[5]. Chengbo Yu et.al. narrates an environment monitoring system and discusses the reason of choosing ZigBee technology as communication module in Wireless Sensor Networks. The system uses CC2430 board and verifies the correctness and feasibility[6]. Peng Jiang et. al describes a water environmental monitoring system based on a wireless sensor network. The system consists of three parts: data monitoring nodes, database station and remote monitoring center. The system has accomplished the online auto-monitoring of the water temperature and pH value environment of an artificial lake [7]. Dr.S.S.Riaz Ahamed, et al has discussed about ZigBee IEEE 802.15.4 standard for data communications. It is concluded that ZigBee is low power, low cost, wireless mesh networking standard which provides network, security, and application support services[8]. Luis Ruiz-Garcia et al Paper shows study of the technical and scientific state of the art of wireless sensor technologies and standards for wireless communications in the Agri-Food sector. The paper focuses on Wireless Sensor network RFID including ZigBee module. Future trends of wireless communications in agriculture and food industry are also discussed [9]. Mitsugu Terada et al describes a ZigBee sensor network for data acquisition and monitoring . A ZigBee module is connected via a USB interface to a Microsoft Windows PC, which acts as a base station in the sensor network. Data collected by sensors are sent to the base station PC. The data are recorded in the hexadecimal number format by device control software [10].

In this Paper a data acquisition system is proposed for factories and industries or environment monitoring, which measures the certain parameters like temperature, humidity, the level of gases present in atmosphere, motion of any person near the restricted areas at a time and transmit these parameters to the control room wirelessly as well as to the concerned person of the area by the latest smartphone/ tablets/wearable device.

2. Hardware Development

The system comprises a transmitter section, a receiver section and a tablet/smartphone.

2.1 Transmitting/Receiving sections

Fig 1 shows block diagram of the transmitter section with power supply, temperature sensor, metal sensor, gas sensor, PIR sensor and sound sensor, which gives the measured data to the Arduino micro-controller and it transmits the data to the receiver section using ZigBee module. Fig 2 shows the block diagram of the receiver section. Arduino Mega micro-controller in the receiver section which, collects the data came from the transmitter section using ZigBee module and further transmit it to Bluetooth terminal of smart phone. Serial interface to PC is also
provided to collect the data from ARDUINO mega board, on PC screen using terminal v1.9.

Table 1 gives brief description of the modules which are used to develop hardware for the system.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Device/Module</th>
<th>Make/ Model no.</th>
<th>Specifications and working</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sound Sensor</td>
<td>Sunrom model no.1148 [11]</td>
<td>It detects sound at preset time duration and also has adjustable output time duration</td>
</tr>
<tr>
<td>2</td>
<td>Metal sensor</td>
<td>Sunrom model no. 1139 [11]</td>
<td>Detects metal objects upto the range of 7cm</td>
</tr>
<tr>
<td>3</td>
<td>Motion sensor</td>
<td>Sunrom model no. 1133 [11]</td>
<td>It is wireless module, having two way data communication availability. It operates on license free 2.4 GHz band. It can be interfaced in UART mode with controller.</td>
</tr>
<tr>
<td>5</td>
<td>Temperature</td>
<td>Sunrom model LM35, Calibrated directly in Celsius (Centigrade), Linear + 10.0</td>
<td></td>
</tr>
</tbody>
</table>
3. Software Development

Programming is done in Arduino 1.0.5 in ‘C’ language. The Arduino has been programmed to test the hardware as well to achieve the goal of WSN application, which involved the following steps-Coding/debugging, compiling, burning and evaluation. Blue Term is used to capture the real time data in smart phone via bluetooth. Blue Term is a free app for android and you can found it in the Google Play market. Terminal emulator for communicating with any serial device using a bluetooth serial adapter.

3.1 Simulation

Fig.3 shows Proteus simulation model for the system, as simulation is done before hardware implementation to check the feasibility.

4. Results and Discussions

The primary goal of this paper is to develop a wearable device for early warning in the restricted area, displaying various physical parameters like temperature, hazardous gases, sound, metal useful for agricultural farmer by wirelessly measuring them. The system is based on based on zigbee and Bluetooth wireless protocol.

Such a system has many advantages, especially when the restricted areas are to be kept intrusion free. It will also useful for farmers for getting all information about the environment in a single piece of device which is easily operable by anyone. This system is a reliable communication system without breakdown because of the use Personal Area Network. All the data can be read by the smart device without interruption and delay because of the efficient use of communication algorithm in the control node. Employing embedded technology, based on Arduino,
the Wireless Sensor Nodes are designed and implemented. One such node is shown below in fig 4 which is transmitting section for sending sensory data. The results show that the temperature and gas sensor data given by the sensor node is accurate. The data received from sound and metal sensors are also found to be accurate. The RF module Zigbee operated at 2.4GHz ISM band really help for secure data transmission.

![Fig 4 View of Transmitting section and Receiving section](image)

The fig 4 shows the receiving section. The temperature in degree centigrade and gas data in ppm is continuously observed on the monitor of the base station. Thus, the control room could get the temperature of different places and the presence/absence of hazardous gases in a particular area which could be useful to the farmer for having prior information about the environment thereby increasing the yield. The system works with great reliability. The data received from the sound and metal sensor also correspond to actual intrusion by unwanted objects.

The fig 5 shows the data logging of data’s received from the various sensors. This smart phone will receive data from the field through the central node. The smart phone will be available to the farmers for monitoring various environmental parameters. The farmers will also get the early warning signals if there is any unwanted intrusion in the agricultural field thereby securing the area against the harmful transpassing.

![Fig 5. Smart phone as data logger](image)
References


10. Mitsugu Terada “Application of ZigBee sensor network to data acquisition and Monitoring”, Measurement Science review, Volume, 2009