Surveillance Rover for Scientific Applications

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***Abstract* -- Rover is a vehicle equipped with different type of sensors and moving mechanisms aimed to work for scientific applications. A rover essentially consists of a platform that can move on either wheels or chains. It can be controlled remotely. The sensors collect required data from the surroundings and generate audio-visual indications or transmit the data to distant monitoring facilities. Rovers are used to investigate the areas where the accessibility is poor and in suspected disasters. The rover described here can be used to sense smoke, temperature, electric shock and living body and to capture audio and video. Advancement in technology has provided different sensors for constantly monitoring the said parameters. This rover is self powered with a rechargeable battery and it moves on wheels. It can work continuously for hours with this in-built battery.**

Keywords -- Astable multivibrator, Pick-up coil, Distant monitoring facility, Poor accessible areas

I. Introduction

Rover is a moving platform or vehicle equipped with different electro-mechanical gadgets. It is a hybrid product of electronics and mechanics. Rovers are mainly used for collecting data or materials from places where accessibility is poor or dangerous. Rovers contain different type of sensors and even mechanical facilities for various applications. Sensors are normally meant for detecting physical conditions of the area like heat, electric shock, smoke or even detecting the presence of live human body. Camera and voice transmitter capture and transmit the video and audio information from surroundings Rovers carried by the aero-space vehicles are used to explore the geography of other planets.

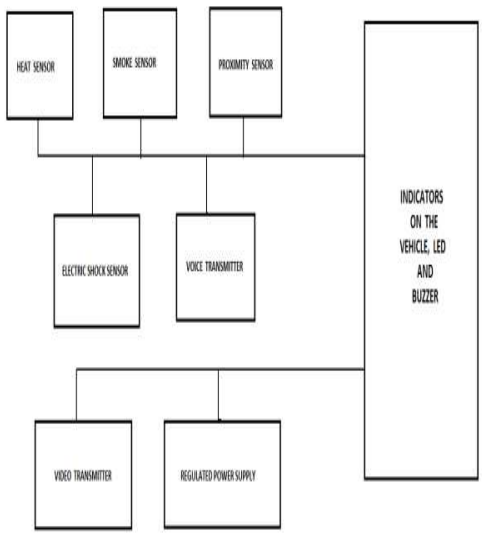
By electronic and mechanical means they collect samples, analyze it an will send to space stations or control centers in the earth. Rovers can be driven on wheels or on chains. It can be controlled by remote controls or wires depending on the application and the distance it has to travel. The assembly of a rover mainly involves robotics and electronics. Modern rovers are equipped with software and micro –controllers for smooth and accurate functioning. The rover presented here is used for sensing temperature, electric shock, smoke, living body and to capture audio and video of the surroundings. It moves on wheels and produce audio visual indications against respective inputs. Audio and video will be transmitted to a remote monitoring facility.

II. Robotic Sensors

Sensors are important aspects of robotics and many sensors are optical. Video, infrared and UV sensors are common, in addition to tilt and location; sensors help the robot to navigate in a variety of environments. A robot lacking sensor is deaf and blind and likely to run into things. With sensors it can find its way around, locate objects and access situations that have significance for surveillance. The robot can take a picture or select a segment of video and extract various shapes or colors that are distinctive or recognizable and match them against the database to figure out what they are or how they deal with them. Many types of sensors are used in these robots.

A.Smoke Sensor

It is used to sense the presence of heavy smoke in a remote area. It produces an audio-visual alarm when the sensor detects smoke. The transistor responsible to trigger



the IC555 is kept in OFF state by providing negative voltage at the base by the conduction of the LDR against the lighting of an LED inside the sensing chamber the opacity increases and the LDR becomes non-conductive. The transistor become forward-biased and triggers to produce output. When the density of the smoke decreases, the LDR starts to receive bright light from the LED and the process repeats.

Audio-visual indications are equipped in the circuit. It produces an audio visual alarm when the sensor detects smoke. The transistor responsible to trigger the 555 IC is kept in off state by providing negative voltage at it's base by the conduction of an LDR against the lighting of an LED inside the

Optical smoke detector is used to detect the presence of smoke with an optical sensor When the smoke is detected it generates an alarm. The circuit is built around a 555 counter IC. Smoke sensor used here is an optical sensor made with an LDR and a white LED. LDR conducts when the light falls on it from the white LED. The conductivity of LDR depends on the intensity of light falls on it. When the light falls on it the LDR conducts normally. But when the smoke enters into the sensor, opacity will develop and the intensity of the light falls on to the LDR changes and which in turn varies the conductivity LDR. This variation of the current through the LDR is made use of to sense the presence of smoke.

Resistor R1 limits the current through the LED inside the sensor. .Normally the LDR inside the sensor is in conductive state and therefore the base of transistor T1 is at a low potential. Preset VR1 determines the threshold level and resistor R2 provides additional protection to transistor T1 and the sensor unit. The trigger input (pin:2) of IC 555 wired as mono stable is pulled high by resistor R3. Normally, when there is no smoke near the sensor pin No: 2 remains high due conduction of the transistor T1 and as a result the output the IC will be in low state.

