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DEPLOYMENT OF AI CONTROLLED ROBOT FOR INSPECTION AND PROCUREMENT OF OBJECTS AND DETECTION OF HUMAN PRESENCE IN HAZARDOUS ENVIRONMENTS IN MINING INDUSTRY

YASHWANTH PRASAD P	UG FINAL YEAR STUDENT, EEE, R.M.K COLLEGE OF ENGINEERING AND TECHNOLOGY, CHENNAI, 601206.
ROHIT D	UG FIRST YEAR STUDENT, ECE, R.M.K COLLEGE OF ENGINEERING AND TECHNOLOGY, CHENNAI, 601206.

ABSTRACT:

To implement a Robot for detecting the human presence in hazardous situations (Disaster Survillance) inside the mining industries. To deliver the food and medicines to the workers trapped in coal mines with the help of pre trained neural network which uses the camera and other sensors to track the current location and bring out the best from it.

KEYWORDS:

COAL MINE, DISASTER SURVEILLANCE, ROBOT, SENSOR.

INTRODUCTION

Coal mine is a special type of mine which is dangerous in nature. Such mines will usually be an underground system which has less number of pit heads. In case of any accident as given in Table 1, it will be difficult for people to escape out of the mine. The dangerous factors that an accident will bring along are collapse of tunnel, gas explosion, undesired level of O2, CO and CO2, high temperature, fire break out, etc. All these factors can cause human and property loss. These fatal factors menace people. After a Coal mine disaster, the situation inside the mine is not known. Entering into a mine without knowing the exact situation is dangerous as the chances of a second explosion is high. Many rescuers are killed by this second explosion. Detection of the situation inside the tunnel is of high importance. Due to this the transmission along the tunnel is a difficult thing. This is the condition of the normal tunnel. When an explosion occurs, the situation inside the tunnel worsens and the conveyance inside the tunnel becomes really difficult. To overcome such hazardous situation, a robot can be deployed for disaster surveillance.

- The need of man force in the several industries is increasing but several factors like Injuries, human errors impact the man power thereby the efficiency is decreased.
- Working in a Hazardous environment causes a major impact to the workers' health.
- The human errors are unavoidable in any sector.

Table 1.Statistics Analysis of Death Accident in Coal Mines[1].

Accident type	Occurrence	Death count
Gas accidents	3318	492
Cavings	1332	907
Flood Accidents	1111	166
Transportation	261	230
Dust	234	4
Gun fire	58	39
Collapse	57	14
Electricity	40	38

The accidents due to gas leakage, dust, collapse and transportation can be overcome convincingly by using the mobile robot. The gas sensors will indicate the presence of harmful gases and it will alert the workers to be better prepared to tackle the situation. This is the main objective of using the robot, to reduce human and material loss.

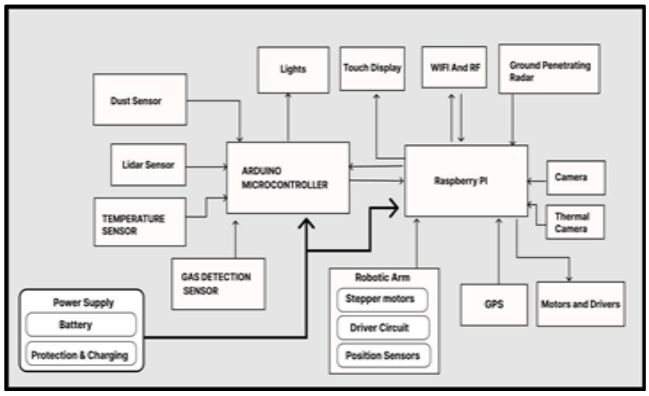
II. LITERATURE REVIEW

The staggering data from [1] reveals that huge number of accidents occur in a coal mine during and after a disaster. The main reasons being, gas accidents, caving, flood, etc. This really asks for the development of a system that can help minimize the human and material loss that happens during rescue operations. Gas explosion is the most serious one in all mine disasters for after the gas explosion, the scene becomes extremely complex [2]. Thus gas sensors are mandatory in the robot to be deployed. The idea of a Mobile Robot to be able to aid the rescue team entering into a coal mine[3] got picked up with the tremendous uplift in the field of technology. The Robot is used to reach the disaster zone and it is used for rescue and research operations. The robot can go into explosion environment and detect gas contents, temperature, etc. The data can be sent to controller in safe field. The robot is designed in such a way that it suits the mine tunnel. It can

