Rescue Robot in Coal Mines

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Abstract

Coal mine is a hazardous place in which numerous lethal variables are risky for human life, particularly when impacts happen. Rescue team typically doesn't have a clue about the real circumstance of the mine passage. Accordingly, it might be exceptionally risky for rescuers to go into mine passages to inquiry survivors without distinguishing ecological data previously. To tackle this issue, robot is created for helping individuals to do the rescue work. The robot is used for detecting the explosion environment of coal mine. We developed a prototype of a fully autonomous robot which can be used to indicate presence of harmful gases inside a mine for mine rescue operations in case of emergencies caused by natural calamities such as explosion. Coal mine rescue robot is a sort of portable robot. It can go into blast environment and discover gas content.

Keywords: Coal Mine, Hazardous, Rescue

I. INTRODUCTION

A coal mine is an underground tunnel system. There only a few pitheads on ground. If there are some accidents, people are easily trapped in tunnel and often cannot escape from it. It has dangerous accidents as collapse, gas explosion, CO, CO2 poison gas, low O2 content, high temperature, smoke, coal dust, fire, water, etc. All these accidents can kill people easily.

CH4 gas is intergrown with coal. When coal is mined, CH4 gas is released. Gas is pushed off by forced ventilating system. But if the ventilating system is faulty or gas is leaked from coal layer, gas diffuses throughout the tunnel. A flame current can cause a heavy gas explosion. Mine tunnel passageway is narrow, so the explosion wave can destroy any thing in the tunnel. All devices and people may be affected, and the gas of CH4, CO, CO2 and coal dust are filled in the tunnel, and the environment of the tunnel comprises of low O2 content and high temperature. Besides, the forced ventilate system has been damaged, the gases cannot be pushed out and gets accumulated in tunnel. A fire may cause a second explosion. People in tunnel could be poisoned by CO, stifled by CO2 and low O2 content, high temperature and coal dust. Rescuers on ground cannot go into mine tunnel because situation is not known and they may be killed by second explosion. So, detection of mine tunnel situation is the first mission. A Robot is an ideal tool in coal mine disaster. The robot used in coal mine tunnel must have many special characteristics which are different from other robots on ground.

Coal mine tunnel is a special environment. The first problem is explosion gas is everywhere in tunnel. Any fire can cause an explosion. Robot must be designed as a flame-proof device to avoid malfunction of components. The second problem is the mine have narrow tunnel and rugged. The middle of the tunnel is railway. One side of the railway is belt transmission. The other side is a narrow road on coal. The mine passageway is filled with many obstacles and rugged coal road, so it is difficult to move inside the mine tunnel. But various obstacles must be crossed. Communication is another difficult problem in mine tunnel because electromagnetic wave is absorbed and echoed in a coal tube. Because of many corners in the tunnel, Wave cannot cross these corners easily.

II. PROBLEM STATEMENT

The mobile robot is designed so that it can run in explosive environment, climb over uneven surface areas, check gas contents and perform live surveillance using a camera.

For communication, Bluetooth would work only to a specified area and the robot couldn't be controlled beyond the signal region. This lead to the usage of wide wireless communication technologies like RF transceiver. RF transceiver has much better range compared to Blue Tooth and it can transmit the data or commands and receive data from long distance from the mine.
Once the communication and sensing of robot is finalized the focus is shifted on how to make it more reliable. The idea of camera on the robot helps in getting live feed of what is happening inside the tunnel and it will help the rescue team to follow the less dangerous path and the way for rescuers get in to the mine.

III. LITERATURE REVIEW

Flooding, subsidence, roof collapse and explosions are the common causes for accidents leading to death and injury of many miners. A large number of abandoned underground mines pose a serious threat to the efficient operation of mines. A few past accidents in India as well as the whole world reveal that this area requires serious attention.

