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implementation of rescue robot using iOt to detect ambient situations in coalmines

Kothapally Ajay Kumar & Mr B Raveendra Nadh
PG Scholar, Dept of ES Vardhaman College Of Engineering(Autonomous) Shamshabad,Hyderabad Telangana,India
Assistant Professor Dept of ECE Vardhaman College Of Engineering(Autonomous) Shamshabad,Hyderabad Telangana,India
ajaykumarkothapally@gmail.com & bravindra64@hotmail.com

ABSTRACT

Now a day's rescue operation in coal mine was treated as a dangerous task. Even if any explosion occurs it can't be easily known to the inside labours. After explosion occur when rescue workers get into the mine without knowing the environmental condition. The environmental parameters such as toxic gases, high temperature, methane leakage, oxygen are sensed by using sensors and the sensed data are transmitted to the control room through Wi-Fi. Hence this paper aims to design a coal mine detect and rescue robot using raspberry pi3 model. The robot has a camera that transmits live video signal to the control room. If the temperature exceeds a threshold value then it provides a cooling fan is automatically ON and if any gas leakage is detected the workers are given an alert through a Buzzer. The robot is controlled using navigation buttons in the webpage and it consists of sensor data, live video and buzzer alert. With the help of this robot, it is possible to reduce the loss due to coal mine disaster and efficient rescue operation can be carried out.

Keywords: Coalmine, Raspberry Pi3, Robot, Wi-Fi

INTRODUCTION

In the hazardous working environment, human safety is an important concern. Coal mines is a place in which human lives are more dangerous and many workers are injured due to explosions and leakage of toxic gases .Fire accidents can also happen. At the same time if any person is absent in an important place for monitoring, it may also cause serious hazards. At present many systems are implemented in industrial areas but still those accidents are occurring. With the robot which will give a live video of the environment and this video is transmitted to the mobile phone to the user who is controlling the robot by means of Wi-Fi technology. If any serious situation occurs. The new method is to design a robot and that robot is allowed to enter into the coal mine area. The robot will be equipped with some sensors like temperature and gas for detecting the toxic gases and the ambient temperature. The robot used must be a flame-proof so that even if any disaster occurs it will transmit the information to the receiver without fail. Also, it must be designed to work in the high temperature situations. A camera is also interfaced means an alert given to the nearby workers.

Wireless communication is also an important issue inside the industry. Usage of

wired technologies are not worthy as the cables will get damaged after a certain period of time or due to some environmental factors. So the wireless transmission technology is preferred. The industrial monitoring protocol should be designed such that the system must have a reliable end to end data delivery. The data which is collected from the robot should be transmitted without any delay and loss of data. Some of the techniques like Zigbee, Bluetooth have a small range and the data rate is minimum when compared to Wi-Fi. So using Wi-Fi the data can be transmitted to a wide range with a high data rate of 54Mbps.