run in explosion environment, climb over ruins, check gas and if needed, slot can be provided wherein it can carry food and first aid kit to the workers trapped inside. A biped robot was initially tipped to be used in the coal mines[4] which can move inside the tunnel and has an RS 232 cable for interfacing. The robot couldn't transverse a long distance it tripped on moving across the debris and the RS 232 cables couldn't be used for a long distance. Thus a different mode of legs had to be used and after research, the usage of a conveyor belt type robot was developed. The conveyor belt as seen on the military tanks would maneuver over debris and rough terrains. Now, the focus was onto the means of communication to transfer data and commands to and fro from computer and robot. In the earlier days, the robot had RS 232 cables to provide communication between the robot and the CPU[4]. The RS-232 as the interface for communication and control to allow the robot to receive demands from the user and track objects autonomously. Though the RS 232 gave creditable communication, it had several short comings. Due to its limited size, the robot was not able to move deep into the mine. And there was the danger of the cables getting twinned or cut inside the tunnel resulting in loss of data or at times, it can spark a fire inside the tunnel. A better way of communication had to be used. The advancement in technology saw the usage of Blue Tooth for wireless communication [5]. The mobile robot has the capability to move around autonomously using complicated and powerful algorithm. The algorithms are stored in a PC that acts as a master cum server. All sensor readings from the mobile robot will be transmitted to the master and processed. Then, command or instruction for further action is transmitted from the server to the mobile robot in a bidirectional full duplex communication mode. Hence, the main "brain" is in the server instead of the mobile robot. This again had the shortcoming of limited coverage area. The Blue Tooth would function only to a specified area and the robot couldn't be controlled beyond that. This lead to the usage of much wide wireless communications technologies like RF transceiver and ZigBee[6]. The ZigBee had much better range than Blue Tooth and hence it could transmit commands and receive data from long distance from the tunnel. Once the communication and movement and sensing of robot was finalized, the focus shifted on how to make it more reliable. The idea to use a 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. i.e, it helps in mapping of the mine. Robot wireless sensor networks are an increasingly capable platform and show great potential in environments from future battlefields to disaster discovery. Robot wireless sensor networks can enhance multimedia surveillance and provide the foundation for strategies based on multi-modal sensor integration [7]. The IEEE paper authored by Shan Cai, Zhao-long, Xu Jie, Yang Xiao-zhi Liu et al [8] concerns a robot system fit for detecting mine disaster information on the basis of the working principle of detecting robot system. It introduces in details the structure of the system; the technologies of passing through obstacles, obstacles avoidance by using sensors; the collection of information and wireless transmission modules, including gas sensors, temperature sensors, network cameras and wireless transmission modules.

III. ARCHITECTURE

The sensor unit must be directly interfaced to the controller. The monitoring device takes the current readings and sends them to the Microcontroller. The controller circuit is responsible for transmitting this information. Controllers are designed at hardware level. The 2.4GHz module is interfaced with the controller via the standard serial port. Readings are periodically reported to monitoring system in the form of radio packet service. These data's are updated by the PC/SERVER. The readings about the parameters of the mine will be thus updated and automatically displayed on the monitoring system. So that rescue team can view the readings continuously. And motion detection camera is used to visualize the critical situation of the mine.



IV. METHODOLOGY

- The robot has an arm in the font to pick up the medicines or the food packages and hand over it to the persons trapped in mines.
- The proposed method saves time and also human resources and is easy to operate with external monitoring from afar
- Additional sensors can be incorporated for taking temperature readings, monitoring rock stability, and other conditions that might affect worker safety.
- Robot has the camera in the front and the IR LEDs on the other sides.
- With the help of pre trained algorithm, the data is processed and the commands are informed to the Arduino through Serial port and the movements are done according to the data received from the pi.
- The sensors and camera attached to the robotic arm can send the pictures to the far away station through IoT.
- The thermal sensor detects the difference in temperatures and hence the human presence.
- Robots may also make it possible to reopen old mines that were abandoned after becoming

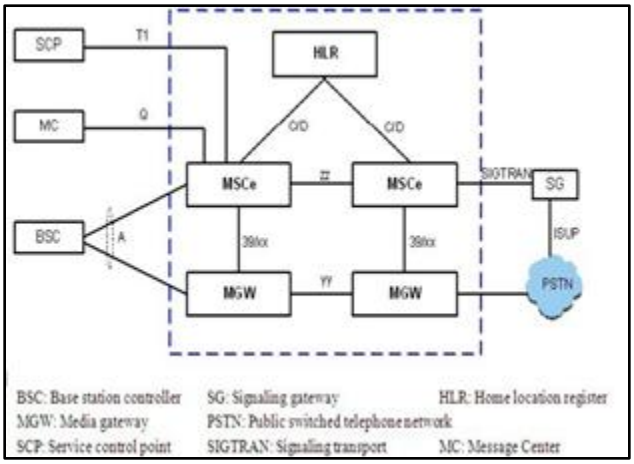
unproductive or flooded with water.

- The algorithm also learns by itself that so that potential are identified and the data is encrypted and stored into the database. So, wherever the data is needed the robot can fetch the data from the database. This helps in identifying the reusable mines.

V. SENSORS AND COMPONENETS

GPRS:

GPRS uses a packet-mode technique to transfer high-speed and low-speed data and signalling in an efficient manner.



IR SENSOR:

- An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a Passive
- IR Sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes that can be detected by an infrared sensor.
- The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED.
- When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received.

