Zigbee Based Hazard Detecting Helmet

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Abstract. A Baneful gas detector, a volatile event indicator with several other features is developed, which is a smart helmet. Here, some of the life-threatening events are being overcome by using this helmet. Those hazardous events are impact of something heavy to the workers head, dangerous gas, and deportation of helmet. These events are identified by using accelerator for finding the impact, gas sensor for finding the harmful gas and Infrared Sensor for finding the removal of helmet. Once the environmental conditions are being checked by these sensors, the information is processed by the PIC micro-controller and is sent to the receiver node through the wireless sensor network. This wireless transmission is done by using Zigbee technology. The obtained data at the receiver node is then processed through the ARM processor for performing the alert process in both the receiver end and the transmitter end i.e., the user. The development of smart helmet presents the solutions to the issues faced.

Keywords—Gas detector, Event Indicator, PIC micro controller, Helmet, Infrared Sensor, ARM processor.

Introduction

The administrators ought to be aware of the jeopardy situation arising when the workers are under their supervision. Being aware always can be sometimes hard. The workers have safety measures made to protect them from hazard causing event. Even though they have the safety guards, if the gears are uncomfortable, they tend to remove them. In case of miners and construction site workers, they must have to work in warm conditions. Thus, the safety tools must be of small size, less in weight and comfortable for the workers. The safety helmets provided for the workers does not have any additional technology in order to know whether the co-worker has encountered some harmful bumps. The scope is to transmute the existing system of the safety helmet to be even safer by having an additional feature of GPRS module. The interrogation was to add features without changing its physical shape and adding any further weight to it. The objective is to improve the helmet by adding wit. When the worker removes his helmet, the user needs to be alerted. If the workers are hit by an object i.e., if an impact occurs, he may become unconscious. Also, the hazardous gases ought to be identified and the deportation of helmet must be identified. Thus, safety parts are used to exchange data to the receiver part. The working conditions creates noisy environment in industries. Though they tend to work in groups, they don’t watch each other frequently. An alerting system needs to be assimilated such that when one of the workers experience a hazardous act, which will warn the others who are within certain radius of 5 m. By using gas sensors, they are warned and immediate evacuations can be made. And by using other sensors like Infrared, Vibration and Temperature sensors, the other life-threatening events can be avoided.

Existing System

The monitoring systems which are used for coal mine are mostly cable network even now. If we want to expand this network, it will be a tedious process. Also, there are certain disadvantages in handling the cables, which are the wear and tear property, aging property of cables. If there any blind area for monitoring...
appears, there is need of installation and excess amount to be spent in maintenance. If there is any possibility of an accident, the cables and sensors connected through it will be fully damaged, which in turn creates a problem during the event detection and the rescue search. When we use wireless network technology, the above mentioned disadvantages will be dissolved. In specific, while using wireless technology, it has the solution to solve the key problems. Through the node network, the data will be collected to an embedded network controller and sends them to the personal computer and will also be displayed on the LCD. When the sensor reaches beyond their threshold level, Global System for Mobile Communication (GSM) modem will send the message to mobile. ZIGBEE is a wireless network technology, which can work in a very short range and low rate. The proposed system can be divided into management through monitoring layer, data collection at underground and a layer of transmission based on location. On the whole, it involves two sections, namely, underground section and ground section. The role of underground part is to collect the data on environment conditions like temperature and gas, and sent the collected information to the microcontroller. The microcontroller displays the information in the LCD and sends the required information through the transmitter of ZIGBEE. And, in the ground part, the information will be obtained by the ZIGBEE receiver and will be sent to GSM with the help of controller, also the required important information will be displayed on the LCD at Ground section.

Proposed System

In the existing system, the person’s location cannot be tracked during hazardous events. In the proposed system, each node has multiple sensors which are used for monitoring the surrounding environment if any abnormal condition occurs. It will automatically send the updated the information like GPS location and sensor data to all the nodes through the server in purpose to alert the central control for easy tracking and secure their life.

