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Unmanned Ground Vehicle (UGV's) for Coal Mines

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Abstract: In India from last few decades, coal mining has witnessed a phenomenal growth in production and demand of coal, according to 12th Action plan, demand of coal to the power utilities, power captives, steel industries, cement industries and others, with 8% growth of GDP. With this scenario, technology for coal production (opencast mining, underground mining), during this process many of fatal accident may happen, to prevent these accident, some technological face mechanisms is required with geo-mining atmosphere and its awareness to the mining industry. In this paper we suggest an unmanned machine to check the geo-mining atmosphere through wireless control for Rescue team.

Key words: ZigBee, UGVs, UAVs, USVs, Robot.

I. INTRODUCTION

Safety is a prime intension of a coal industry for proper functioning. It's not only for employees and workers but also for the environment and nation. Coal mines are the most critical challenge for safety, health and environment compared to other industry due to the complication in its operation and maintenance with wide range of hazardous. Due to huge technological progress, the safety culture and safety at work still serious issues. That's why maintaining of high standards of health, safety and environment in coal mines is of immense significance. To save the fatalities life of coal mines workers, due to unfortunate natural accident or unknowingly human made disaster, demands sophisticated and organized rescue planning from a government or rescue team [12]. The intension is to get out to the accident areas, find the affected workers and help them as fast as possible. Accident comes with many obstacles for the rescue team that makes it hard for them to reach the victims, for example rainstorms, collapsed roof or side walls, obstructions, explosion and dangerous gases and different substances. The rescue team must rapidly and securely collect information of the accident areas, a task that is both difficult and dangerous [18]. Rescue robots, that are a type of field robots, can serve as appreciated tools for human teams under disasters [17]. They can reach places between rubble and hazardous places that humans cannot, and effectively gather crucial information. The robots can also reach victims through narrow spaces and apply them with fluids and medication. To be useful tools the rescue robots must be smart and dynamic so they do not become obstacles for the rescue team. Because of the unstructured and dynamic environment that occurs during disasters, the robots are nowadays in a degree teleported [12], which demands that the robots have a good communication with the rescue team.

There are several rescue robots still under progress and some of them have even been used in some emergence situations. The challenge facing to get perfect rescue robots working on the different field is to make them advanced or intelligent in software and reliable hardware to work in critical zone in the way that it can handle all possible obstacles [17]. The significance of this paper is to get a valuable introduction of rescue robotics or unmanned machines, their challenges, how they are used today and what improvements could be in future of rescue robots for coal mines.

II. BASIC ROBOT STRUCTURE

Its structure configured in five sections such as supply system, communication system, control system, sensor system, drive system.

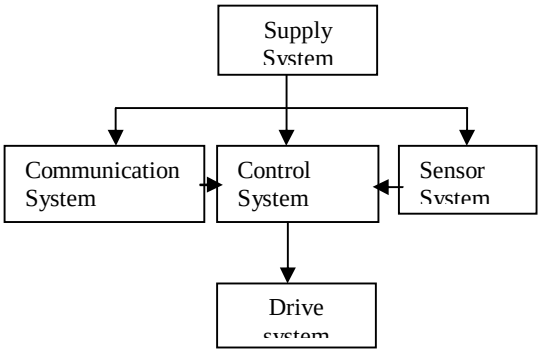


Fig.1: Basic robot structure

III. TYPES OF UNMANNED VEHICLE

These are mainly four types of rescue robots according to [23] that can be categorized like this:

