Rescue Robot for hazardous coal mines

Pratima Bhagat[1], Kishori Birdawade[2], and Komal Amle [2]
MIT Academy Of Engineering, Alandi,Pune India
[1]pratima.bhagat1@gmail.com

***Abstract* — Utilizing a robot to support rescue work force in mine salvage missions is a dynamic territory of examination. We are going to create a robot to send it into the mine to accumulate data about the earth inside a mine. 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 under such circumstances. 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, the coal mine identify and salvage robot might be created for helping individuals to do the rescue work force. Coal mine detect and rescue robot is used for detecting the explosion environment of coal mine. We will develop 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. This paper plans a coal mine recognize and salvage robot. It has numerous characters suitable to mine passage. It is made out of mechanical, electrical, machine, control, correspondence, sensor, and so forth. There are three real parts in developing the robot and they are mechanical, electronic and programming configuration. In this paper, the execution of inserted control framework focused around the ARM is introduced. The inserted control framework can attain numerous undertakings of the robot, for example, ecological data obtaining correspondence with the remote control framework and executing complex control calculations.**

***Index Terms* — Rescue Robot, coal mines**

I. Introduction

Coal mine is a special mine. It is a tunnel system underground. In the event that there is any flaw, individuals are shut in shaft and they regularly can't escape from tunnel. It has hazardous components as breakdown, gas blast, CO toxin gas, Co2 gas, low O2 content, high temperature, smoke, coal dust, flame, water, and so forth. All these components can execute individuals in mine. When coal is mined, gas is released. Gas is push off by forced ventilate system. Basically the robot is composed of mechanical institution, control system, motion system, communication system, power system and sensor system. The block diagram of the robot is shown in figure.

But if forced ventilate system is faulty or there is gas explosion from coal layer, gas is filled in tunnel. A fire point can cause a big gas explosion. Mine tunnel is a tube; gas explosion wave can destroy any thing in tunnel. All devices and people may be damaged. After disaster, gas,

CO, CO2, low O2 content, high temperatures, smoke, coal dust, are filled in tunnel. Because forced ventilate system has been damaged also, all gas cannot be push out and accumulate in tunnel. A fire may cause a second gas explosion. Rescuer on ground doesn't dare to go into explosion mine tunnel. Because situation is not known, any one may be killed by second explosion. So detect mine tunnel situation is the first problem to rescuers. Robot is a good device in this situation. Robot used in coal mine tunnel has many special characters which are difference to robot 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 robot as a fire point when robot is fault. The second problem is narrow and rugged tunnel, rail track in the middle tunnel and belt transmission on other side.

II. Motivation For Project

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 revel that this area requires serious attention. For example, on February 2, 2001 around 16 million gallons of water from a nearby tank gushed into the Bagdigi coalmine (India) trapping at least 45 miners. Much similar type of accidents has also been reported earlier. 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 as .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 leads 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.

The above discussion clearly shows that only limited attempts have been made for node application in underground mines. The issues behind this usually are:

- The mine environment is not stable and in constant state of evolution. Therefore, mining node should be adaptive or very flexible.
- All these systems are suitable for working in dry mines.
- The much unstructured nature of mine tunnel often possesses hindrance for approachability and trainability.
- Generally tethered systems are preferred for mine environment (which also reduces

operational range). If the cable is damaged by roof collapse; people have to enter the mine to rescue the system

Almost all of the system are unsuitable even for partially water logged mines/ tunnels To overcome such difficulties, this node was taken which is capable of working both on dry as well as fully/ partially water-logged mines/ tunnels with RF/ Acoustic communication. This paper is organized as follows: a background followed by system description, then system architecture, communication system, system software, followed by report on field testing and finally the results and discussion.

III. Coal Mine Rescue Robot Description

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 Microprocessor is the main heart of proposed system. An electronic device, Microprocessor which contains processing Power, memory and Input Output ports for interacting with different connected devices. In this system microprocessor is the brain of system which 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. Serial Communication is used to transfer the data inside the microprocessor 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. Form 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.

IV. Block Diagram Description

This system basically consist of, gas sensor, proximity sensor, emergency key, temperature sensor, RF transmitter/ receiver pair, camera The robot work in manual mode.

