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Safety Measures In Mines using Automation

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ABSTRACT

In this paper we are implementing surveillance, safety measures for mine workers which is most essential in underground mining areas/sections. Here we are presenting MEMS based sensors network used to monitor the environment parameters of underground mine area and sends all sensed parameters/data to the PLC(Programmable Logic Controller). Gas sensor is used to detect the gas found underground. The vibration sensor is used to detect the vibrations .Vibration above a particular level would be assumed as a problem in the mine which would actuate the lift and provide timely help to the workers.

Keywords : Sensors Network, PLC, Gas Sensor, Vibration Sensor

I. INTRODUCTION

Safety of person is primary concern/aspect in any industry, especially in undergrounding mining industry. To avoid any type of unwanted phenomena, all mining industry follows some basic precaution and phenomena. In underground coal mine major of accidents occurred are based on fire and natural gas and overheating of surroundings. We are also considering the health condition of a person using Fall-Detector, made of MEMS-Accelerometer (ADXL335). Coal mine safety monitoring system based on wireless sensor network can timely and accurately reflect dynamic situation of staff in the underground regions to ground computer system. The hybrid underpass radio propagation model comprising of the free space propagation and the modified waveguide propagation is proposed. However, using popular radio communication inside underground mines has some drawbacks. While radio signals are transmitted, attenuation, diffraction, multi-path and scattering are frequently very serious. Thus, wireless communication is the important need today for the fast, flexible safety, accurate and production method in underground mines.

There are different other research ideas proposed by different people on wireless communication. In a network called chain-type wireless underground mine sensor network (CWUMSN) is recently proposed which consists of three kinds of sensor nodes: sensing nodes, cluster head nodes, and a base station deployed on both sides of the tunnel at regular intervals to monitor the underground environment and locate the miners. A new decision-making approach to coal and gas outburst prediction with multisensory information fusion is proposed.

This system is design by considering all these parameters i.e. it can sense temperature, pressure, humidity, Fire, Gas as well as Persons Fall. Therefore the designed system is giving a very good solution for most of the problems faced in mine accidents.

A good communication system must be set between mine workers and Remote Base Station For this wired network communication is inefficient in underground mining areas. So we are choosing a wireless network system based on RF communication at 2.4 GHz (CC2500 RF Module is a Trans-Receiver module which provides easy to use RF communication at 2.4 GHz.) And GSM networks for sending SMS to fire and Ambulance.

II. METHODS AND MATERIAL

The proposed system is divided into two segments. First is a hardware circuit that will be attached with the body of the Mine Workers. It may be preferably fitted with

the safety helmet of the workers also. This system has a sensor module consisting of some sensors that measures real-time underground parameters like temperature, Humidity, Accelerometer, LDR, Fire Sensor and Gas concentration. Excess Gas concentration is meant for the harmful gases like Methane, Carbon-monoxide, Butane and Propane.

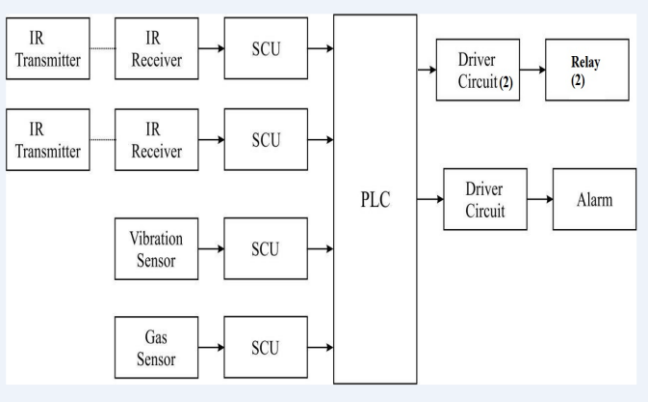

Figure 1. Block Diagram of the system

PLC is used with the sensors to receive the sensor outputs and to take the necessary decision .When there is any vibration in the coal mine then there could be a potential problem which could lead to mine collapse. At this time the vibration sensor detects any vibration in the coal mine and will forward its input to the PLC . The PLC will then turn on the alarm indicating that there is some problem in the mine and the concerned official can take measure to do the needful to reduce or minimize the gravity of the situation

As soon as the alarm will be turned on a lift will move don the mine to bring out the workers trapped inside the mine.An IR sensor placed at the gate of the lift will count the number of workers entering the lift When the lift will get filled to it capacity it will move up an.