When the sensor detects smoke, the LDR gets insufficient light from the white LED and as a result transistor T1 forward biases to make trigger pin 2 of IC 555.The output pin of IC 555 will be high due to triggering and the transistor T2 will turn-on. T2 acts as a relay driver. The relay is wired to operate an audio/visual alarm. When a no smoke condition arises, the output of IC 555 became low and the alarm stops. The circuit works on 6 volts regulated DC.

B. Temperature Sensor

Used to detect high temperature and it produce an audio-visual indication as long as the external temperature is maintained high. The sensor is a Germanium diode connected in reverse biased state. When the temperature is high the diode became conductive and the negative voltage through the diode turns a transistor off which turns the alarm on.

The circuit is used to sense the rise in temperature around the sensing element. The circuit is built around a 555 IC. Sensor used here is a Germanium diode (1N 34) encapsulated in a metal plate as sensing surface. The heat sensing diode is connected in reverse biased mode. At normal temperature the resistance of the diode is high (At normal temperature due to junction barrier, the diode offers high resistance) and as a result transistor T1 conducts to hold the reset pin 4 of 555 IC in low state.

IC 555 is wired as an astable multivibrator. When the temperature around the sensor diode increases due to overheating the resistance of the diode falls and the transistor T1 stops conduction due to the negative voltage developed at the base of transistor T1. This enables IC 555 "ON" and the oscillator starts to trigger an alarm.

Preset VR1 can be varied to change the sensitivity. The alarm continues till the temperature around the diode reaches to normal level. The circuit works on regulated 9 V DC. Diode is connected in reverse biased mode. At normal temperature due to junction barrier the diode offers high resistance.

C. Electric Shock Sensor

A circuit used to sense the presence of electricity without physically touching it. A decade counter IC 4017 is employed to build this circuit. IC counts the field changes while AC travels through a conductor and provides a visual indication. A sensing coil senses the AC induction field and transmitted to the counter.

. This is a contact less sensor that works on the principle of, "picking the radiating electro-magnetic fields around the current flowing surface". A pick-up coil is used to sense the field and is called the field coil. The circuit is built around a Decade counter IC CD 4017. CD4017 gives output according to the input pulses (clock) counted at its input pin(14). When the sensor is close to the live wire or electric field the circuit activates and the LED glows. As the input impedance of the CMOS IC CD 4017 is high, the electric field induced in the sensor is sufficient to clock it. The output obtained at pin No: 11 of the 4017 drives the LED. The circuit works on regulated 9 Volts DC.

D. Living Body Detector

There are two types of sensors to sense the presence of human.

Sensor-1- Based on the electric field developed by a living body (Proximity Sensor)

This sensor works on the principle of sensing the electric field generated by a living body. The sensed voltage is amplified and which in turn used to bias a transistor and which in turn triggers a 555 IC to produce an audio-visual indication.

Senser-2- Base on the Passive infra red radiations emitted from a living body.

This sensor is exclusively used to detect the living human body which emits IR radiation.

The sensor used here is proximity sensor. Proximity sensor is used to detect the presence of a living body with in a reach of few centimeters. All living things produce an electromagnetic field around it due to the electrical activities inside the body. This circuit triggers an alarm when such a field is detected around the sensor equipped. The circuit is built around a 555 counter IC.

When the power is turned on, capacitor C3 (47 pf) charges through resistor R1 (1Mega Ohm). Output pin 3 of 555 remains high as long as the voltage at its pin No: 2 is below 2/3 volt Vcc; the buzzer beeps for this period. Beyond that voltage, the output resets (became low).

Transistor T1 and T2 (BC 548) form a Darlington pair .As long as T1 and T2 remain in cut-off state, capacitor C3 retains the charge and the buzzer is off. When a living body comes close to the sensor loop T1 conducts due to the pickup of electric field at its base. So the capacitor C3 gets a discharge path and the voltage at pin 2 of IC 2 going below

1/3 Vcc sets output pin 3 high. As a result, the alarm triggers.

The alarm continues until C3 charges to 2/3 Vcc due to gradual withdrawal of the body part from the pick-up loop. The series combination of capacitor C5 and resistor R3 within dotted lines is optional and reduces the signal strength at the base of T1. Sensitivity can be varied by changing the values of C5 and R3. The circuit works on regulated 9 V DC.

E. *FM Voice Transmitter*

A very sensitive voice transmitter is installed in the rover. It is built around an op-amp IC 741 and an RF transistor. A condenser microphone is used to pick sounds from the surroundings. It can transmit up to few meterseffectively and can be monitored with an FM receiver.

A sensitive FM voice transmitter picks the sound signals from where the rover moves. The signals can be heard through an FM receiver from a certain distance. The sound picking element is a condenser microphone. It works on the principle of varying the capacitance in between two plates kept closely. The microphone contains FET to amplify the signals. The output impedance of the microphone is high. An external polarizing voltage is required to bias the condenser microphone. Sometimes this power is called Phantom power. The microphone can pick audio signals from several meters away. It then amplifies and transmits in the FM frequency range.