A. Manual Mode:

In Manual mode, these sensors are temperature sensor, gas sensor and the proximity sensor. These sensors will sense their respective parameters in the coal mine hazardous conditions the system is also provided with an emergency key to detect the injured worker. The worker just need to press this key and the crew on the base station will get to know about the injured worker. If any of the hazardous condition is detected like fire, gas leakage or temperature rise in the coal mine then the buzzer will start buzzing so that authorities will get to know about the present atmospheric condition with the coal mine and precautionary measures can be take place well on time. The robot is wirelessly controlled using a wireless zigbee RF transmission. All the measured parameters from the sensors will be transmitted to the base station using a zigbee wireless transmission. On base we have a pc interfaced with the RF receiver. After receiving the parameters, the respective parameter will be continuously updated and displayed on the visual window. The ROBOT is also tracked and the track map will be shown on vb on pc.

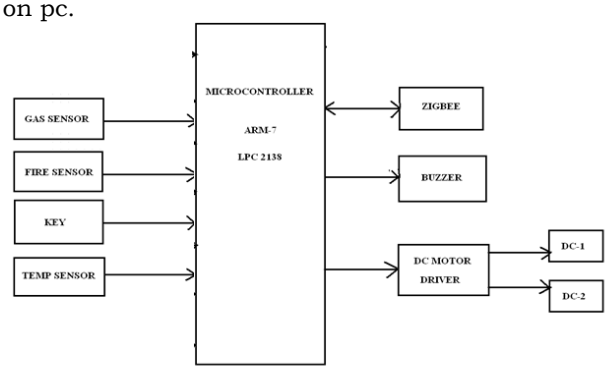

Figure.1 Block diagram of Mine Monitoring System

V. System Implementation

A. LM35

The LM35 series is of precision devices with integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

Features

1. Calibrated directly in degree Celsius (Centigrade)
2. Linear a 10.0 mV/ degree Celsius scale factor
3. 0.5^{0}C accuracy guarantee able (at a25§C)
4. Rated for full b55^0 to a150^{0}C range
5. Suitable for remote applications
6. Low cost due to wafer-level trimming
7. Operates from 4 to 30 volts
8. Less than 60 mA current drain
9. Low self-heating, 0.08^{0}C in still air
10. Nonlinearity only g(/4^{0}C typical)
11. Low impedance output, 0.1 X for 1 mA load

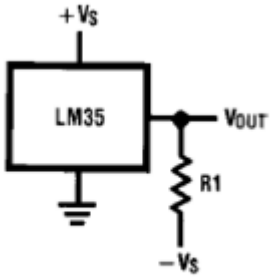

Figure.3 LM35

B. MAX 232

Since the RS232 is not compatible with today's microcontrollers, we need a line driver (voltage converter) to convert the RS232s signals to TTL voltage levels that will be acceptable to the TxD & RxD pins of microcontrollers. For example MAX232 from Maxim Corp. [18]. It converts the RS232 voltage levels to TTL voltage levels & vice versa. The advantage of MAX232 is that it uses a +5V power supply which is same as the source voltage for PIC18F4520. There are two sets of line drivers for transferring & receiving data. For proposed system, we use only one set only that is T1 & R1 are used together for TxD & RxD of PIC18F4520. The T1IN is the TTL side & is connected to TxD of the microcontroller while T1OUT is the RS232 side that is connected to the RxD pin of RS232 DB connector. The R1IN (pin13) is the RS232 side that is connected to the TxD pin of the RS232 DB connector, & R1OUT (pin12) is the TTL side that is connected to the RxD pin of the microcontroller.

C. ZigBee

Xbee and Xbee-PRO Modules were built to meet Zigbee/IEEE 802.15.4 standard and backing the remarkable needs of minimal effort, low-control remote sensor systems. The modules oblige minimal power and provide reliable delivery of critical data between devices. The modules work inside the ISM 2.4 Ghz recurrence band and are pin-for-pin perfect with one another and compatible with each other.

D. MQ-6 Semiconductor Sensor for LPG

Sensitive material of MQ-6 gas sensor is SnO2 with lower conductivity in clean air. In the presence of target combustible gas, the sensor poses higher conductivity along with the gas concentration increase.MQ-6 gas sensor also poses high sensitivity to Butane, LPG, Propane and Natural gas. It can also be used to detect various combustible gas, mainly Methane and suitable for different application.