BLOCK DIAGRAM

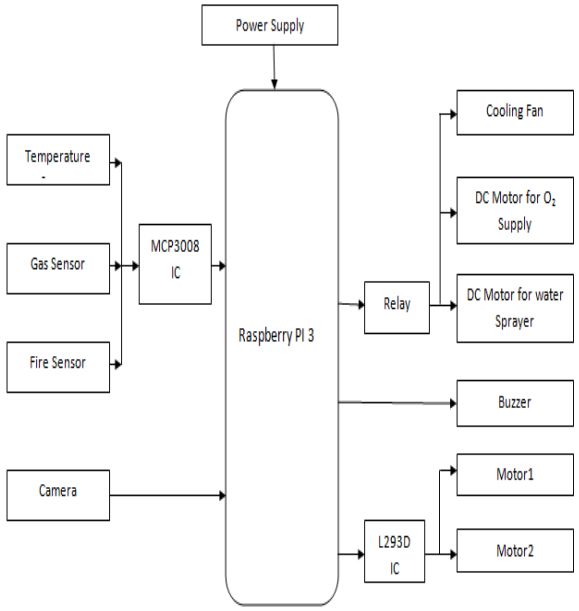


Fig.1 Block Diagram of Transmitter

The block diagram of the transmitter section for the coal mine monitoring is shown in the Figure-1.The Raspberry Pi3 board is interfaced with the temperature sensor and gas sensors. A camera is connected to one of the USB port of the board. A buzzer is connected for giving alert to the labours and a cooling fan is interfaced in order to reduce the ambient temperature in case if the temperature exceeds a threshold. A Wi-Fi dongle is connected to the USB port. Two DC motors are connected for the robot movement through the relay circuit. Another DC motor for supplying oxygen is connected to the board. This whole module is sealed and it is allowed to monitor the working environment. The power supply for the robot wheel is given by using a 12v battery.

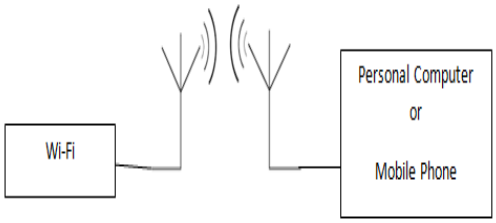


Fig.2 Block Diagram of Receiver

In the Figure-2 the block diagram of the transmitter section is given. In this section a mobile phone or a personal computer can be used. The robot is tethered with the mobile phone. The created web browser is opened in it and used.

HARDWARE IMPLEMENTATION

The Raspberry pi3 microprocessor is used since this is compact in size and the power consumption is too low. Broadcom chip BCM2837 SOC is placed in it and it has a memory of 1GB LPDDR2 RAM with 1.2GHZ frequency. Raspberry Pi3 board is selected because it is fast when compared to the earlier versions. Many sensors or peripherals can be interfaced with it at the same time and can work very fast as the quad core processor is used in it. This processor allows us to interface many

modules at a time. It has 26 GPIO pins, two 3.3V pins, two 5v pins and 8 ground pins. It has 4 USB ports also which allows us to connect the camera, Wi-Fi module etc.

The temperature sensor used here is LM35.As it is an analog sensor. It is used to sense the ambient temperature of the coal mine industry. This sensor is connected with the GPIO pins. The working of the cooling fan depends on the above sensed data. LM35 sensor has an operating range of about -55°C to 150°C. Inside the industrial area the temperature may exceed above 45°C. So this sensor is used.

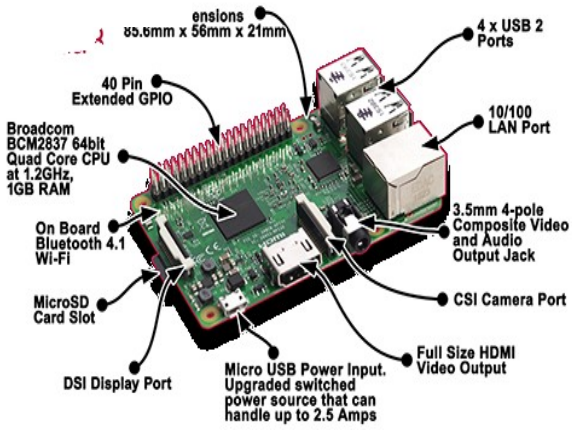
MQ2 gas sensor is used in order to sense the gas leakage in the mining areas. A gas sensor is for detecting the combustible, flammable and the toxic gases. The MQ2 sensor mainly detects the methane gas which is most emitted in coal mining areas. The voltage required is 5V which is provided from the GPIO pin. In the gas sensor, H-pins are allowed to heat for a while so that it can detect the gas. Once the gas is detected, an alert is given to the workers.

The Fire sensor is used as a simple and compact device for protection against fire. The module makes use of IR sensor and comparator to detect fire up to a range of 1 - 2 meters depending on fire density.

