Solar Based Robotic Vehicle for Fault Detection

N.Saravanan[1], Naveen R[2], K.H. Sivanand[3]
[1, 2, 3] *Department of Electrical and Electronics Engineering, ACS College of Engineering, Bengaluru-74, India*

***Abstract*— The aim of this work is to design a Solar Powered mobile robot that can inspect the abnormal conditions such as gas leakage, fire hazard, worn out insulation in an underground cable tunnel, which can precisely detect the exact location of fault point by using a GPS tracker. This Solar Powered mobile robot is used as substitute for human presence to detect the fault.**

***Keywords*: Photo voltaic cell, GPS Tracker, ARM 7.**

I. INTRODUCTION

Other than generation, transmission of electrical energy stood as a challenging project due to different constraints because the inception of using electrical electricity. It's far commonplace to have transmission line held alongside the roadside being mounted on poles. However the idea of having an underground cable to transmit power is likewise some other opportunity. Overhead lines are prone to lightning strikes which can cause service interruption. Overhead strains use bare conductors and might motive damage in the event that they spoil. The protection value of overhead strains is extra consequently, underground cable for energy transmission stood as 2nd concept aside from the overhead traces. There are numerous challenges to be addressed in implementing this technology. To make the tunnel environment safe enough for functioning and retaining 0 downtime of deliver we want to check and correct the faults taking place in the underground cable. but, it is a tough mission to locate the fault in underground cable when compared to overhead traces. This cellular inspection robot is one enterprise to test on-line the situation of tunnel the usage of cell analyzing robotic. This technique gained momentum and there are numerous experiments being conducted and examined for the online tracking.

II. BLOCK DIAGRAM

Step one of this task is constructing a platform to hold all of the above mentioned sensors integrated into circuits into the tunnel. Two 10 rpm vehicles are constant at the again stop of the platform to force the robotic. All of the sensors, transceiver, GPS tracker, GSM, H-bridge and energy presenting battery are linked to the microcontroller in step with the pin diagram. Then the GPS module is attached to transmission and receiving pins of the microcontroller and the tracker is tested.

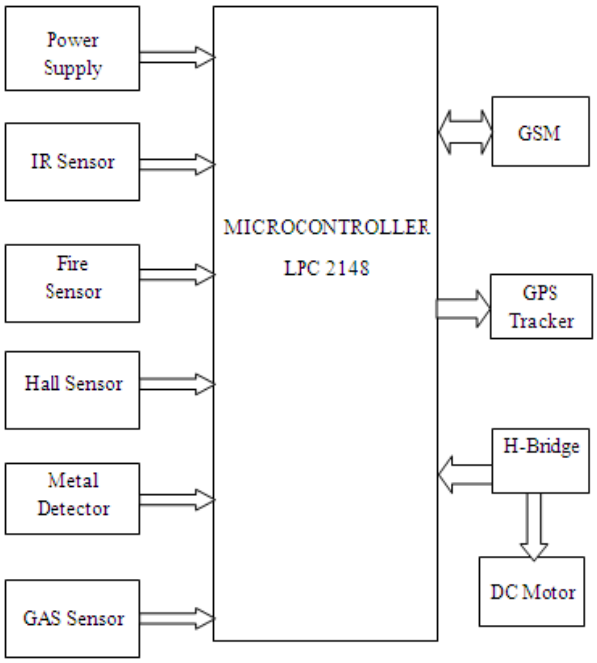


Fig 1 Block Diagram

The microcontroller has only two pins for external communication which are to be accessed by both the GPS tracker and the wireless transceiver. To attend this need the serial port software is used to convert the digital pins into communication pins which are connected to transceiver.

All the above circuit elements are integrated into the circuit to their final positions and after testing the whole circuit is placed on the robotic base. Final testing of all the setup is done. The robotic platform is free to move in forward and reverse direction and can move inside the tunnel with ease. This is placed in the virtually created underground cable environment in our college laboratory and the robot is passed through this passage.