1. Block Diagram of Proposed System

In transmitting end, there are four types of sensors used, which are vibration sensor, IR sensor, gas sensor and temperature sensor. These sensors are respectively used for: checking the air quality, checking the unusual rise in temperature, detecting the impact of a heavy object and determining the deportation of helmet. They are then connected to the Zigbee module. As the PIC micro controller has self-reprogrammable software control, it is used in data processing unit of receiver end control station. The sensors used are respectively used for: checking the air quality, checking the unusual rise in temperature, detecting the impact of an heavy object and determining the deportation of helmet. These sensors are connected with the micro controller in order to process the data. This interfaced block is then connected to the LCD display to display the data such as temperature, vibration and gas; and also, it displays the data whether the helmet is close or open i.e., whether the helmet is worn or not. They are then connected to the
Zigbee module. In the receiving end the ARM7 processor is present which receives the data from the PIC micro-controller through zigbee in order to process the data. The LCD is used to display the respective warning message when the hazard is detected. GSM/GPRS module function is to track the location of the user when they face any of the hazards. The sensor network-based monitor system is implemented for monitoring the environmental value in work place. Two controllers are used for monitoring the sensor data and updated information is passed to all. The PIC micro controller is used for monitoring the environmental information like temperature, gas value in work place and information is passed to the zigbee and then to another zigbee in gate way. ARM micro controller is used for monitoring the message if any abnormal event occurs, the message is passed to server with GPS location of the user and alert all the employees. 20 ARM is used for data processing which is LPC 2141 micro controllers. It is used in case of data processing since it is known for its advantage of miniaturization and low power consumption. The LPC2141 microcontrollers can be connected with any number of protocols due to which it is connected to the LCD display, Zigbee module and GSM/GPRS module. It also has an advantage that there would be large buffer size and high processing power.

Figure 2. Block Diagram of Receiving End

2. Module Description

a) GPS/GPRS Module: A GSM/GPRS module assembles a GSM/GPRS modem with standard communication interfaces like RS-232 (Serial Port), USB etc., so that it can be easily interfaced with a computer or a microprocessor / microcontroller based system. The GPRS/GSM module is shown in figure 3.

Figure 3. GPS/GPRS Module

The power supply circuit required for the system will be built in the module that can be activated with the help of the respective adaptor. To establish communication between a computer and a GSM-GPRS system, the GSM/GPRS module can be used. The MODEM is the soul for such modules.
b) **Gas Sensor:** A gas detector is a piece of equipment that becomes aware of the occurrence of gases in the particular area, repeatedly as a part of protection method. This type of apparatus is used to identify a gas leak and made to be in-line with the managing of method.

![Gas Sensor](image)

**Figure 4. Gas Sensor**

So, with the help of this, the process can be completed. In current time period, the monitoring of gases produced is important. For the home appliances and protection method at manufacturing area, the supervising the gases are very decisive. So the gas sensors are very important part for such systems. The gases which are hazardous to the human like LPG, Alcohol, Propane, Hydrogen, CO and even methane can be detected through the MQ-2 type Gas sensor, when it goes beyond its limit. The resistance of sensor in 1000 parts per million in air (ppm) Hydrogen is the range of level of concentration of a gas. Even though the gas sensors are very small in size, they react spontaneously to the gas present in the environment, which helps in updating of the system information that involves the concentration of molecules at gaseous state.

c) **Temperature Sensor:** The temperature sensor used here is LM35, which is a precision IC temperature sensor that has its output directly proportional to the temperature.

![Temperature Sensor](image)

**Figure 5. Temperature sensor**

Compared to a thermistor, LM35 helps in measuring the temperature accurately. Also, it has certain advantages like low self heating. The range of operating temperature is -55°C to 150°C and the output voltage varies by 10mV.

d) **Piezoelectric Sensor:** The piezoelectric sensor is mostly used for the measurement of touch, vibration and shock measurement. The basic principle is that it experiences acceleration, whenever a structure moves.

![Piezoelectric Sensor](image)

**Figure 6. Piezoelectric Sensor**
This piezoelectric sensor can generate a charge when physically accelerated. The vibration and shock experienced by the sensor can reduce the life of any electronic and electromechanical system; so the mentioned properties can be used to reduce noise and vibration and also to modify the response of the system. Even after long term exposure to very small vibration, the delicate leads and bond wires can be stressed.

