"A Hardware Implementation Of Hazardous Gases Detection Using Robot"

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Abstract:

A repair work was going at a digester which is used for fermentation and production of biogas in the year 1997, Italy. During repair work an explosion has occurred. Loss of gas and residues of welding operations are the cause for explosion. If we keep on doing survey nearly 37 deaths have been occurred because of explosions from the year 1993 to 1999. Though by keeping in this mind with the help of Robot we have developed a project to take care of hazardous gas detection in order to save people from these kind of explosions.

Keywords: *Coal mines, CO2, Microcontroller, GSM module transceiver and Sensors*

I. INTRODUCTION

The fermentation and production of biogas plays a very important role in digester. Leakage of gas and residues of welding operations are the cause for explosion. Italy is the best example for the Explosion. In the year 2009, near UK ,during the biogas production A worker was trying to loosen up a crust that was preventing the digester from working properly. He died after breathing the gas inside the digester [1][2].

In view of this, The robot plays an important role in order to detect the poisonous gas. This paper tells that the robot reaches the ON SITE, it detects and sends the environmental conditions such as temperature, presence of poisonous and dangerous gases. A robot equipped with different sensors for detecting various gases and if value of gases crosses set limit then system provide safety to workers who are working in coal mine and biogas plants [3][4][5]. An environmental air pollution monitoring based on the IEEE 1451 standard for low cost requirements". According to this paper, it deals with developing of a system which helps to detect various gases based on the sensors used.It deals with the implementation of the various sensor arrays in the STIM (Smart Transducer Interface Module)and in the form of array types.It discusses about the different programs which have lead to precise measurements of gases in order to build an environmental air pollution monitoring system which is capable of developing a clear air pollution monitoring by the IEEE standard. This usage of sensors produces low cost, low maintainance, quick response and also the ability to produce continuous measurements of precise data [6]..[16].

The benefits of data centre temperature monitoring deals with the developing of temperature monitoring and sensing device with some benefits. In this temperature sensing device, it consists of the hardware interconnector for interfacing8 distinct interconnector with pairs of sensors present at distinct points. The temperature is monitored by using real time data logger application. This device allows the registration of temperature at different points of the data centre followed by data interpretation over a period of time [17]..[19].

This project is to build a surveillance robot which is economically, technically and operationally feasible. The robot requires minimal maintenance and as the robot is autonomous it does not require any operator. It can also send data to any computer and smartphone because Bluetooth is used for communication. The robot uses two motors to drive a caterpillar track which by design is focused on torque rather titan rpm. So it can cover more harsh terrain.

II. COMPARISION

Nihal Kularathna et.al.presented a paper "An environmental air pollution monitoring based on the IEEE 1451 standard for low cost requirements". According to this paper, it deals with developing of a system which helps to detect various gases based on the sensors used.It deals with the implementation of

the various sensor arrays in the STIM (Smart Transducer Interface Module)and in the form of array types.It discusses about the different programs which have lead to precise measurements of gases in order to build an environmental air pollution monitoring system which is capable of developing a clear air pollution monitoring by the IEEE standard. This usage of sensors produces low cost, low maintainance, quick response and also the ability to produce continuous measurements of precise data.

S.Albert presented a paper "The benefits of data centre temperature monitoring ".According to this paper,it deals with the developing of temperature monitoring and sensing device with some benefits. In this temperature sensing device, it consists of the hardware interconnector for interfacing8 distinct interconnector with pairs of sensors present at distinct points. The temperature is monitored by using real time data logger application. This device allows the registration of temperature at different points of the data centre followed by data interpretation over a period of time.

III. BLOCK DIAGRAM

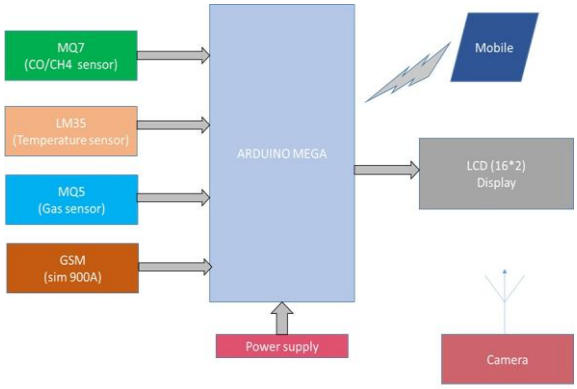

Figure 1: Interfacing of Sensor and GSM with arduino

The above figure shows the block diagram implementation of Interfacing of Sensor and GSM with arduino. The sensors used 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 pc.