The information regarding the environment around the robot is transmitted wirelessly to the wireless receiver and transmitter which is connected to a microcontroller. The data is thus transmitted by the transceiver on the robot to the transceiver connected to the microcontroller near the control unit. Microcontroller when interfaces to computer the data can be seen on the computer screen.

III. CIRCUIT DIAGRAM

ARM7 LPC2148

Micro controller is system on chip. Micro controller is used to perform specific task whereas microprocessor is used for multitask. Example for microcontroller system is washing machine; example for microprocessor based system is computer. ARM7 is a microcontroller in which it has many series in that we are using LPC2148. LPC2148 is the widely used IC from ARM7 family. It is manufactured by Philips and it is preloaded with many peripherals making it more efficient and a reliable option for the beginners as well as high end application developers.

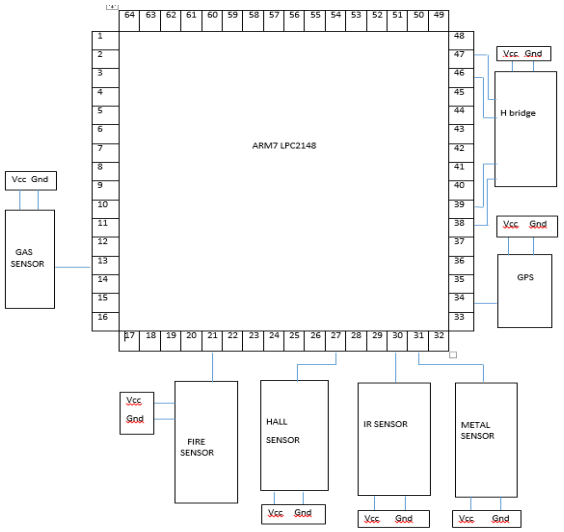


Fig 2 Circuit Diagram

LPC2148 need minimum below listed hardware to work properly:-

1. Power supply
2. Crystal oscillator
3. Reset circuit
4. RTC crystal oscillator
5. UART

Power Supply

LPC2148 works on 3.3V power supply LM117 can be used for generating 3.3V supply. However, basic peripherals like LCD,ULN2003(Motor Drive IC) etc. works in 5V so AC mains supply is converted into 5V using below mentioned circuit & after that LM117 is used to convert 5V into 3.3V.

Reset Circuit

Reset button is essential in a system to avoid programming pitfalls and sometimes to manually bring back the system to the initialization mode.MCP 130T is a special IC used for providing stable RESET signal to LPC2148.

Oscillator Circuit

Oscillations, the heartbeat, are provided using a crystal & are necessary for the system to work.

RTC Oscillator Circuit

It provides clock for RTC (Real Time Clock) operation.

UART

LPC2148 has inbuilt ISP which means we can program it within the system using serial communication. MAX232/233 IC must be used for voltage

Infrared Sensor

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. 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.

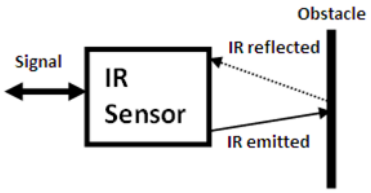


Fig. 3.3 IR Sensor

Temperature Sensor

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ^{o}C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 ^{o}C temperature rise in still air.

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ^{o}C rise/fall in ambient temperature, *i.e.*, its scale factor is 0.01V/ ^{o}C.

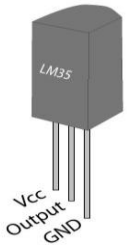


Fig.3.5 Temperature Sensor

Gas Sensor

The working principle behind the MQ-5 gas sensor is as follows: The sensor has a sensitive filament made of SnO2. In the presence of clean air, this filament tends to have lower electrical conductivity. When a combustible gas such as LPG is introduced, the filament's conductivity rises, and the amount of change in its conductance/resistance can be used to indicate the equivalent gas concentration. This effect tends to be particularly pronounced at higher temperatures, and resistive heating element is present as well. SnO2 is particularly sensitive to Methane, Butane and Propane, but is also sensitive to other combustible gases as well.