Raspberry pi3 having only digital pins. All the sensors are analog sensors, so we have to convert analog values to digital values using MCP3008 IC.

A normal USB camera is connected to the board. The camera captures and sends the live video signal to the receiver. It has a coverage area of 150 feet. The data transmission rate is about 54Mbps. So the live video can be transmitted without any delay.

The robot wheel is connected to the two DC motors of 10rpm. Those motors are given 12V as the input voltage. The motors are not directly connected to the raspberry pi board. They are interfaced by means of a relay circuit. The cooling fan and the buzzer will work by means of the relay operation which acts as the switch here. A 4 channel relay board is used. The relay will also acts as a safety measure because the robot wheels are given a 12V and if any back emf occurs means it will short and damage the raspberry pi board directly. So in order to avoid this, an optocoupler is placed in the relay circuit board.



Raspberry pi3 Board

SOFTWARE IMPLEMENTATION

The raspbian os is used in the raspberry pi board. It is a free operating system that is based on Debian which is particularly optimized for the Raspberry Pi hardware. It comes with over 35,000 packages and pre-compiled software bundled in a

simple format for easy installation in the Raspberry Pi. The coding for all the sensors and the robot movement are done using the python coding. Python is preferred since it is a simple and a minimalistic language. It is also free and open source software. This can be used in many platforms such as Linux, VxWorks, and PocketPC etc. Also, it supports procedure-oriented programming as well as OOPS. The web browser is created by using HTML. The static IP address should be configured in the raspberry pi for the Wi-Fi dongle. This assigned static ip address is for connecting with the Wi-Fi of the mobile phone for the live video transmission. Since a normal usb camera is used it must be initially installed in the raspberry pi3 board using the linux commands.

PROPOSED WORK

A robot is designed using the raspberry pi board. The raspberry pi board is given a power supply of about 5V. The sensors which are connected are given power through the GPIO pins. An usb camera is fixed in the robot. The camera will capture the industrial environment and it will transmit the live video to the mobile phone and displayed in the created web browser. In the web browser five navigation buttons are formed for the front, back, left, right movement of the robot and stop button for stopping the robot. The Wi-Fi dongle in the robot must be tethered with our mobile phone using the username and password. After tethering, a web browser should be opened and the static IP address must be given and the user name and the password of the raspberry pi are typed. After authenticating, the created web browser will be opened automatically and the robot is operated using the navigation buttons in the browser page. The robot wheels are given 12V from a separate rechargeable battery. The movement of the robot depends on the python coding inside the raspbian os. The wheels are connected through a relay. The relay which here used is a 4-channel relay. When the robot is kept stationary, the GPIO pin which is connected to that particular relay is given HIGH. During movement they are set to LOW. When the temperature sensor senses the temperature above 35ºC, the GPIO pin which is connected with the cooling fan through the relay is set to LOW which will operate the cooling fan. Also, when any gas is sensed, the GPIO pin of the buzzer is kept LOW and thus the buzzer will be ON. If there is more suffocation inside the mining area, the carbon dioxide emission will be more. When this CO2 is sensed, the oxygen supply cylinder will be opened by setting the GPIO pin of that particular relay to LOW.

The robot movement operations are given using the python coding and saved in the SD card in the microprocessor. These movement functions are called from the web browser navigation buttons using webiop macro function. When any navigation button is pressed it will call the particular function from the main program and the particular operation will takes place. For giving alert the audio file is saved inside and if any emergency situation occurs the ALERT button is pressed and thus the sound will be produced. The sensed data will be displayed in the corner of the web browser.