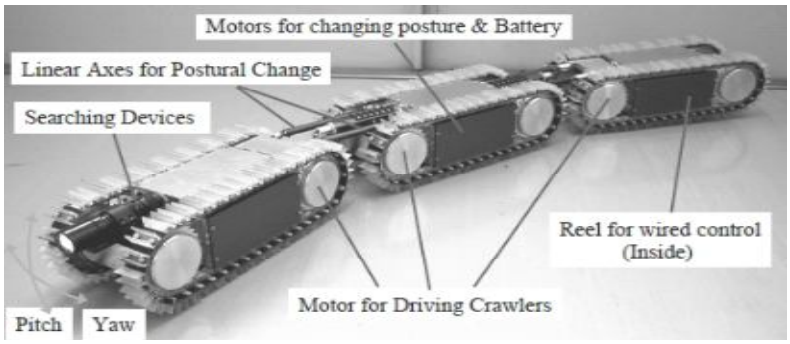
UGVs – Unmanned Ground Vehicles. These robots works on the ground or surface and can help rescuers to find and interact with trapped victims, in areas were human cannot enter.

UAVs – Unmanned Aerial Vehicles. These robots can easily work above the ground surface and transport medical treatments to victims and can give the signal of the situation to the rescue team.

UUVs – Unmanned Underwater Vehicles. These robots can search through water and identify fatalities, hazardous subject or material.

USVs – Unmanned Surface Vehicles. These robots work on the water surface, and can help rescuers to locate and bring the right equipment to the victims.

