Smart Helmet Using Zigbee

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***Abstract*- In recent days coal mining has been a very dangerous activity that can result in a number of adverse effects on the environment for example during mining operations methane, a known greenhouse gas, may be released into the air. Underground mining hazards include suffocation, gas poisoning, roof collapse and gas explosions. Keeping all these aspects in mind we designed a system, i.e. smart helmet using ZigBee technology for monitoring the hazardous gases, abnormal temperature conditions and the humidity levels in the air. The improved safety features in our system will dramatically increase life expectancy of the coal miners by alerting them about the hazards.**

***Index terms*- Zigbee, Smart Helmet, WSN, Embedded**

I.INTRODUCTION

Led type helmets are usually powered by three or four AA or AAA batteries. Systems with heavy batteries (4xAA or more) are usually designed so that the light emitter is positioned near the front of the head, with the battery compartment at the rear of the head. The headlamp is strapped to the head or helmet with an elasticized strap. It is sometimes possible to completely disconnect a headlamp's battery pack, for storage on a belt or in a pocket. Lighter headlamp systems are strapped to the user's head by a single band; heavier ones utilize an additional band over the top of the user's head. White LEDs were quickly adopted for use in headlamps due to their smaller size, lower power consumption and improved durability compared with incandescent bulbs. Power LEDs rated 1 watt or more have displaced incandescent bulbs in many models of headlamps. To avoid damage to electronic parts, a heatsink is usually required for headlamps that use LEDs that dissipate more than 1W. To regulate power fed to the LEDs, DC-DC converters are often used in 1W+ lights, sometimes controlled by microprocessors. This allows the LED to provide brightness that is not affected by a drop in battery voltage, and allows selectable levels of output. Following the introduction of LEDs for headlamps, sometimes combinations of LED and halogen lamps were used, allowing the user to select between the types for various tasks

II. DISCUSSIONS

A. Problem Statement

To develop a Smart Helmet which has the following features:

1. A DHT sensor which is capable of sensing the humidity and temperature within the mine.
2. Atmospheric pressure sensor that is capable of sensing the pressure inside the mine.
3. IR sensor to detect the risk of falling rocks.
4. Oximeter to detect the oxygen levels.
5. A gas sensor that detects the harmful gases inside the mine.
6. The system should be Zigbee compatible and Arduino powered.
7. It should send notifications to the supervisor monitoring outside the mine.
8. The supervisor should be able to alert the mine worker too.

B. Literature Review

C. J. Behr, A. Kumar and G.P. Hancke, "A Smart Helmet for Air Quality and Hazardous Event Detection for the Mining Industry", IEEE 2016.

A smart mining helmet was developed that is able to detect three types of hazardous events such as danger level of hazardous gases, miner helmet removing, and collision or impact (miners are struck by an object). The hazardous events were classified as a miner removing the mining helmet off their head. An off-the-shelf IR sensor was then used to successfully determine when the helmet is on the miner's head.

Ge Bin, LI Huizong, "The Research on ZigBee-Based Mine Safety Monitoring System", 2011 IEEE.

C. Proposed Methodology

This project includes various sensors which would detect various risks for workers working in a mine. The project uses ZigBee for long range reliable communication. The project uses an Oximeter for pulse rate detection as well as oxygen level detection. It uses an IR sensor for detecting falling rocks. The device uses Gas sensors for detecting level of toxic gases inside the mine. It also uses an Atmospheric Pressure sensor for detecting increase or decrease in atmospheric pressure which can result in risks for the mine worker. Temperature and humidity sensors are also used. ZigBee boards are used at both end – Mine worker's helmet as well as Supervising Unit. Alerts at both ends are given using buzzer and LED indications.

III. OVERVIEW OF ALGORITHM (MATHEMATICAL MODEL)

Inputs: hum, temp, pres, ir, oxi, mq135
Output: ahum, atemp, apress, air, aoxi, amq135, aled, abuzz
Notations:
hum = Humidity sensor value
temp = Temperature sensor value
pres = Pressure sensor value
ir = IR sensor value
oxi = Oximeter value
mq135 = Gas sensor
ahum = Alert from Humidity sensor
atemp = Alert from Temperature sensor
apres = Alert from Pressure sensor
air = Alert from IR sensor
aoxi = Alert from Oximeter
amq135 = Alert from Gas sensor
aled = Alert through LED
abuzz = Alert through Buzzer