ALGORITHM OF PROJECT

Step1: Power Supply to the Raspberry PI Board

Step 2: Initialization of GPIO Ports for Raspberry PI, Sensors and Hardware

Step 3: If any sensor value greater than threshold value the buzzer gives an alert

Step 4: If temperature exceeds threshold value cooling fan will be ON

Step 5: If gas value exceeds threshold value oxygen cylinder will be opened

Step 6: If fire value exceeds threshold value water sprinkler will be ON

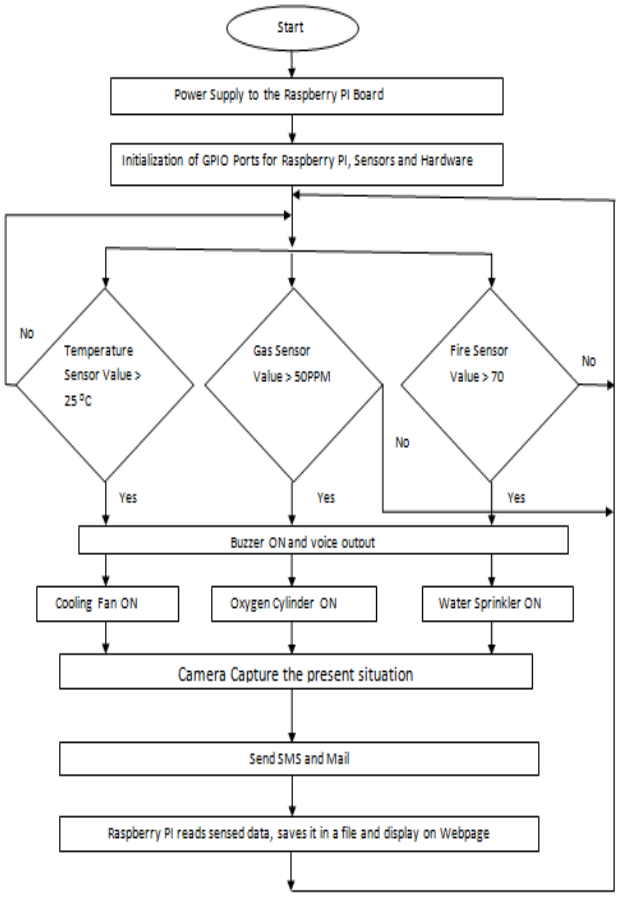
Step 7: Then Camera Capture the Present Situation in coalmine

Step 8: SMS and Mail send to the control room

Step 9: Raspberry PI reads sensed data, saves it in a file and display on Webpage

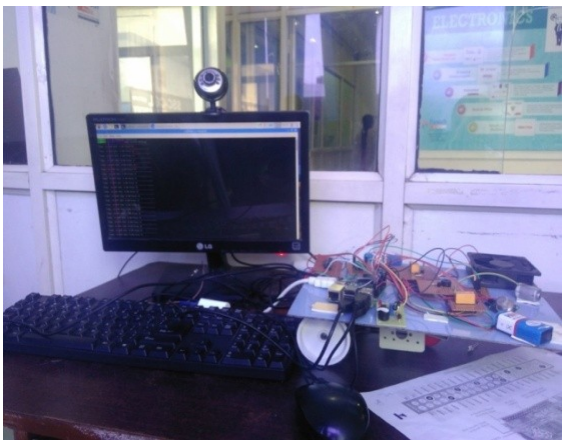
Step 10: This Process repeats until system stop by the user