Picture 1: UGVs Robot



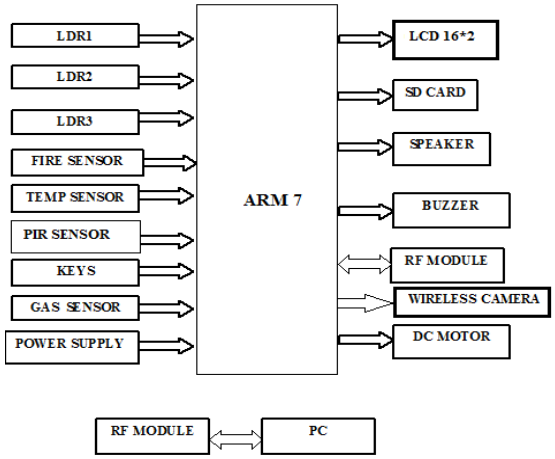
Picture 2: UGVs Robot

Picture 3: UGVs Robot

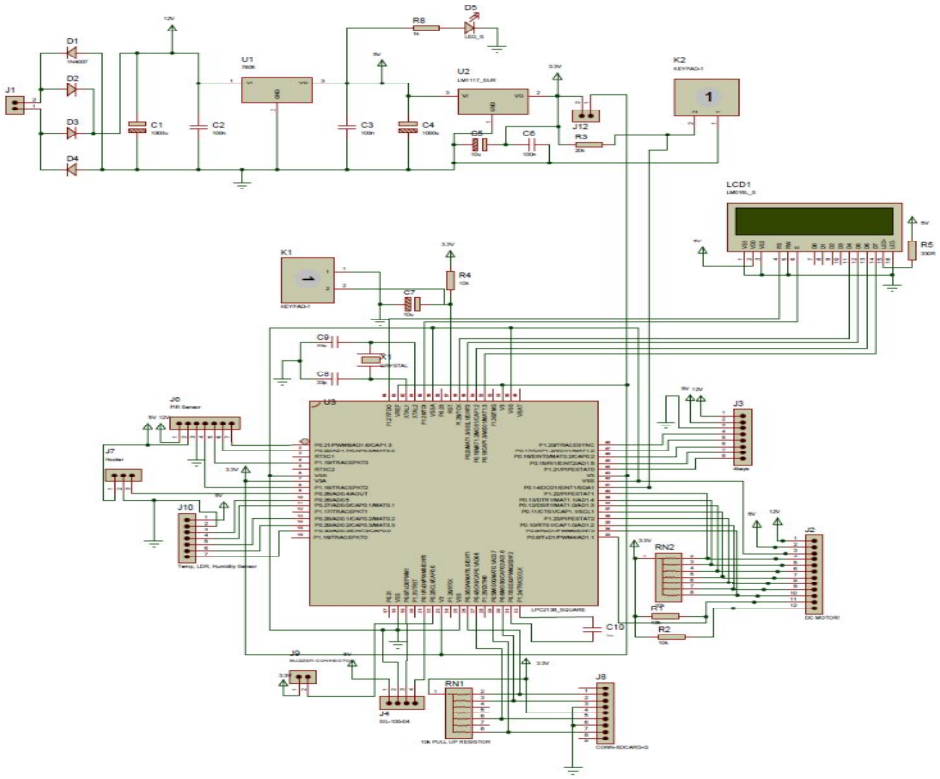
Picture 4: UAVs Robot

Picture 5: USVs Robot

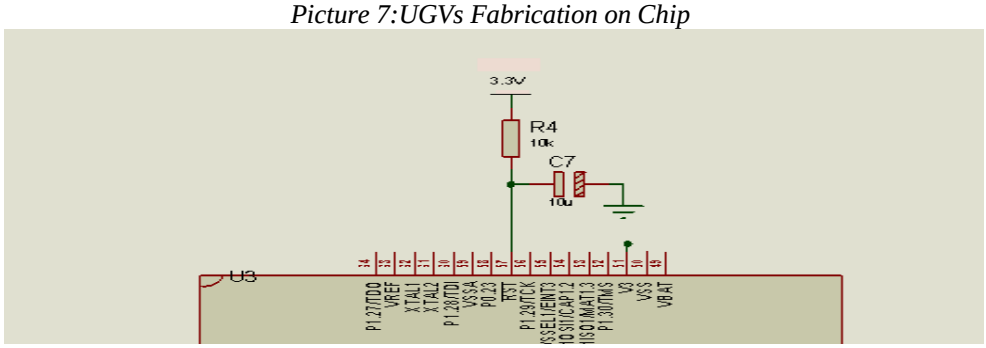
IV.RESCUE ROBOTS ARCHITECTURE: Here we developed working model of UGVs for coal mines. In which uses a desktop computer to monitor and control the position of the robot using RF module along with HD Camera and to detect the parameters like Gas using Gas sensor, Temperature with temperature sensor, Fire with fire sensor, Humidity, PIR sensor etc.