Metal Detector

At the heart of an Inductive Proximity Sensor is an electronic oscillator consisting of an inductive coil made of numerous turns of very fine copper wire, a capacitor for storing electrical charge, and an energy source to provide electrical excitation. The size of the inductive coil and the capacitor are matched to produce a self-sustaining sine wave oscillation at a fixed frequency. The coil and the capacitor act like two electrical springs with a weight hung between them, constantly pushing electrons back and forth between each other. Electrical energy is fed into the circuit to initiate and sustain the oscillation. Without sustaining energy, the oscillation would collapse due to the small power losses from the electrical resistance of the thin copper wire in the coil and other parasitic losses.

Inductive proximity sensors operate under the electrical principle of inductance. To amplify a device's inductance effect wire is twisted into a tight coil. This inductive proximity Sensor M12PNP has four components; the coil, oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of a doughnut around the winding of the coil that is located in the device's sensing face which is shown in Fig. When a metal object moves into the inductive proximity sensor's field of detection, Eddy circuits build up in the metallic object, magnetically push back, and finally reduce the Inductive sensor's own oscillation field. The sensor's detection circuit monitors the oscillator's strength and triggers an output from the output circuitry when the oscillator becomes reduced to a sufficient level.

Fire Sensor

This fire sensor circuit exploits the temperature sensing property of an ordinary signal diode IN 34 to detect heat from fire. The circuit is too sensitive and can detect a rise in temperature of 10 degree or more in its vicinity. Ordinary signal diodes exhibit this property and the internal resistance of these devices will decrease when temperature rises.

In the reverse biased mode, this effect will be more significant. Typically the diode can generate around 600 milli volts at 5 degree centigrade. For each degree rise in temperature; the diode generates 2 mV output voltages. That is at 5 degree it is 10 mV and when the temperature rises to 50 degree, the diode will give 100 milli volts. This voltage is used to trigger the remaining circuit.

Hall Sensor

When a beam of charged particles passes through a magnetic field, forces act on the particles and the beam is deflected from a straight path. The flow of electrons through a conductor is known as a beam of charged carriers. When a conductor is placed in a magnetic field perpendicular to the direction of the electrons, they will be deflected from a straight path. As a consequence, one plane of the conductor will become negatively charged and the opposite side will become positively charged. The voltage between these planes is called Hall voltage.

The Hall-effect is the generation of voltage across the opposite edges of current carrying conductor which is placed in a magnetic field.

When an electric current passes through a conductor placed in a magnetic field, a potential difference is developed across the conductor in a direction perpendicular to both magnetic field and the current and its magnitude is proportional to the current and magnetic field.

This is known as Hall-effect and it is basis for many magnetic field measuring instruments and devices.

Most of the sensors use the Hall-effect to sense the presence of magnetic fields, such sensors are called as Hall-effect sensors. The basic element of a magnetic sensor is the Hall-element. These sensors are usually packed in a four-terminal housing in which two terminals are control terminal and other two are differential output terminals.

The control current is applied at the control terminals whereas the output is observed at the differential output terminals. A basic Hall-effect sensor converts the magnetic field to electrical signal.

A magnetic system converts the physical quantities such as position, speed, current, temperature, etc. to a magnetic field which in turn can be sensed by Hall-effect sensors.

The hall voltage produced is due to the creation of electric field by the separation of electric charges in an external magnetic field. That means whenever electric charges on this Hall sensor W49E are in the external magnetic field due to the current flowing through the cable they experience a force and get aligned on either sides creating a magnetic field and hence the hall voltage.

$$V = R\ (I * B)/t \qquad (3.1)$$

V is the hall voltage, I is the current through the hall sensor, B the external perpendicular magnetic field and t the thickness.

GPS

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver.

The GPS system consists of three segments

1. Control segment

2. User segment

3. Space segment

User segments send the request of the position that is required. Through control segment the three satellites are selected through which the latitude, longitude and altitude information is collected & is sent to user segment. Space segment where the satellites of GPS receiver will be allocated. From that three GPS satellites are selected and information is sent to the GPS receiver on the user segment.