Algorithm:
if (hum<50) then set ahum == HIGH
else set ahum == LOW
if (temp>45) then set atemp == HIGH
else set atemp == LOW
if (pres>thres) then set apres == HIGH
else set apres == LOW
if (ir=0) then set air == HIGH
else set air == LOW
if (oxi<thres) then set aoxi == HIGH
else set aoxi == LOW
if (mq135>thres) then set amq135 == HIGH
else set amq135 == LOW
if (ahum == HIGH || atemp == HIGH || apres == HIGH || air == HIGH || aoxi == HIGH || amq135 == HIGH) then set aled == HIGH && abuzz == HIGH
else set aled == LOW && abuzz == LOW

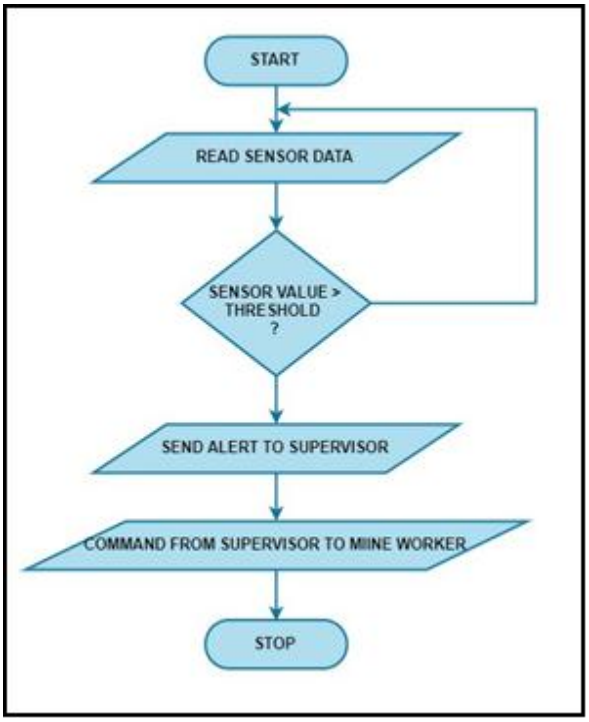
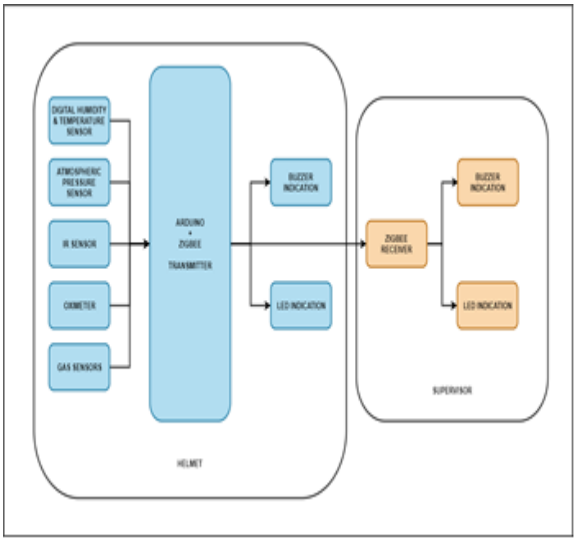


Figure: Flowchart of the System

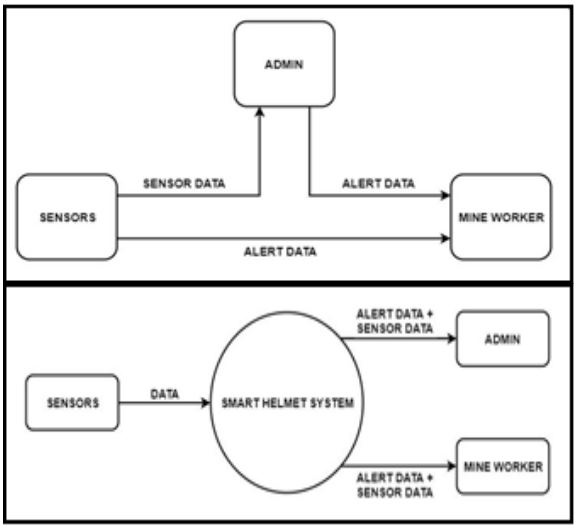
IV. SYSTEM ARCHITECTURE



V. DIAGRAMS USED IN SYSTEM

A. High Level Design

B. Data Flow Diagram



C. Class Diagram

VI. HARDWARE USED

A. Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27).

B. Zigbee S2C Modules

Digi international has recently introduced the new zigbee s2c module. the previous s2 & the traditional s1 both are discontinued. the new module is powerful with both uart & spi communication. Operating frequency band is the industrial, scientific and medical (ism) radio band.