The circuit comprises of 2 stages namely, a high-gain audio preamplifier and a VHF oscillator .The audio preamplifier is based on an op-amp IC 741. By adjusting 1 mega-Ohm preset, the gain of op-amp can be varied .The a vhf oscillator is wired around RF transistor C 2570. The amplified audio signal modulates the RF carrier frequency. The modulated signals are transmitted from the antenna. Inductor L1 has four turns of 20 SWG wire on a 4 mm diameter air core wound with a slight spacing to a length of 1.5cms. Frequency of transmission can be adjusted by varying the space between the turns of the inductor or varying the capacitance if the trimmer capacitor with a value of 22 pF. Any frequency slot can be selected in between 88 to 108 MHz .The output power is highly restricted to mill watt range because of the transmitter works on broadcast spectrum. An ordinary FM receiver kept few meters away can be used for monitoring the signals.

Operational amplifiers are otherwise called comparators. These amplifiers have two inputs and one output. Inputs are called inverting input and non-inverting input. Output will always depend on the variation of voltage in either of the inputs. Op-amps provide high gain normally.

F. *Video Transmitter*

A video camera and a video transmitter are installed to capture the vision and for Navigation and to capture visual data. It can transmit visuals without distortion upto few meters. The camera is self-powered. A television receiver remotely kept can be used to monitor the visuals.

III. PCB Fabrication

Electronic circuits can be assembled in many ways. Small circuits can be tested on Bread boards, involves the usage of excessive wire lengths for interconnections. This is not recommended especially for the circuits that operate on high frequencies (Ex: Radio Frequency applications). Another method is the usage of general purpose boards called Vero boards(strip boards, island boards etc). Here also the interlinking of components are not that much easy, lots of cuts and makes to be performed in order to function the circuit.

The most recommended way to assemble an electronic circuit is the usage of Printed Circuit Boards or PCBs. PCB is the dedicated platform to assemble a particular circuit. Inter connections are made with printed copper lines or foils. Placement of each component is pre - determined and the holes are drilled to insert the leads.

PCB fabrication starts from the circuit diagram. Initially with the support of a PCB design software the component placement and routing is done. Component leads are placed at "PADS" and interlinking or routing is done by "TRACKS". This is called the PCB layout. A PCB has 2 sides: component layout side and solder side.

Next stage is to transfer the PCB layout in a copper clad board. A copper clad board is made with a copper foil sticked at one surface (two surfaces in double sided PCBs) of an insulator board made with paper epoxy-hylm epoxy or glass epoxy material. Among these, the glass epoxy board is used for high quality and high precision assemblies. A mirrored image of the older side layout is transferred to the copper foil by screen printing method or manual drawing. The ink or paint should be of water proof in nature (Ex: Plasticisor inks). After drying the print the board is immersed into the solution of Ferric chloride prepared in warm water. The solution tray should be placed under a lamp or direct sun light. The reaction is photo chemical. Then agitate the tray slowly to flow the solution uniformly all over the board.

After 10 to 20 minutes (depends on the concentration of the chemical) the copper foil free from the printed layout dissolves away, leaving the prints intact. This process is called Etching .Then wash the board in fresh water, dry it and remove the paint or ink with a suitable solvent and drill holes with a mini drill at the pads. The tracks and pad can be tin coated for enhancing conductivity and solderability. After finishing the component assembly, the PCB should be washed with isopropylalcohol, dry it and apply a thin coat of insulation varnish all over the solder side.

IV. Applications

This rover can be used for few applications as described below.

- Like surveillance, navigation and monitoring applications.
- For rescue operations during earth quake, effluence of toxic gases, floods, fire and similar natural calamities.

- Used for detecting the presences of live human body from the natural calamities like flood or war affected areas.
- For the detection of extreme temperature, smoke inside mines, industrial go downs, storage area of toxic materials, explosives etc. where safe and direct human access is difficult.
- Video and Audio transmitters can be used for security applications in different areas (military).

V. Conclusion

The idea behind the development and construction of this project is aimed to the practical implementation of the theoretical knowledge gained till now. The circuits in the project involve all most all commonly used electronic components and it's applications like rectification, amplification, modulation, demodulation, filtering, limiting, different kinds of sensing techniques, PCB design & construction and mechanics. All the Printed Circuit Boards are self designed and self fabricated.

The rover is designed and the aforesaid parameters are verified. The parameters can be sensed either individually or at a time. Since there is separate LED and buzzer for each sensor, there is no confusion in producing output of each parameter. Further, a light is attached with the rover to light the dark areas.

VI. Future Work

This project can be further extended by adding few more sensors. Further, the movement of the rover can be controlled using stepper motor. Using a data transmission scheme, status of the sensor can be transmitted back to the control station.

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The estimated amount of this project is Rs. 5000/-

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