**e) IR Sensor:** The Infrared technology deal with a broad range of wireless applications, mainly in sensing control and distant control. In electromagnetic spectrum, the infrared waves are separated into three different regions. The wavelengths of the regions like near the infrared region, at the mid of infrared region and far from the infrared region are, 700 nm to 1400 nm for near infrared region which can be used in fiber optic applications, 1400 nm to 3000 nm for mid infrared region which can be used in heat sensing and 3000 nm to 1 mm for far infrared region which can be used in thermal imaging respectively.

![Figure 7. IR Sensor](image)

**f) PiezoBuzzer:** The Piezo buzzer generates resonance on the basis of the reverse effect on piezoelectric effect. The underlying concept is the production of pressure discrepancy or tension by the application of electric latent over a piezoelectric substrate. It is possible to use these buzzers to attentive a user to an incident equivalent to a switching operation, counter signal or sensor data. It produces a same piercing sound irrespective of the voltage dissimilarity functional to it. They push on one conductor and pull on the other when a voltage is applied through these crystals. This movement push and pull, results in a wave of sound. In the 2 to 4 kHz range, most buzzers generate sound.

![Figure 8. Piezo Buzzer](image)

### 3. Results and Discussion

The sensor network-based monitor system is implemented for monitoring the environmental value in work place. There are two ends here which are transmitting and receiving end, where two controllers are used for monitoring the sensor data and updated information is passed to all. The PIC micro controller is at the transmitting end and it is used for monitoring the environmental information like temperature, gas value, vibration level i.e., impact on helmet of the user in work place. These obtained datas from the sensors are processed using the PIC micro controller and information is passed to the Zigbee. This data transmission is done with the help of the serial port connecting the Zigbee with the micro controller interfacing.
The receiving end has ARM micro controller and it is used for monitoring the message if any abnormal event occurs, the message is received. Here, it contains datas like vibration, temperature and gas level and it is keeps on updating with respect to the information received from the transmitting end. This updated data can be viewed in LCD display and also the information is updated in the web server. This dual data transmission is done with the help of the serial port connecting both the LCD display and the GSM/GPRS module. When the user suffers any hazard, inorder to identify the position the node of the zigbee is used to track the user. Thus, the affected worker can be saved as soon as possible.

The Infrared sensor is used to detect the deportation of helmet. It displays the message of “Helmet close”, when there is interruption in the signal transmission of infrared signals. When there is continuous transmission of Infrared signal, then in LCD display, there is display of “Helmet Open”. When there is no abnormal change in the surrounding, then the data is displayed. When there is abnormal change in the surrounding in case of gas, then there would be change in the data displayed by updating the data with the help of PIC. This in turn alerts the system and the buzzer is on.

![Figure.9 Off State Transmitting End](image1.png)

![Figure.10 Off State Receiving End](image2.png)

![Figure.11 On State Transmitting End](image3.png)

![Figure.12 On state Receiving End](image4.png)

![Figure.13 Display of message regarding use of helmet](image5.png)

![Figure.14 Display of message regarding deportation of helmet](image6.png)
4. Cost Estimation of Proposed System

| COMPONENTS     | QUANTITY | RATE(Rs) |
|----------------|----------|----------|
| Zigbee Module  | 2        | 2000     |
| GPRS Module    | 1        | 1750     |
| PIC 16F877A    | 1        | 270      |
| ARM            | 1        | 1250     |
| Buzzer         | 2        | 30       |
| LCD Display    | 2        | 150      |
| Gas Sensor     | 1        | 400      |
| IR Sensor      | 1        | 140      |
| Vibration Sensor | 1    | 20       |
| Temperature Sensor | 1 | 60     |
| USB            | 1        | 250      |
| **Total(Rs)**  |          | **6350** |

Conclusion

In the proposed system, we present a system with a lesser cost and efficient system than the existing system for a wireless monitoring system. It consists of different modules which includes the modules for communication, network processing and interfacing of wireless transducer. The purpose of choosing wireless network over wired is that wireless is more flexible and we can stay away from the problem which occurs due to wiring. Also, we can stabilize the sensor networks. The proposed system can be improved further by adding devices to measure the Blood pressure and Heart rate of the user. The type of gas exposed and the concentration of gas can be determined in the future. In the proposed system, only the Supervisor will be able to know the location of each user. In future, we can make the user to know the location of the workers/users relative to his location.

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