FLOWCHART OF PROJECT



Flowchart of Project

RESULTS



Project Setup

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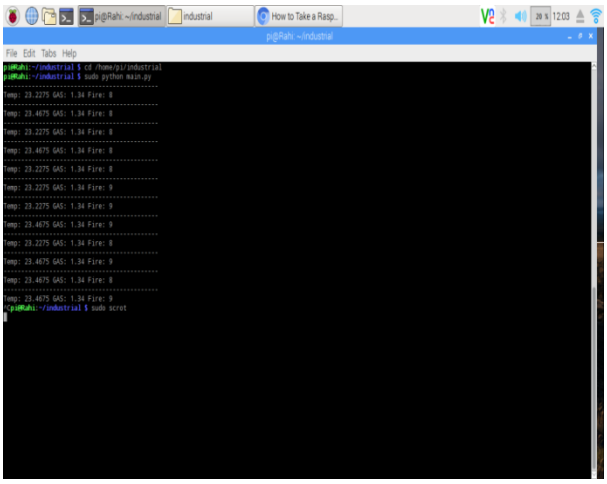
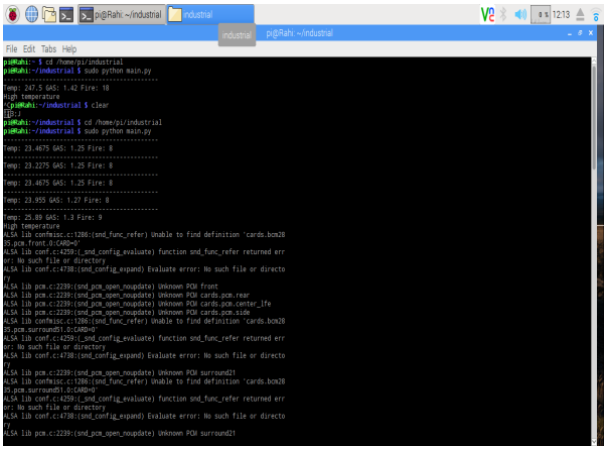
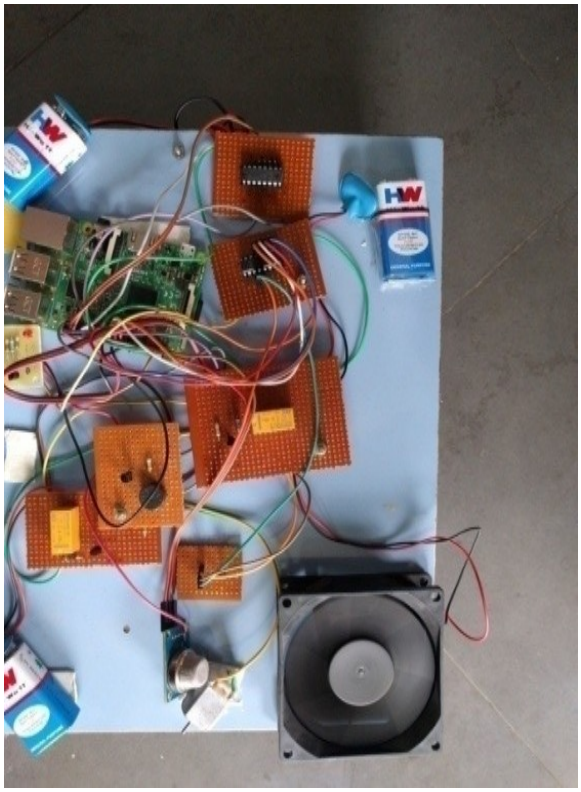