The figure 2 shows the block diagram of Robot. The Robot is installed with 8051 Microcontroller and Bluetooth in order to communicate with the Server to detect the Hazardous gas in the underground.

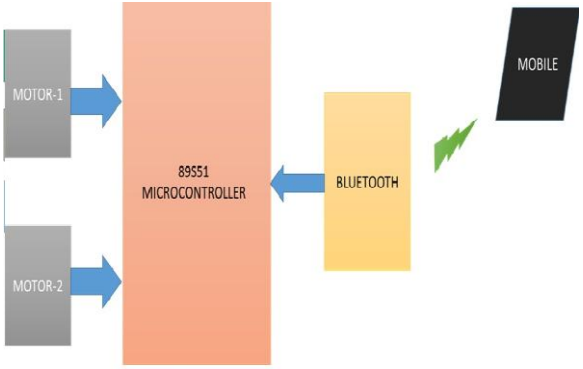

Figure 2: Block Diagram of Robot

IV. METHODOLOGY

The hardware at the local site is composed of microcontroller ATMEGA, GSM module transceiver, sensors such as LM35 for temperature detection, MQ5 sensor for CO and methane gas sensor, driver IC, RS 232connector PC Monitor display, buzzer for alert Various sensors like carbon monoxide MQ5,temperature sensor LM-35,IR sensor takes analog measurement from local site for detecting various parameters such as carbon monoxide, temperature levels, through ADC gives digital output to the microcontroller ATMEGA.GSM transmits this digital sensor data to the remote monitoring site located at maximum distance from local site (30m). GSM can be used at router Remote monitoring site (pc) continuously monitoring sensor data in the designed format of GUI. Whenever the sensor data exceeds the specified threshold (preset) value of temperature, carbon monoxide , the GSM module at remote monitoring site is transmit alert signal to local site by blowing buzzer continuously

In this project there are two sections. The first section is ON SITE Section and OFF SITE section. The designed systems are placed in different

parts of the site and connected by means of GSM. In ON SITE Section the sensors will sense the environment conditions such as temperature, Methane gas,CO gas etc, and this information is send to ADC of the micro controller. Microcontroller displays this information in the monitor display and sends through GSM transmitter. In OFF SITE Section,GSM receiver takes that information and sends to the controller in turn sending the information to GSM as well as displaying on the GUI display. Here GUI sends the message and Store data of various parameter in data log.

The parameters such as temperature, Methane gas and carbon monoxide gas are measured by means of respective sensors and the output voltage measured by them is directly connected to the ADC of the ATMEGA , as the output voltage never exceeds 5V, there is no need of connecting a signal conditioning circuit. The number of people inside the area is monitored by the help of LM35,MQ5 gassensor.If any of the received parameters are beyond the set limit, then a Buzzer will be ON, giving warning to the people. The parameters are displayed on the Monitor display and as well as transmitted to the Onsite Section through the GSM.

The GSM receives the information and sends to the ATMEGA controller. The monitor to the controller displays the information in the OFF SITE Section. The controller is communicated viaGSM through RS232.

V. HARDWARE AND SOFTWARE REQUIREMENTS

Any embedded Platform is considered, The Hardware and software requirements is major challenging trade off among them.

A. HARDWARE REQUIREMENTS

The hardware needed for the system are as below:

- Arduino Mega
- SIM 900 GSM module
- MQ5 sensor
- MQ7 sensor
- LM35 Temperature sensor
- 16X2 LCD display
- 89S51 microcontroller
- Bluetooth module

a). Arduino Mega

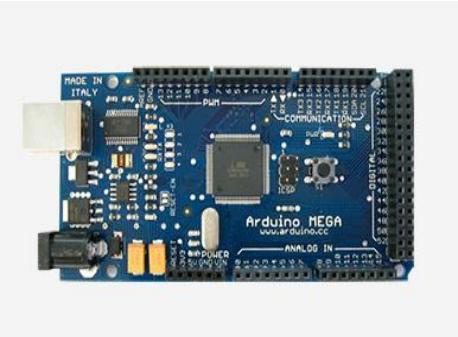

Figure 3: Module of Arduino

The Figure 3 shows the Arduino Mega microcontroller board based on the ATmega1280 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz 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 a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically.
External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.
The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.
The power pins are as follows:
VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board

regulator, or be supplied by USB or another regulated 5V supply.
3V. A 3.3 volt supply generated by the on-board FTDI chip. Maximum current draw is 50 mA.
GND. Ground pins.