GSM Sim 900A

GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/ 1800 MHz The Modem is coming with RS232 interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The onboard Regulated Power supply allows you to connect wide range unregulated power supply . Using this modem, you can make audio calls, SMS, Read SMS, attend the incoming calls and internet ect through simple AT commands.

H-Bridge

In general an H-bridge is a rather simple circuit, containing four switching element, with the load at the centre, in an H-like configuration. An H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards.

IV. ADVANTAGES

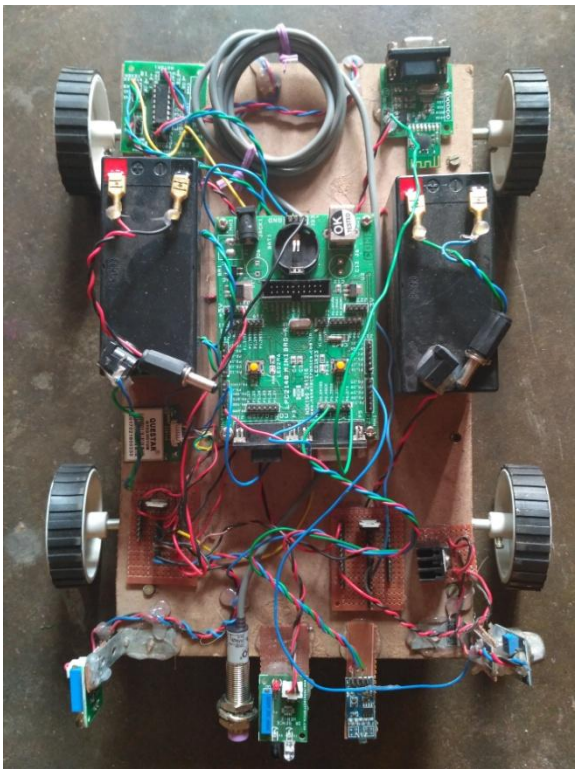
- Reliability of underground cables increases.
- Takes less time to clear the fault.
- Less weather effect when compared to overhead lines.
- Continuous power supply can be done.
- Exact location of fault can be detected.
- Particular fault can be known via GSM.

V. APPLICATIONS

- Nuclear Power Plant.
- Refineries.
- Chemical and Petrochemical Plant.
- Underground fault detection.
- Gas stations.
- Shopping complex or Malls

VI. CONCLUSION

The aim of the project is realized by testing the inspection of a mobile robot in a virtual environment conducive in producing real time operating atmosphere of an underground cable which can accurately spot the fault point and can report the co-ordinates of the fault point, which is novel attempt by using a GPS tracker. The main aim of this project is to design this Robot that can inspect the conditions in an underground cable tunnel even in dangerous environmental conditions where human presence is harmful. Hence this robot is used as substitute for human presence.



REFERENCES

[1]. G Mallesh, M.Ajith rao, "wireless Communications for underground Mining Safety", IJPRES, Vol. 4, Issue 2, Jan 2016.

[2]. B Jiang, M Raymond, "Robotic Platform for Monitoring Underground Cable Systems".

[3]. R Montero,R. Montero, J. G. Victores, S. Martínez, A. Jardón, C. Balaguer, "Past, Present and Future of Robotic Tunnel Inspection".

[4]. Fu Zhuang, Chen Zupan, Zheng Chao and Zhao Yanzheng,"A cable tunnel inspecting robot fordangerous environment",IJARS, Vol.5, No.3(2008), pp.243-248.

[5]. Xingsong Wang, Fengyu Xu, "Design and Experiments on Cable Inspection Robot", IECON, 2007.

[6]. Heena Sharma,M.T. Deshpande, Rahul Pandey, "Different Types of Fault Analysis and Techniques of Fault Location using PSCAD",IJETAE, Vol.3, Issue 5, May 2013.