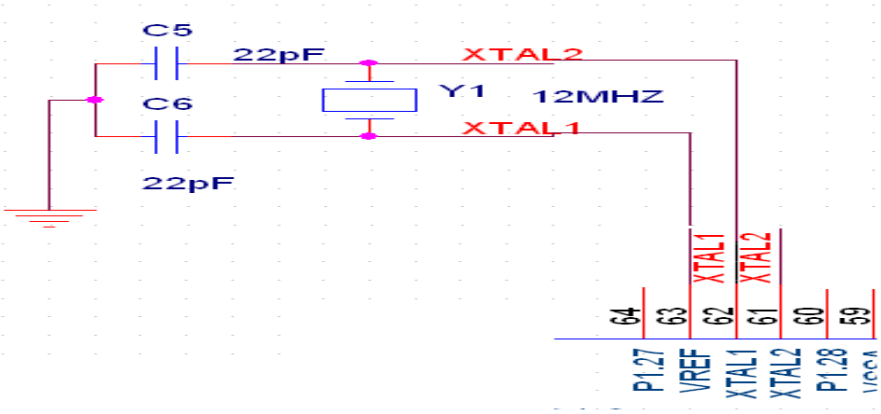
Picture 6: UGVs Architecture



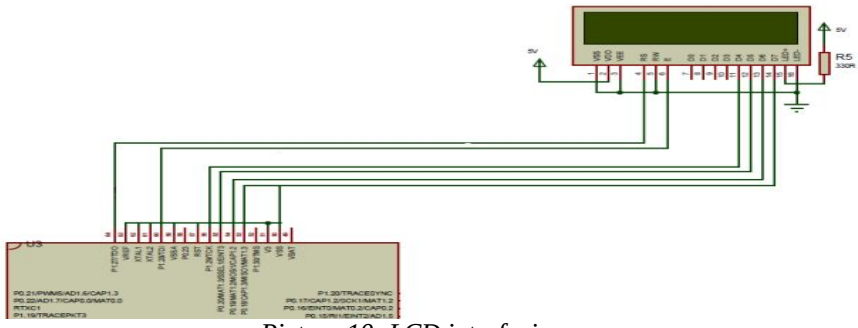
Picture 7:UGVs Fabrication on Chip



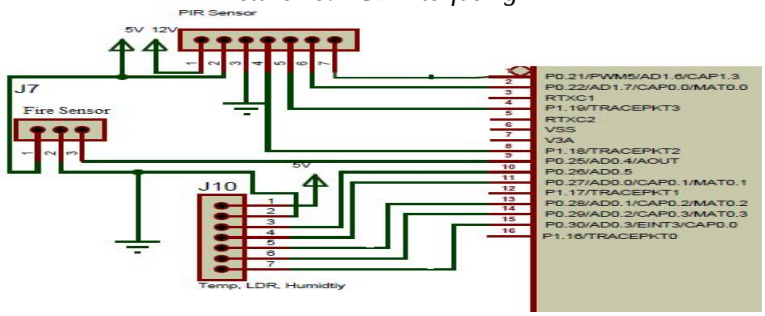
Picture 8: Reset Circuitry



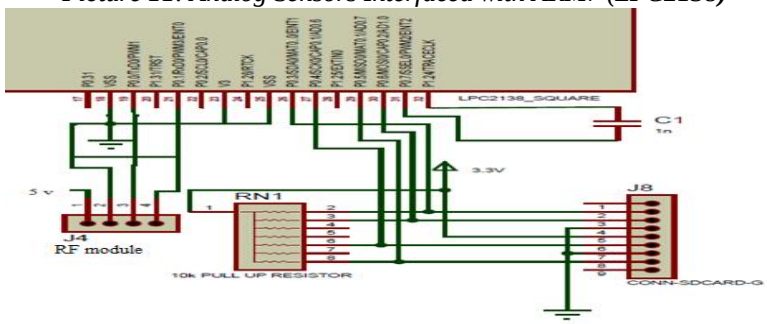
Picture 9: Crystal Circuit



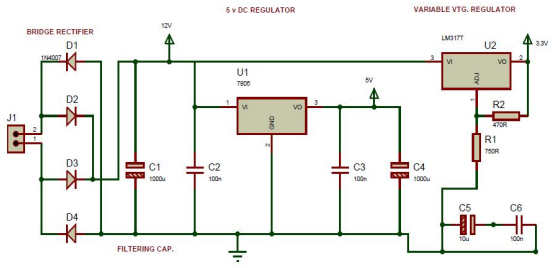
Picture 10: LCD interfacing



Picture 11: Analog Sensors Interfaced with ARM7 (LPC2138)