The ATmega1280 has 128 KB of flash memory for storing code (of which 4 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

The Arduino Mega has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega1280 provides four hardware UARTs for TTL (5V) serial communication. An FTDI FT232RL on the board channels one of these over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Mega's digital pins.

The ATmega1280 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation on the Wiring website for details. To use the SPI communication, please see the ATmega1280 datasheet.

b). GSM SIM 900

Figure 4: GSM Module

The Figure 4 shows the GPRS module breakout board and minimum system of SIM900 Quad-band/SIM900A Dual-band GSM/GPRS module. It can communicate with controllers via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands). This module supports software power on and reset.

The Table 1 shows the different levels of hardware requirements for the Implementation.

Table 1: Levels of Hardware Requirements

Sl NO.	Module	Description
1	Sensor MQ 35	Wide Range Gas Sensor
2	MQ 7	Low Conductivity Gas Sensor
3	LM 35 Temperature Sensor	Linear Temperature Sensors
4	16*2 LCD Display	Displaying Screen
5	AT89S51	low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of In-System Programmable Flash memory
6	Bluetooth Module	Bluetooth operates at frequencies between 2402 and 2480 MHz, or 2400 and 2483.5 MHz including guard bands 2 MHz wide at the bottom end and 3.5 MHz wide at the top

B. SOFTWARE REQUIREMENTS

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures Single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License or the GNU General Public License permitting the manufacture of Arduino boards and software distribution by anyone.

Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus on some models, which are also used for loading programs from personal computers. Themicrocontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment based on the Processing language project.

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

The embedded c programming language is used in the microcontrollers. The embedded c language is a general-purpose programming language that provides code efficiency, elements of structured programming and a rich set of operators. Embedded c is not a big language and is not designed for any one particular area of application.

It's generally combined with its absence of restriction, makes embedded c A convenient and effective programming solution for a wide variety of software tasks. Many applications can be solved more easily and efficiently with embedded c than with other more specialized languages.

The embedded c language on its own is not capable of performing operations (such as input and output) that would normally require intervention from the operating system. Instead, these capabilities are provided as a part of standard library. Because these functions are separated from the language itself, embedded c is especially suited for producing code that is portable across wide platforms.

VI. RESULTS

A. Mechanical Design

The robot is built rigid enough for a prototype;it is reinforced with carbon fibre sticker.All the circuits fit in and are screwed properly to the body.To reduce the complexity most of the components are prototyped on the bread board.The power supply is an array of rechargeable 9v batteries.

B. Working of the Sensor

The detections sensors used are temperature sensor,MQ5 and MQ7 gas sensor.The temperature sensor is producing accurate results,as it was compared with other sensors to make sure about the result.Testing the accurate results of MQ5 and MQ7 sensors are very difficult,because the availability of natural gases are restricted. Therefore alternates had to be used for demonstration purpose and testing.Instead of methane in MQ7 sensor,butane from cigarette lamp sensor had to be used,this showed a rise in the value, but the percentage of gas in comparison to the atmosphere were not able to deduce.For this a proper chemical lab and equipment is required.Similarly instead of using pure carbon monoxide in MQ5 sensor,for safety purpose a burnt out candle smoke was used,this is also CO,because of the absence of oxygemn.Again not an accurate mode of testing,but because of the lack of resources it was required.

Nevertheless the datasheet was used to determine the properties of the MQ series sensors, and even without proper testing a value built using simple setups.A gas leak from a cigarette lamp within seconds hiked the MQ5 sensor output and the Gas was detected.