III. HARDWARE DESCRIPTION

A. Piezo Electric Sensor

A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge. The prefix piezo- is Greek for 'press' or 'squeeze'.
Piezoelectric sensors are versatile tools for the measurement of various processes. They are used for quality assurance, process control, and for research and development in many industries. Pierre Curie discovered the piezoelectric effect in 1880, but only in the 1950s did manufacturers begin to use the piezoelectric effect in industrial sensing applications. Since then, this measuring principle has been increasingly used, and has become a mature technology with excellent inherent reliability.

They have been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a tilt sensor in consumer electronics or a pressure sensor in the touch pads of mobile phones. In the automotive industry, piezoelectric elements are used to monitor combustion when developing internal combustion engines. The sensors are either directly mounted into additional holes into the cylinder head or the spark/glow plug is equipped with a built-in miniature piezoelectric sensor.

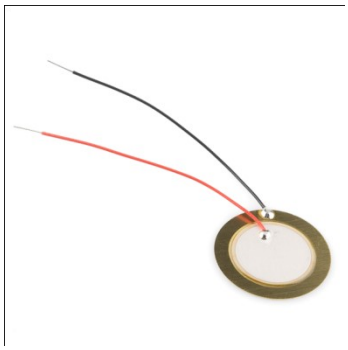

Figure 2. Piezo Electric Sensor

The rise of piezoelectric technology is directly related to a set of inherent advantages. The high modulus of elasticity of many piezoelectric materials is comparable to that of many metals and goes up to 106 N/m².Even though piezoelectric sensors are electromechanical systems that react to compression, the sensing elements show almost zero deflection. This gives piezoelectric sensors ruggedness, an extremely high natural frequency and an excellent linearity over a wide amplitude range. Additionally, piezoelectric technology is insensitive to electromagnetic fields and radiation, enabling measurements under harsh conditions. Some materials used (especially gallium phosphate or tourmaline) are extremely stable at high temperatures, enabling sensors to have a working range of up to 1000 °C. Tourmaline shows pyroelectricity in addition to the piezoelectric effect; this is the ability to generate an electrical signal when the temperature of the crystal changes.

B. DC Motor

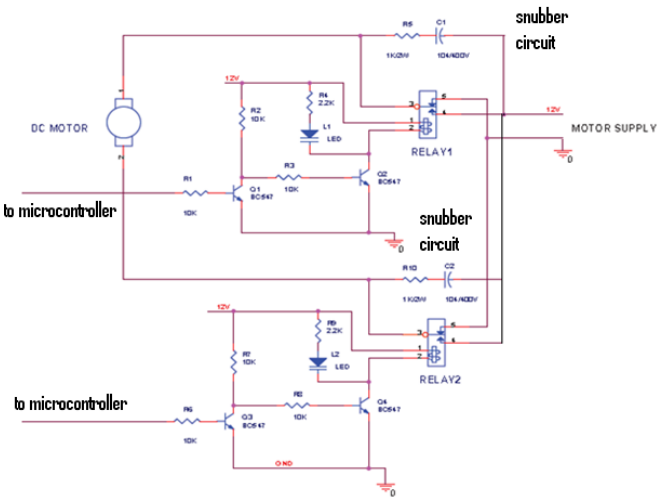

Figure 3. Circuit of DC motor

This circuit is designed to control the DC motor in the forward and reverse direction. It consists of two relays named as relay1, relay2. The relay ON and OFF is controlled by the pair of switching transistors. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and normally open (NO). The common pin of two relay is connected to positive and negative terminal of DC motor through snubber circuit respectively. The relays are connected in the collector terminal of the transistors Q2 and Q4.