Picture 12: RF module and SD card interface with ARM 7



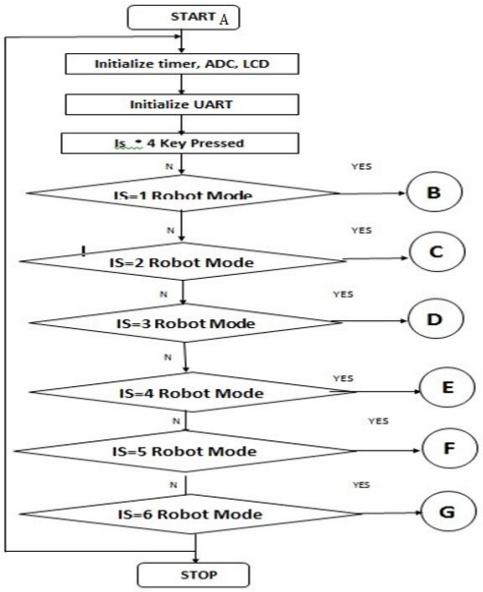
Picture 13: Power Supply Circuit

V. SOFTWARE DETAILS:

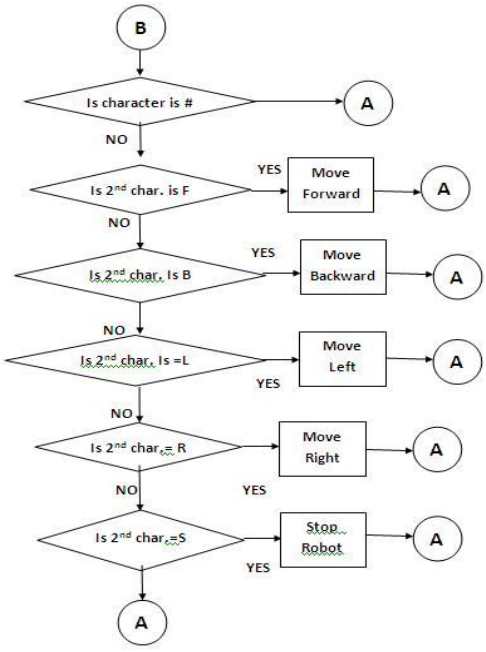
For the UGVs, Embedded 'C' language is used for Arm 7 programming. **Flash Magic** is a tool which supports ISP (In System Programming) feature. It is used to burn a hex code in EEPROM of microcontroller.

Keil µVision IDE: The µVision IDE from Keil combines project management, source code editing, program debugging, and complete simulation in one powerful environment.

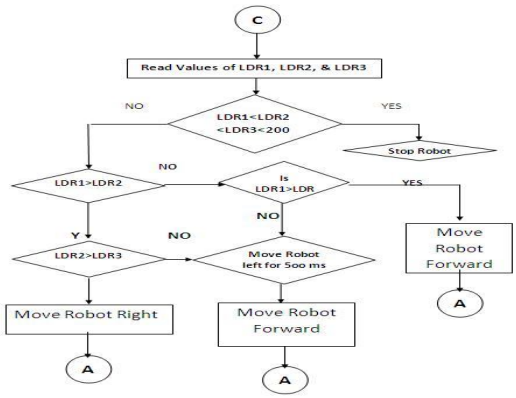
Visual basic 6: It is used as a front end application at the local system and has been used to control the robot through RF module connection With this software & some environmental condition with the UGVs in a coal mines some logical flowchart are designed.



Flow chart 1: Main Flowchart for UGVs



Flow chart 2: For Manual Operation of UGVs



Flow chart 3: Flowchart for Auto mode of UGVs

VI. PERFORMANCE ANALYSIS

Their analysis of the different parts of the system is as follows-
1] Analysis of Temperature Sensor (LM 35).
2] Analysis of Gas Sensor (MQ 6)
2] Analysis of PIR Sensor.
4] Analysis of Humidity Sensor.

1] Temperature sensor LM35-

Temperature sensor LM 35 kept in different temperatures situations like in Air conditioner (A.C.) at 25ºC and at normal room temperature 33 ºC. Then observed output of LM 35 on LCD and PC as below.

S. No	Different Condition	Temp measured ^{0}C	Temp by LM35 ^{0}C
1	Air Conditioner (25ºC)	22	24
2	Normal Room at 32 ºC	31	31.7
3	Near open freeze	6	6.7
4	Near Electrical Room Heater	40	41.2

Table 1: Analysis of Collected Data for LM 35

2] Gas Sensor MQ 6:

Condition I-If LPG Gas releases intentionally for 30 sec, then Gas sensor indicate the following reading after particular time.

S. N	Time in min	Gas % Concentration	Remark
1	30Sec	99.9%	Gas Detected
2	1min	86.4%	Gas Detected
3	2min	74.2%	Gas Detected
4	3min	63.1%	Gas Detected
5	4min	50.9%	Gas Not Detected

Table 2: Analysis of Gas Sensor for condition I

Condition II-If LPG gas leaks continuously on one place, then gas sensor indicate the following reading considering the distance in one minute.