On September 27, 1995, 74 miners were killed in four different accidents in four collieries in Dhanbad mines (India). The Chasnala Mine Disaster of Indian Iron and Steel Company Limited in the 1975 was perhaps the most gruesome tragedy of this kind killing 375 miners. The average death toll per year from 1953 to 2003 in India is 12.74 whereas that for the entire world is 119.88. The new kenda coal mine disaster on January 25 in 1994 in Bihar killed 65 people. The miners waited long for help but ended up after a painful death as the coal mine turned into a gas chamber filled with carbon monoxide. The explosion which occurred on May 28 in 1965 at Dhanbad coal mine was so fierce that killed 268miners. The mine was privately owned by Raja of Ramgarh. The incident is also known as Dhori Colliery Disaster.

This shows that in spite of the introduction of advanced technologies death tolls are not substantially reduced globally. It is reasonable to conclude that many of such deaths could be minimized. This may lead for developing "Node Technology" which can be deployed within shortest possible notice to gather most recent information of the site and organized a rescue operation immediately.

IV. METHODOLOGY

The rescue robot is sent inside the mine to detect the internal environmental conditions and it also tracks the proper path by avoiding the collisions with obstacles on its way. To achieve these things, mine monitoring robot is equipped with different sensors along with signal conditioning circuits and microprocessor as main building blocks of our system.

The Microcontrollers are the main parts of proposed system followed by the RF module. The microcontrollers contain processing power, memory and Input Output ports for interacting with different connected devices. In this system decides the sequence of output signal. Gas Sensors will be used to detect harmful Gases and notify microcontroller about the level of such gases in the surrounding atmosphere. As the outputs of sensors are not compatible to the microcontroller, we have to provide proper signal conditioning to make it compatible with microcontroller. Proximity Sensor senses the obstacles present in the path of mine rescuer systems and hence helps in selecting proper path avoiding collision.

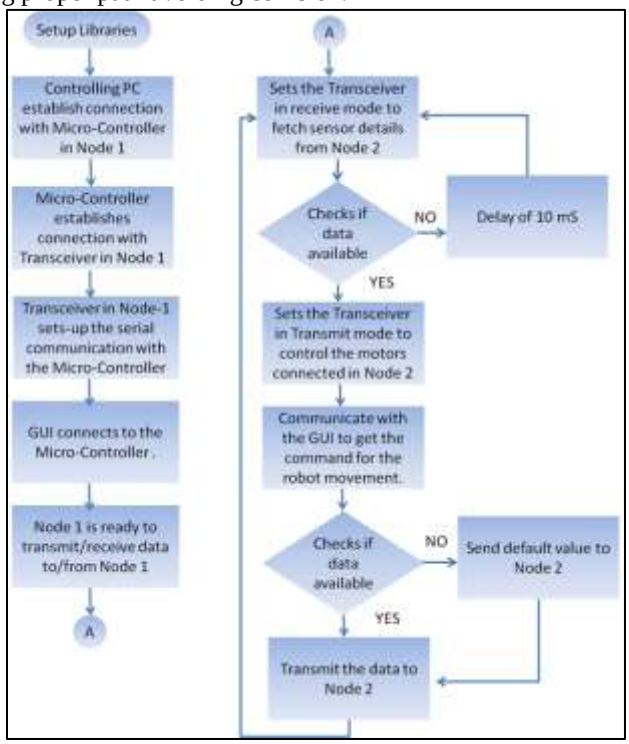

Fig. 1: Flow Chart of Wireless Communication between RF Transceivers and Microcontroller

Serial Communication is used to transfer the data from the microcontroller to the PC so that it can be analyzed properly and suitable actions are taken accordingly. The microcontroller receives the signals from sensors and processes this data. This data can be transferred to a PC outside the mine via serial communication. Then this data can be displayed on a PC screen and can be observed by the rescue persons. From this received information from the robot the rescue persons can take the required action.

Today, RS232 is the most widely used serial I/O interfacing standard. This standard is used on PCs and numerous types of equipment. Here the PC is connected to one transceiver module via comport. This module can transfer and receive information to and from the other transceiver module via serial peripheral interface protocol. Different types of sensors are then interfaced to the second transceiver.

