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Design of Robotic Vehicle for Metal Detection Applications

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Abstract— **This project is designed to build a simple, cost effective and feasible robotic vehicle that can be employed in production shop floors, warehouses, inventory etc., where metals play an important role. The vehicle is employed with simple metal detection circuit that can detect metals. The system is controllable by a remote with the usage of Radio Frequency signals. The metals detection circuit consists of an alarm system that warns about detection of a metal. The required operation is achieved by an 8051 microcontroller. The directions and movement of the vehicle is done by signals and commands received from the transmitter. The driving motors used for the movement of the system are connected to the microcontroller. The Radio Frequency powered remote control has a range of controlling up to 200 meters. The metal detection circuit is mounted on the vehicle and its working operation is automatically done on sensing any metal. If the system senses any metal, it warns by producing a sound. The sound can be achievable by incorporating alarm system with buzzer. This system is important to aware about the detected metal. The design can be developed further by adding additional sensors such as ultrasonic sensor for obstacle detection and a camera for observing the scenes on a screen. The system can be used for detecting metals in foundry shops, jewel industries, land mines in army base, construction sites, plastic industries etc.,**

Keywords— **Radio Frequency, Metal detection, Motors, Microcontroller, Alarm.**

I. INTRODUCTION

Small scale production industries prefer automation system with low cost. Every production industry has departments where metal plays an important role such as shop floor, warehouse, inventory etc., Metal detection is an important and required system in foundry shops while recycling sand and knockouts, plastic industries while moulding, jewel industries for reducing wastage, construction sites for detecting steel structures in concrete and in land mines in army bases. This project is very helpful for fulfilling the above needs. The main objective is to design and fabricate a low cost radio frequency controlled simple robotic vehicle which can detect metals.

It consists of a control unit with a metal detection circuit that warns the user by producing an alarm sound if it detected any metal. The required operation is achieved by an 8051 microcontroller. The directions and movement of the vehicle is done by signals and commands received from the transmitter. As the design is said to be cost effective, the receiver and transmitter works on the radio frequency at 433 MHz. The advantage of Radio Frequency control over Infrared control is its controlling range as RF has 200 meters while IR has only a few meters limit. The directions and movement of the vehicle is done by signals and commands received from the transmitter. The driving motors used for the movement of the system are connected to the microcontroller. The receiver decodes the signal before sending the command to the microcontroller for driving the Motors.

The metal detection circuit is mounted on the vehicle and its working operation is automatically done on sensing any metal. If the system senses any metal, it warns by producing a sound. The sound can be achievable by incorporating alarm system with buzzer. This system is important to aware about the detected metal. The design can be developed further by adding additional sensors such as ultrasonic sensor for obstacle detection and a camera for observing the scenes on a screen. The ultrasonic sensor may help the system to prevent minor accidents. The system can also be developed further by mounting it on a material handling system such as

trolley. The system can be used for detecting metals in foundry shops, jewel industries, land mines in army base, construction sites, plastic industries etc.,

II. DESIGN

A. Microcontroller

The AT89C51 microcontroller is chosen as a controller of this project as it is low power, it has high performance CMOS 8 bit microcomputer with 4K bytes of PEROM. The Atmel AT89C51 is a very good microcomputer that offers a highly-flexible and cost-effective solution to many control applications.

B. Receiver

The STR-433 MHz IC serves as a receiver for this project. The data in the data pins are received by this IC from the antenna pin. In receiver module, there are two data pins.

C. Transmitter

As the design is cost effective and longer operating range is required, the STT-433 MHz is a better RF transmitter and it is chosen. It is also good for battery powered applications.

D. DC Motor

The primer mover required for movement of this vehicle is DC motors. The DC motor is chosen as it is good for battery powered applications. It is also compact. It provides rotatory motion to the wheels and the required torque to move the vehicle. The motor driver module which is L293D is used while connecting the motors with the controller.

E. Chassis

The chassis is an important part of the design as it is the base which holds every part and system. The chassis should be robust in design and cost effective. So, the chassis is built using Stainless steel. Stainless steel is easily available, cost effective, has better mechanical properties, easily machinable.

F. Metal detector circuit

The metal detector circuit has an oscillator. It produces AC current that powers the coil, producing an alternating magnetic field. This is the simple metal detector. If the metal which is electrically conductive is detected, eddy currents will be induced in the metal. This develops an alternating magnetic field of its own. This change in the magnetic field due to the detected metallic object is detected by using another coil to measure the magnetic field.

TABLE I
DESIGN SPECIFICATIONS

S.no	Component	Specification
1	Microcontroller	Atmel AT89C51
2	Receiver	STR-433 MHz
3	Transmitter	STT-433 MHz
4	DC Motor	2 * 9V DC motors
5	chassis	Stainless steel
6	Battery	9V Battery
7	Wheels	ABS plastic
8	Metal Detector coil	Copper
9	Cables and connectors	-

The other components required for fabrication of this design are Resistors, Transistors, Diodes, LED, Push buttons, IC, RF Encoder Decoder IC, Capacitors, PCB and Breadboards, L293D, RS232, Transformer, Adaptor, Switch and IC sockets. The software used for programming the electronic systems are Keil µVision IDE, Flash Magic, Proteus. The MC programming language is C programming.