When high(5 Volt) pulse signal is given to either base of the Q1 or Q3 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero (Zero volt)signals given to base of the Q2 or Q4 transistor. So the relay is turned OFF state.

When low pulse is given to either base of transistor Q1 or Q3 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 or Q4 transistor so the transistor is conducting and relay is turn ON. The NO and NC pins of two relays are interconnected so only one relay can be operated at a time.

The series combination of resistor and capacitor is called as snubber circuit. When the relay is turn ON and turn OFF continuously, the back EMF may fault the circuit. So the back EMF is grounded through the snubber circuit.

- When relay 1 is in the ON state and relay 2 is in the OFF state, the motor is running in the forward direction.
- When relay 2 is in the ON state and relay 1 is in the OFF state, the motor is running in the reverse direction.

C. Relay

Relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil.

Figure 4. Relay

D. IR Detection Circuit

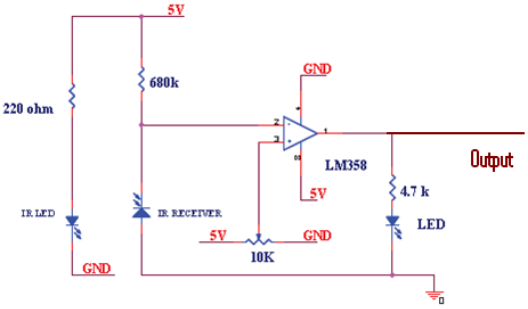

Figure 5. The IR Detection circuit

Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other.

The transmitted signal is given to IR transmitter whenever the signal is high, the IR transmitter LED is conducting it passes the IR rays to the receiver. The IR receiver is connected with comparator. The comparator is constructed with LM 358 operational amplifier. In the comparator circuit the reference voltage is given to Non inverting input terminal. The inverting input terminal is connected IR receiver. When interrupt the IR rays between the IR transmitter and receiver, the IR receiver is not conducting. So the comparator Non inverting input terminal voltage is higher then inverting input. Now the comparator output is in the range of 0V. This voltage is given to microcontroller and LED will OFF.

When IR transmitter passes the rays to receiver, the IR receiver is conducting due to that non inverting input voltage is Higher than inverting input. Now the comparator output is +5Volt so the output is given to microcontroller so LED will glow. This circuit is mainly used to for Line tracking and length calculators etc.

E. LPG GAS Sensor

Schematic Circuit

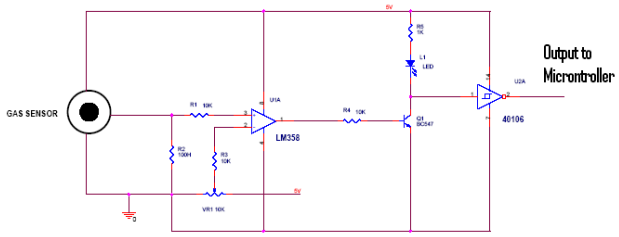

Figure 6. LPG gas sensing circuit

Ideal sensor for use to detect the presence of a dangerous LPG leak in your car or in a service station, storage tank environment. This unit can be easily incorporated into an alarm unit, to sound an alarm or give a visual indication of the LPG concentration. The sensor has excellent sensitivity combined with a quick response time. The sensor can also sense iso-butane, propane. The unit will work with a simple drive circuit and offers excellent stability with long life.

This circuit is mainly designed to sense the present LPG GAS in the atmosphere. The LPG GAS (Propane) is sensed by the gas sensor. The gas sensor is the one type of transducer which produces the voltage signal depends on the gas level. Then the voltage signal is given to inverting input terminal of the comparator. The comparator is constructed by the operational amplifier LM 741. The reference voltage is given to non inverting input terminal.

The comparator compares with normal reference signal and produces the corresponding output error signal. Then the output voltage is given to microcontroller in order to determine the presence of a dangerous LPG leak.