V. SENSOR UNIT

A sensor (also called detector) is a converter whch can measures a physical quantity and converts it into a Signal which can be read by an instrument or observer. Sensors used in this project are CH4, Te32mperature Sensor, CO and Ultrasonic sensors for which MQ-4, LM35, MQ-7, HC-SR04 sensors are used respectively. Sensor MQ-4 can detect the gas concentrations in many conditions from 200 to 10000ppm. The LM 35 has a range of 0-110 degree Celsius. The HC-SR04 sensor is used to detect the obstacles in front of the robot within range 3m from it. The sensors module is designed by using the electronic software Proteus ISIS and soldering of the sensors in to the printed circuit board is done. The values read by the sensors are transmitted to a PIC wherein it compares the measured value with that of the set points and if the measured value goes above the set points, Rescuer will be made aware of it by the window saying ”CH4 level has exceeded ”. It helps in having good knowledge about the environment. By using wireless video camera we can track the information about inside the tunnel.

VI. MICROCONTROLLER UNIT

The Arduino Mega 2560 is a microcontroller based on the ATmega 2560. It has 54 digital input/output pins of which 15 can be used as PWM outputs, 16 analog inputs, 4 UART hardware serial ports, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started. The mega is compatible with most shields designed for arduino Deumilanove or Diecimila

VII. RF MODULE

The 433MHz UART RS232 module is low cost, high performance transparent FSK transceiver with operating at 433/470/868/915 MHz. It features small size, high output power, high sensitivity, long transmission distance and high communication data rate with auto set up for communication change and data receiving and transmission control. There is UART interface, it is easy to realize the wireless data transmission with only providing the UART data. It is flexible for the users to set the UART baud rate, frequency, output power, data rate, frequency deviation, receiving bandwidth etc parameters. It is your ideal choice for designing wireless data transmission products which can be widely used on wireless data transmission field. It has a baud rate of 1.2kbps to 115.2kbps.

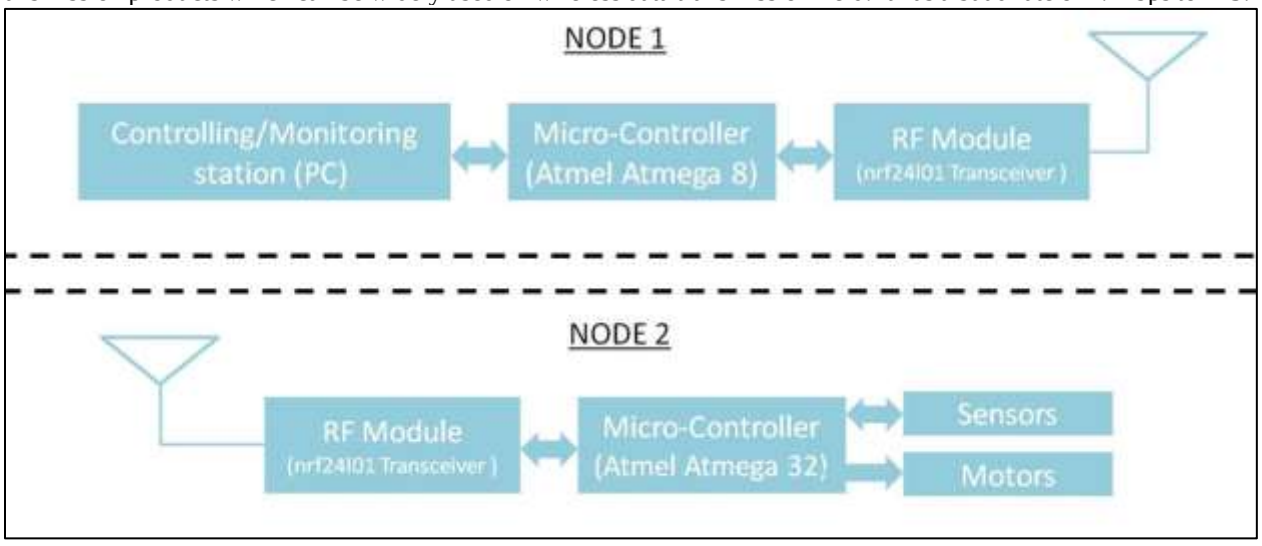

Fig. 2: Block Diagram of Wireless Communication

VIII. GRAPHICAL USER INTERFACE

The graphical user interface (GUI), 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.