RASPBERRY PI:

Using the Raspberry Pi as a dedicated robot programming station which doesn't require another computer. Incorporating sensors into your robot programming (e.g. vision sensors) which are not compatible with the robot controller.

STEPPER MOTORS:

Stepper Motors provide ruggedness, high reliability, simplicity of construction, allow for low maintenance, offer excellent response to starting/stopping/reversing and will work in many environments

LIDAR:

Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth.

THERMAL CAMERA:

A thermal imaging camera (colloquially known as a TIC) is a type of the thermo graphic camera used in fire fighting. By rendering infrared radiation as visible light, such cameras allow fire fighters to see areas of heat through smoke, darkness, or heat-permeable barriers.

LITHIUM ION BATTERIES:

Lithium-Ion batteries are rechargeable and are used in vaping devices, many personal electronics such as cell phones, tablets, and laptops, E-Bikes, electric toothbrushes, tools, hover boards, scooters, and for solar power backup storage

ULTRASONIC SENSORS:

Ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target.

PIR SENSOR:

PIR sensors can detect human or animal motion. Humans emit infrared radiation. When a human comes into the sensing range of the PIR sensor, these changes in radiations are detected by the PIR sensor which causes the output of the sensor to go high.

LDR:

Light-dependent resistor that changes its resistance when different amounts of light fall on it. They work on the principle of photo conductivity where it gives less resistance in high light intensity and high resistance in low light intensity.

GAS SENSORS:

Catalytic diffusion sensors are the most widely used devices for the detection of combustible gases and vapors. These sensors start with wire being wound into coils.

THERMISTORS:

Thermistors are temperature-dependent resistors, changing resistance with changes in temperature. They are very sensitive and react to very small changes in temperature. They are best used when a specific temperature needs to be maintained, and when monitoring temperatures within 50°C of ambient.

MICROCONTROLLER UNIT

The microcontroller that is been used is the PIC 16F877A controller. PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability. The microcontroller is used to collect the parameter value from the sensor unit and compare it with the set point (safer level of gases) and transfer the corresponding data to the

CPU. It also receives commands from the CPU and transfers it to the robot unit for its movement. The microcontroller is the core of the surveillance robot.

ROBOT DRIVER UNIT

The robot driver unit is primarily concerned about the movement of the robot in x-axis and y-axis. The robot is of conveyor belt type as it helps to maneuver over debris and rugged terrain. The wheels are run by two DC motors of 200 rpm. When both the wheels are given with positive pulse, the robot moves in forward direction, when the supply is reversed, it goes in backward direction and similarly by varying the negative and positive, left and right turn can be achieved. To choose the supply given to each motor, L293D IC is used

TRANSCIEVER UNIT

The transceiver unit is used to both transmit and receive data. The 2.4GHZ RF transceiver is used as it offers free bandwidth. To improve the security, other secure frequencies can be used. One transceiver is mounted on the robot unit, which gets the data from the microcontroller and transmits to the other transceiver placed in the control room. Similarly, the transceiver placed in the control room will transmit commands to the transceiver mounted on the robot for the control of robot movement.

CURRENT PROTOTYPE:

VI. CONCLUSION:

The project is aimed at providing human safety for the rescue team in hazardous environments such as coal mines .This is a prototype which can be implemented in real time by using components with better range and efficiency. This robot enters into hazardous environments and provides data like the content of various gases after the explosion has occurred and also the temperature based on which the rescue team will be sent with necessary precautionary measures in order to make sure that the rescue team does not come to any harm. The conveyor belt enables the robot to run in rugged environment overcoming the disadvantage of armed robots as they might trip and fall in such conditions.

In future this can be developed by the use of higher transmission range transceivers so that it can travel for a greater distance and can be used in different environments based on the transmission range. Development can also be made in the number of sensors incorporated in the robot. Various other sensors like LPG sensor, O2 sensor can be added and thus helping to get a much improved image of the environment inside. Implantation of an arm on the robot can help the robot pick up samples or remove small debris from path or open or close any doors if needed inside the mine.

REFERENCES

1. Liu Xiaoli, Guo Liwen, and Zhang Zhiye, Statistics Analasis of death Accident in Coal Mines from January 2005 to June 2009; IEEE 2010

2. 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.

3. GAO junyao, GAO xueshan, ZHU wei, ZHUjianguo, WEI boyu.'Coal Mine Detect and Rescue Robot Design and Research'. IEEE 2008

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

5. H. Choo', Shamsudin H.M.Amin', N. Fisal', C. F. Yeong', and J. Abu Bakar, Using blue tooth transceivers in mobile robot. 2002 Student Conference on Research and Development Proceedings, Shah Alam, Malaysia.

6. 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.

7. Heng Huanga, Fillia Makedona, Dan Popab, and Harry Stephanoub, A feature extraction method for multimedia data analysis in robot wireless sensor networks. IEEE 2007

8. Shan Cai, Zhao-long, Xu Jie Yang, and Xiao-zhi Liu, Detecting Robot System for Mine Disasters. ICEEE 2010.