III. WORKING & METHODOLOGY

The working of the design is based on Radio Frequency signals. It consists of Receiver and transmitter. The transmitter sends the command through signals required to operate the system. The receiver circuit receives the signal through Radio Frequency and controls the system according to it. For metal detection, a metal detection circuit is mounted on the receiver side. When a metal is detected, the vehicle stops and the alarm sound beeps.

The transmitter section has a RF encoder, RF transmitter and Push buttons. HT12E is used as a RF encoder IC. It is an 18 pin IC. The 4-bit binary input is applied to it through the AD0, AD1, AD2, AD3 pins. The TE pin is used for the transmission when it is low. The address pins used for secured transmission are A0-A7. In transmitter circuit, these pins are connected to ground. Parallelly, the 4-bit data is transmitted to the Radio Frequency transmitter. This is also transmitted to the receiver serially.

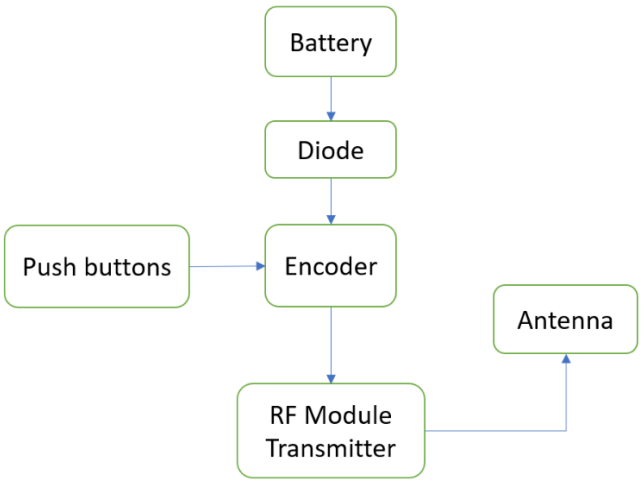

Fig. 1 Transmitter circuit block diagram

Receiver section has an altem AT89c51 microcontroller, Radio Frequency decoder, RF receiver, metal detection system, alarm system with buzzer, L293d motor driver IC and robotic setup. HT12D is used as the RF decoder. Port 2 of the microcontroller is connected by Decoded inputs. The Port P2.0 – P2.3 is connected by the data pins D0-D3. The decoded data controls the movement of the robot through the microcontroller. The port 3.4 is used for the buzzer. It rings when metal is detected.

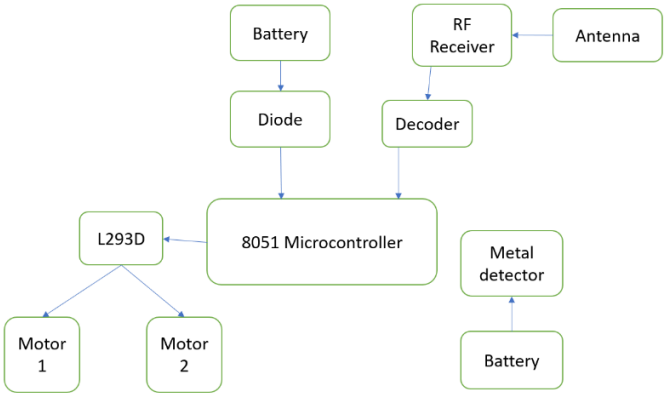

Fig. 2 Receiver circuit block diagram

The pin 3.2 of the microcontroller is for metal detection system. A push button is connected in place of metal detector. The metal detector circuit has an oscillator. It produces AC current that powers the coil, producing an alternating magnetic field. This is the simple metal detector. If the metal which is electrically conductive is detected, eddy currents will be induced in the metal. This develops an alternating magnetic field of its own. This change in the magnetic field due to the detected metallic object is detected by using another coil to measure the magnetic field.

L293d is a IC used as a motor driving module. This IC is used as high frequency current for driving motors will burn out other IC's. L293d has h-bridge internally.

IV. Conclusions

The machine is designed keeping cost effectiveness in mind. The materials and design used in this machine is chosen and designed cost effectively so that even the small-scale production units can easily afford. The machine is feasible and easily affordable by every production shop floors. The design can be further developed by adding additional simple electronic systems such as ultrasonic sensor for obstacle detection, camera for screening, metal separation system etc., It can be Designed and Fabricated easily as it comprises only simple mechanical & electronic systems which is economically efficient. As it is cost effective, it can be easily affordable by small scale production industries, workshops. It can be most effective in land mines, army base, jewel industries, construction sites etc., If it is developed further by adding additional sensors, It can play a major role in Production shop floors, material handling and warehouses.

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