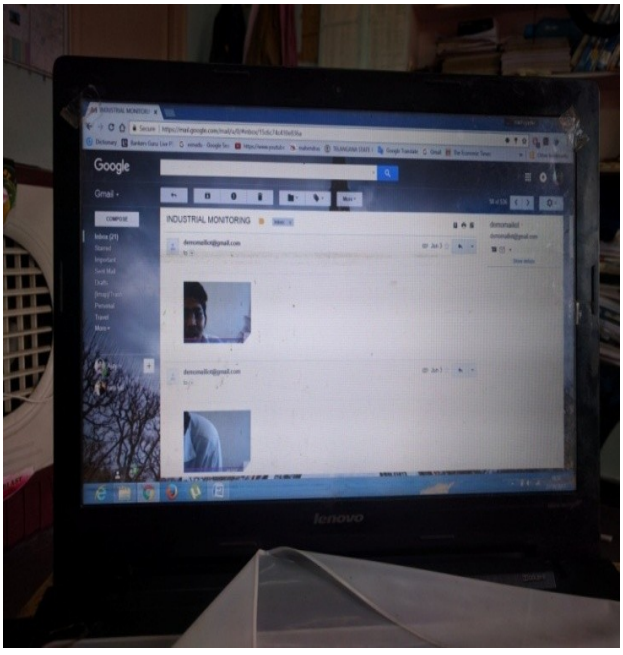
Pi window when main code running



When high temperature detected



When temperature greater than 25 ° C fans is ON



Mail output

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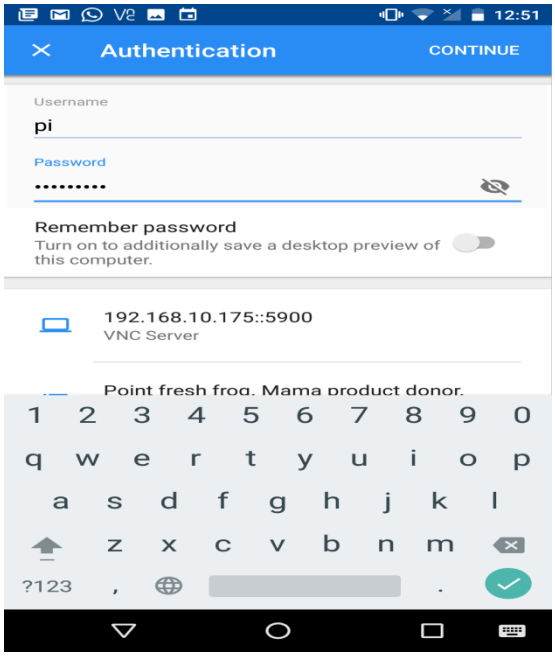
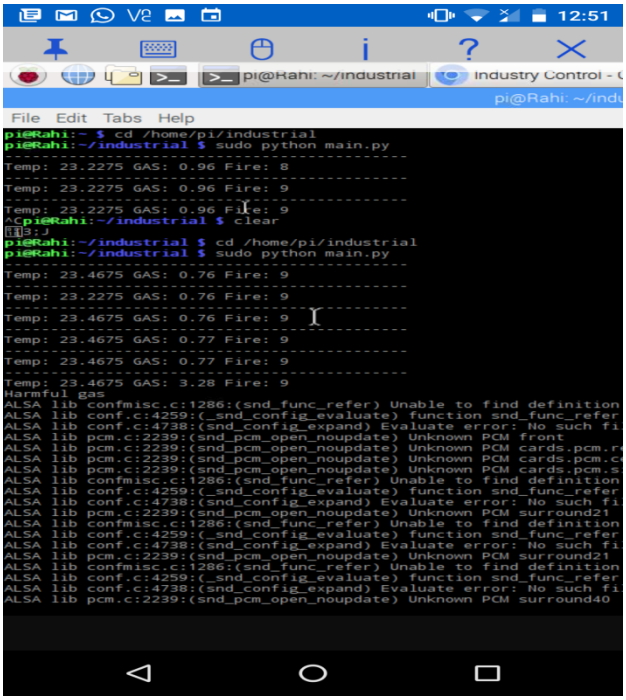


Authenticate Window output



Raspberry pi window in the mobile through vnc viewer

CONCLUSION AND FUTUREWORK

The designed robot is reliable to use and can be used in any working environment. The sensors which are used are so sensitive. The gas sensor will also detect other leakage such as hydrogen, smoke etc. This model can also be used for other purpose also. The work environment can be seen from the controller room itself. Since Wi-Fi is used, the data can be transmitted from any place. The suffocation of the labours working inside the mine is avoided. The accidents are prevented which are caused by ambient conditions. This application can be used for all industrial area where human intervention for security can be avoided. In hospitals, shopping malls also this application can be used. This project can be enhanced by placing a water sprayer in the robot. In case of any fire accidents water has to be sprayed at the right place. Also, some other sensors such as dust sensor, humidity sensor can be interfaced for further convenience of the workers.