F. Programmable Logic Controller

A Programmable Logic Controller, PLC, or Programmable Controller is a microprocessor used for automation of industrial processes, such as control of machinery on factory assembly lines. Unlike general-purpose computers the PLC is designed for extended temperature ranges, dirty or dusty conditions, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are stored in battery-backed or read-only memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a strictly bounded time. The main difference from other computers are the special input/output arrangements. These connect the PLC to sensors and actuators PLCs read limit switches, temperature indicators and the positions of complex positioning systems. Some even use machine vision. On the actuator side, PLCs operate electric motors, pneumatic or hydraulic cylinders or diaphragms, magnetic relays or solenoids. The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a proprietary computer network that plugs into the PLC.

Figure 7. PLC

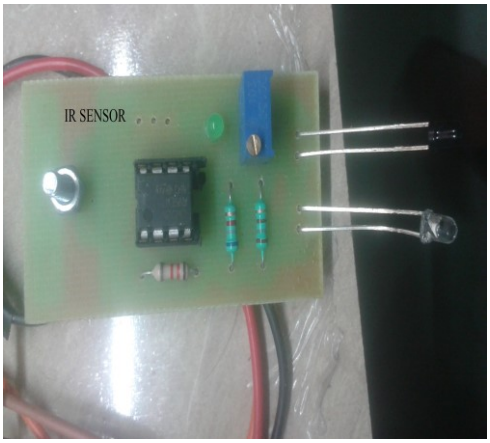

Figure 8. IR Sensor PCB

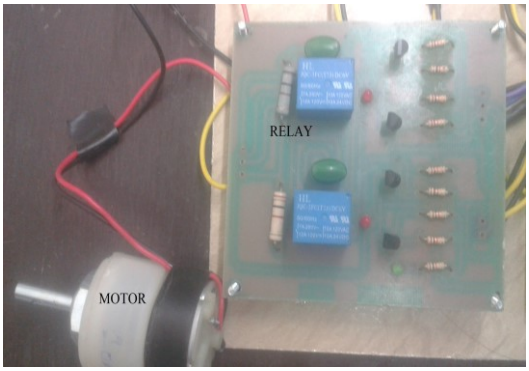

Figure 9. Relay PCB

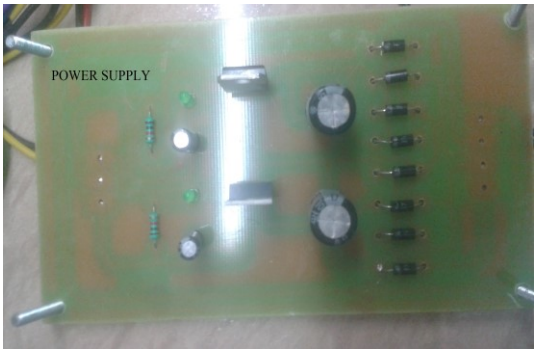

Figure 10. Power supply PCB

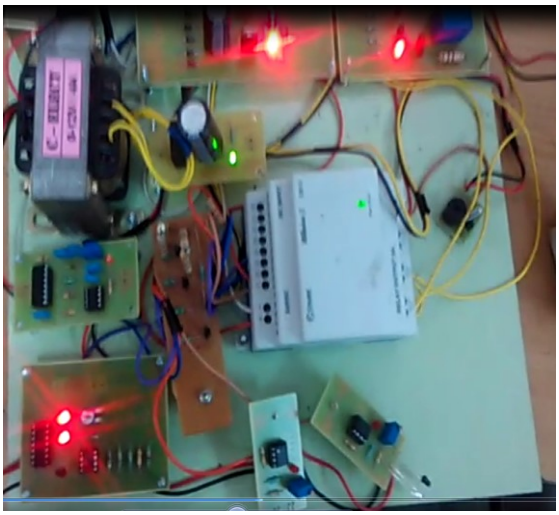

Figure 11. The Final Implementation

IV. CONCLUSIONS

Thus we have been able to present a security system which can be effectively used in the mines. Our system covers the most Important and Primary necessity aspect of any mine workers safety. The system will be helpful in reducing the casualties on the account of the help being provided instantly.

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