C. Zigbee Explorer Board

This is a simple to use, USB to serial base unit for the Digi XBee line. This unit works with all XBee

modules including the Series 1 and Series 2.5, standard and Pro version.
Plug the unit into the XBee Explorer, attach a mini USB cable, and you will have direct access to the serial and programming pins on the XBee unit.

D. BMP180 Atmospheric Pressure Sensor

This precision sensor from Bosch is the best low-cost sensing solution for measuring barometric pressure and temperature. Because pressure changes with altitude you can also use it as an altimeter! The sensor is soldered onto a PCB with a 3.3V regulator, I2C level shifter and pull-up resistors on the I2C pins. The BMP180 is the next-generation of sensors from Bosch, and replaces the BMP085. The good news is that it is completely identical to the BMP085 in terms of firmware/software - you can use our BMP085 tutorial and any example code/libraries as a drop-in replacement. The XCLR pin is not physically present on the BMP180 so if you need to know that data is ready you will need to query the I2C bus.

VII. SOFTWARE USED IN SYSTEM

A. ARDUINO IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board. The source code for the IDE is released under the GNU General Public License, version. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

B. PYTHON GUI

The graphical user interface, is a type of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation. GUIs were introduced in reaction to the perceived steep learning curve of command-line interfaces (CLIs), which require commands to be typed on a computer keyboard. The actions in a GUI are usually performed through direct manipulation of the graphical elements. Beyond computers, GUIs are used in many handheld mobile devices such as MP3 players, portable media players, gaming devices, smartphones and smaller household, office and industrial controls. Designing the visual composition

and temporal behaviour of a GUI is an important part of software application programming in the area of human–computer interaction. Its goal is to enhance the efficiency and ease of use for the underlying logical design of a stored program, a design discipline named usability. Methods of user-centred design are used to ensure that the visual language introduced in the design is well-tailored to the tasks.

VIII. SYSTEM CONTRAINTS

A. Advantages

1. If the risks are determined in early stages one can take immediate actions to avoid accidents.
2. Since it uses ZigBee for communication there is no problem of low range.
3. It secures lives of Mine workers.
4. Zigbee has longer range.
5. It is not much sensitive to the environmental changes and weather conditions.
6. Low power consumption & can be remotely controlled.

B. Disadvantages

1. It requires knowledge of the system for the owner to operate Zigbee compliant devices.
2. It is not as secure as WiFi system.
3. Replacement cost will be high when any problem occurs in Zigbee compliant home appliances.

C. Applications

ZigBee protocols are intended for embedded applications requiring low data rates and low power consumption.

Typical application areas include:

1. Wireless sensor networks
2. Industrial control
3. Embedded sensing

IX. CONCLUSION AND FUTURE SCOPE

A. Conclusion

As the system requirement and the required components can be easily made available this project can be implemented easily. It will provide the safety to coal miners and change the way of their working as well as system controlling the various environmental changes in mines. It has been presented the original design of the low power Zigbee sensor system with an extremely reduced cost. It is reliable system with quick and easy installation. The system might be easily extended. It will improve system scalability and extend accurate position of underground miners in future.

B. Future Scope

1. The helmet can be made light weight by making use of fabricated SMD components in a small size PCB.
2. We can provide SMS alerts along with the led and buzzer indication.

REFERENCES

[1] E.K. Stanek,"Mine electotecnology Research: The past 17 years", IEEE transactions on industry applications, vol. 24, no.5, 1988,

[2] S.Wei, L.Lili, " Multipara meter monitoring system for coal mine based on Wireless sensor Network technology", proc. international IEEE conference on industrial mechatronics and automation, 2009, pp 225-27.

[3] S.Jin-ling, G.Heng-wei, S.Yu-jun, " Research on Transceiver System of WSN Based on VMIMO Underground Coal Mines", Proc. International Conference on Communication and Mobile Computing, 2010, pp 374-378

[4] N.Chaamwe, W.Liu, H.Jiang, "Seismic Monitoring in Underground Mines: A case of Mufulira Mine in Zambia Using wireless Sensor Networks for Seismic Monitoring", Proc. IEEE international Conference on Electronics and Information Engineering, Vol. V1, 2010, pp 310-14.

[5] X.Ma, Y.Miao, Z.Zhao, H/Zhang, J.Zhang, "A novel approach to Coal and Gas Output Prediction Based on Multi-sensor Information Fusion", Proc. IEEE international conference on automation and logistics, 2008, pp,1613-18.

[6] D.Egan, "The Emergence of ZigBee in building automation and industrial controls", J.IEE Computing & Control Engineering, Vol.16, No.2, pp.14-19,2005.