Character/Properties

- Good sensitivity for Combustible gas in widespread range.
- High sensitivity to Propane, Butane and LPG
- Long life and low cost
- Simple drive circuit

Application

- Domestic gas leakage detector
- Industrial Combustible gas detector
- Portable gas detector

VI. Result And Discussion

The robot looks as shown in Fig. 4 with its components attached to it. A 5V and 3.3V power supply is used to run the robot. The robot was test run and it moved well on debris and over rough terrains and the video was transmitted with much clarity.

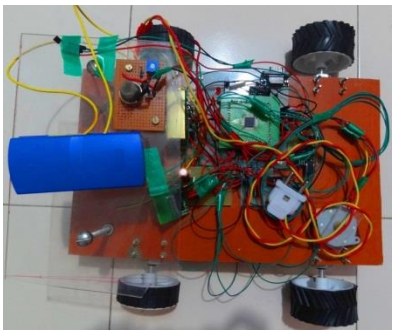

Figure. 4 System Prototype

Our project is a growing application in Robotics field. Many new features are being added to enhance the Rescue Operations using recent technologies. We will attempt is to design the best prototype for the same. The coal mine detect and rescue robot will be designed to help people execute tasks of detecting and rescuing after gas explosion in the underground coalmine. Coal mine detect and rescue robot is a kind of mobile robot. Many factors of mine are considered. It has many characters suitable to mine tunnel. It can go into explosion environment and detect gas content. The data can be sent to control man in safe field. It includes various fields i.e. computer, electronics, mechanical, communication etc.

VII. Future scope

We can check oxygen content:
The system will be equipped with oxygen sensor which will sense the content of oxygen inside the coal mine required for human.

Purifier can be used:
Purifier can be attached to the system so that we can purify the poisonous gas which will be helpful for the workers.

VIII. Conclusions

Our project is a growing application in embedded field. Many new features are being added to enhance the Rescue Operations using recent technologies. The coal mine detect and rescue robot will be designed to help people execute tasks of detecting and rescuing after gas explosion in the underground coal mine. Coal mine detect and rescue robot is a kind of mobile robot. Many factors of mine are considered. It has many characters suitable to mine tunnel. It can go into explosion environment and detect gas content. The data can be sent to control man in safe field. It includes various fields i.e. electronics, mechanical, communication, computer etc.

References

[1] Zhu Jianguo, Gao Junyao, Li Kejie, Lin Wei, Bi Shengjun "Embedded Control System Design for Coal Mine Detect and Rescue Robot" 978-1- 4244-5540-9/10 2010 IEEE

[2] Jong C. Wang, Yan Ting Lin, Huei Teng Jheng, Jyun Sian Wu and Ruei Jhe Li, Object Tracking for Autonomous Biped Robot. IEEE 2010

[3] GAO junyao, GAO xueshan, ZHU jianguo, ZHU wei, WEI boyu, WANG shilin "Coal Mine Detect and Rescue Robot Technique Research" 978-1-4244-3608-8/09 2009 IEEE.

[4] M. Thamrin N., Rosman R, and Sarmawi D. S, Design and Analysis of Wireless Controller Panel using RF Module's for Robotic Wheelchair. IEEE 2011.

[5] A. Davids "Urban search and rescue robots" Tragedy to technology, Intel. Syst. IEEE 17(2), 81–83, 1541–1672 (2002)

[6] Shahram Bahadori, Daniele Calisi, Andrea Censi, Alessandro Farinelli, Giorgio Grisetti, Luca Iocchi, Daniele Nardi, Gian Diego Tipaldi "Autonomous Systems for Search and Rescue"

[7] Zhou, Xin-quan, and Chen Guo-xin. The probability analysis of occurrence causes of extraordinarily serious gas explosion accidences and its revelation. Journal of China Coal Society, 2008, 33 (1): 42-46.

[8] Gow MohKee, Zainah Md. Zain, Rahmatul Hidayah Salimin "Design and Development PIC based Autonomous Robot" 978-1-4244-1676-9/08

[9] Robin R.Murphy, Jeffery Kravitz, Samuel L.Stover, Rahmat Shoureshi "Mobile Robots in Mine Rescue and Recovery" 070-9932/09/2009 IEEE, IEEE Robotics & Automation Magazine