S. N	Distance	Gas % Concentration	Remark
1	2mtr	99.9%	Gas Detected
2	4mtr	84.1%	Gas Detected
3	6mtr	73.9%	Gas Detected
4	8mtr	62.7%	Gas Detected
5	10mtr	51.4%	Not Detected

Table 3: Analysis of Gas Sensor for condition II

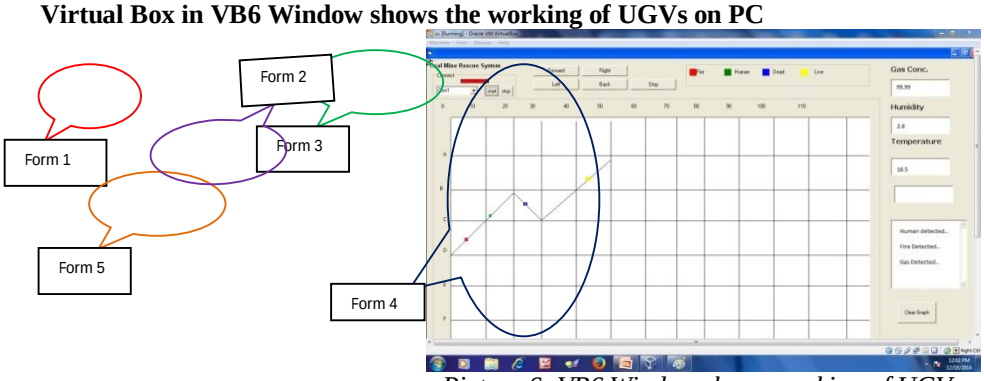
3] PIR sensor (DYP -ME003 SEN005):

PIR sensor is used to detect human. The PIR sensor indicates the following reading considering Distance and Angle for human detection.

S. N	Angle	Distance	Remark
1	<110º	5ft	Human Detected
2	<110º	7ft	Human Detected
3	<110º	15ft	Human Detected
4	<110º	19ft	Human Detected
5	<110º	24ft	Human Not Detected

Table 4: .Analysis of PIR Sensor

Virtual Box in VB6 Window shows the working of UGVs on PC



Picture 6: VB6 Window shows working of UGVs

In this UGVs model visual basic 6 is used as a front end application at the local system and has been used to control the robot through RF module connection. This visual basic 6 front end application has mainly 5 forms each form contains some similar data and conditions. Form1 is Selection of particular com port where RF module is connected. Form 2 indicates the different button used for manual operation for robot. Form 3 indicates different color boxes which indicate the different signal. Form 4 indicates the actual reading of Gas, Humidity and Temperature measured by different sensors. It displays the different message regarding situation of coal mine in the text script window and form 5 indicate the mapping of robot.

OBJECTIVES FOR FUTURE WORK

To eliminate risk of disasters and accidents in coal mines through detailed analysis of accidents and dangerous occurrences using rescue techniques; A controlled automatic unmanned machine (robot) designing for assisting rescuers. This system works even when a ZigBee, Wi-Fi, Gi-Fi, 2G, 3G, 4G etc New concepts like multi-robot teams or swarms (a team of robots) are that extends the communication and sensor network.

VIII. CONCLUSION

The Indian coal mining is changing very fast with the increasing demand for coal, to meet the countries energy security from fatal accidents. The expectation of the society is also increasing day by day and the accident is not accepted anymore. With this UGVs we can reduce the coal mines accident and occupational safety and health in totality.

Whenever any accident occurs, the UGVs (robot) automatically detect the accident, find the location and enter the coal mine tunnel well before the arrival of rescuers. It finds the location of accident, searches for survivors to give them first aid treatment at right time and informs the rescue team about environmental conditions and about the survivors inside the coal mine.

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