Visual Basic is a third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its Component Object Model (COM) programming model. Visual Basic was derived from BASIC, a user-friendly programming language designed for beginners, and it enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects. A programmer can create an application using the components provided by the Visual Basic program itself.

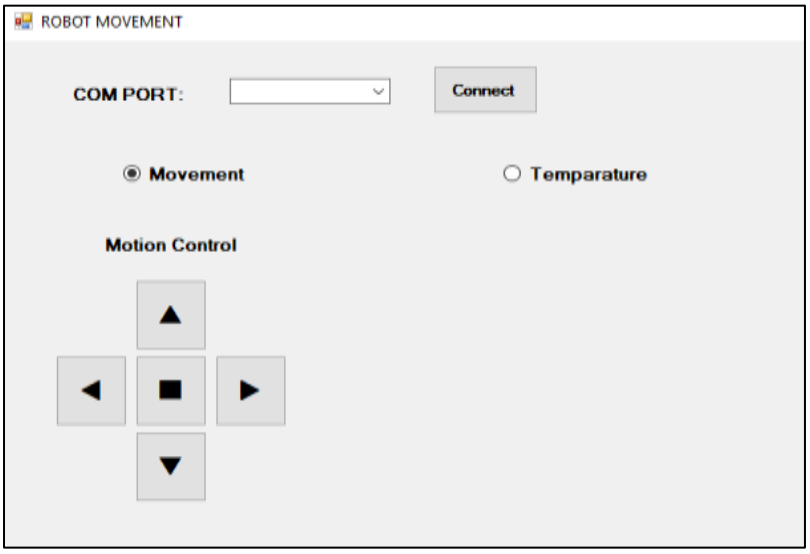

Fig. 3: GUI for Robot Movement Control

IX. RESULT

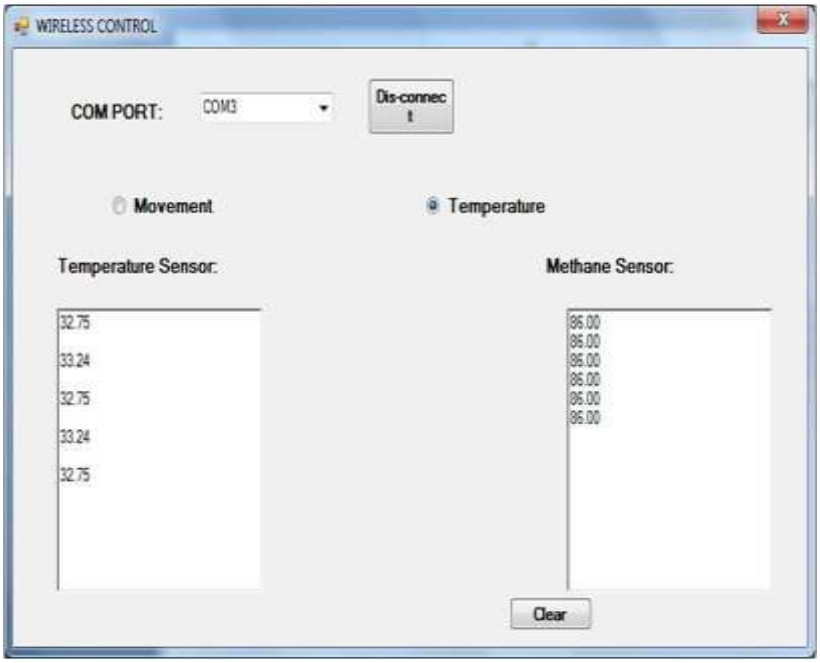

Fig. 4: GUI for Displaying the Information Collected by sensors

X. CONCLUSION

The coal mine rescue robot will be designed to help people, execute task of detecting and rescuing after gas explosions in the underground coal mine. It is a kind of mobile robot. Many factors of mine are considered. It can go into explosive environments, detect gas content and help in live surveillance of the mine. The data can be sent to the base station or to the control room in safe field. It includes various fields i.e., mechanical, electronics, computer, communication, etc.