C. Working principle

Figure 5: Hardware Module

The Figure 5 shows the Hardware Module Implementation. The robot works in dual mode, which means that, the robot can be controlled in both manual mode and automatic mode. This is the distinguishing factor while compared to the other kind of robots, as the most of the bots work in manual mode. The automatic mode robot is programmed within the embedded chip and it makes the robot to act as human beings. This version of robot is mainly defined by the factor named Artificial Intelligence. The second distinguishing factor from the other robots is that, the proposed robot is capable of sensing humans, who are trapped inside the coal mines. The wireless communication used is Bluetooth which helps in transferring the data and messages. In the proposed system, the system circuit can be implemented with the help of a block diagram which includes the sensors, modules of Bluetooth, camera, buzzer unit and the power supply. These devices are interfaced with the help of PIC (6F877A) microcontroller. All of these sensors are directly connected to the PIC (6F877A) micro-controller which have their own default program according to their use.

The working energy of the robot is obtained from the battery which is attached to the PIC microcontroller. A wireless camera, which helps in the live streaming of the nearby incidents, is included along with the other sensors. Buzzer unit act as an indicator, that is, it helps in identifying whether any obstacle is present in its way or not. If an obstacle is present, it gives an alert message to its operator. The PIR (Passive Infra-Red) sensor is used mainly for detecting the obstacles. The motor helps in moving the robot which implemented with the help of driver IC. The aim of the robot is monitoring and detecting the variations in temperature, gas and obstacles in coal mine environments. Not only detecting, tracing on to a screen can be easily done by wireless camera attached on the robot. The visualization of all details is done by using the wireless LCD connected to the robot, so that all details of the environment can trace easily.

VII. FUTURE ENHANCEMENTS

The prototype model an actual rover developed in this project has scope for improvement which could result in this prototype being implemented in real time in various hazardous environments by adopting the following practices.

1)In the future,we can exercise higher transmission range technologies so that the rover can travel a greater distance and be utilized in different environments based on the transmission range.

2)Development can also be made in the number of sensors incorporated in the rover.Industrial grade sensors with better sensitivity and ambient ambient parameters measurements can be used in place of the laboratories/commercial grade ones used in the prototype.Various other sensors like oxygen sensors can be added thus helping in getting a much improved image of the environment inside.

3)Due to the limited usage period of the rover, there is a need to use more energy efficient battery technologies to operate the rover for prolonged periods of time.The prototype cannot be used for hours at a stretch but the actual rover is required to operate continuously until the operations at industries and laboratories are completed.It can be equipped with a more powerful battery or power supply that has optimum energy efficiency.

4)Heat sinks like fans and other cooling mechanism can be incorporated into the actual model which is larger in terms of size and volume so that it can be operational for extended hours in more critical climate conditions.

5)The enhanced model can be equipped with a 360 degree high resolution camera to optimize portability and maneuverability and provide better surveillance of the surroundings. A night vision camera can also be introduced for a more advanced operation.

6)An application can be used which turns on the phone into a network camera with multiple viewing options.The camera can be viewed on any platform with VLC player or any web browser.Video stream can be supported inside wifi network without internet access.Optional video cloud broadcasting is supported for instant global access.

VIII. CONCLUSION

The Project is aimed at providing human safety for the workers in hazardous environments such as coal mines and industrial units. This is a prototype which can be implemented in real time by using components with better range and efficiency. The rover enters hazardous environments and provides data about the harmful gases that may be present and the ambient temperature based on which the workers will be sent with all necessary precautionary measures. Bases on the sensors of CO, temperature, humidity and light intensity, the equipment which is suitable for the surface CO concentration monitoring was developed in order to realize remote real time acquisition of multi variate

information in the monitoring of CO. The use of an autonomous surveillance rover in order to monitor the environmental conditions of an indoor area is an alternative to the application of the network of fixed environmental sensor. The surveillance rover uses on board sensors to obtain the ambient temperature and the gas presence in order to analyze ambient conditions, detect abnormal situations, and propose the development of further actions. The rover is able to measure distributed environmental parameters, detect abnormal ambient situations and improve occupants comfort and safety.

Hence, through this project, we have implemented the existing technologies of Bluetooth, microcontrollers and android operating systems in an innovative manner to develop a Bluetooth controlled rover that functions effectively as both a monitoring and surveillance device whose objective is to identify any factor that endangers the health and safety of minors and industrial workers and alert them to avoid a possible catastrophe**.**

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