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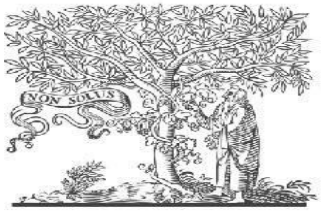

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10.48047/IJIEMR/V12/ISSUE04/200

Title Wireless Metal Detection Robotic Vehicle

Pages: 1542-1550

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Wireless Metal Detection Robotic Vehicle

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Abstract :

Our project proposes a Metal detection robotic vehicle operated using RF remote control wirelessly. The project demonstrates real life robotic vehicles used to detect land mines or other metal based objects on its path. The vehicle is fitted with a metal detection system that senses metals and then alarms the user about it through a buzzing sound of land mine possibility. The system works in conjunction with an 8051 series microcontroller to achieve this operation. The push buttons are used to send commands to move the vehicle forward, backward, left and right. Two motors at receiving end operate the vehicle as per the commands received. As soon as a command is sent it gets transmitted through rf transmitter. At receiving end an rf receiver reads the command and passes it to an 8051 microcontroller for Processing. The microcontroller then operates the motors to move the vehicle through a motor driver IC. The metal detection system attached to the system detects any metal underneath it. On detection it automatically sends on a small buzzing alarm to notify user about it. Thus the metal detection system coupled with a robotic vehicle allows for operating the robotic vehicle.

Introduction

An embedded system is **a microprocessor- or microcontroller-based system of hardware and software designed to perform dedicated functions within a larger mechanical or electrical system**.

For example, **a fire alarm** is an embedded system; it will sense only smoke. An embedded system has three components – It has hardware. It has application software.

It is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. An embedded system is a microcontroller-based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse physical variables and in diverse environments and sold into a competitive and cost conscious market.

Its purpose is to control the device and to allow a user to interact with it.

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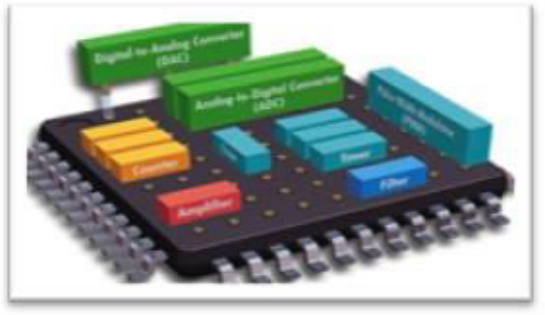


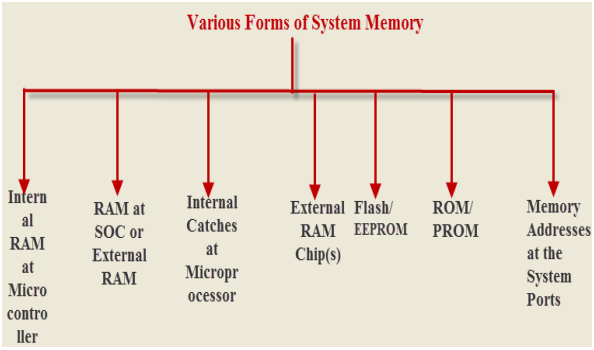
Real Time Operating System:

A system is said to be real time, if it is essential to complete its work and deliver its service on time. Real time operating system manages the application software and affords a mechanism to let the processor run. The Real Time operating system is responsible for handling the hardware resources of a computer and host applications which run on the computer.

An RTOS is specially designed to run applications with very precise timing and a high amount of reliability. Especially, this can be important in measurement and industrial automation systems wherein downtime is costly or a program delay could cause a safety hazard.

Memory:

In an embedded system, there are different types of memories. The various forms of memories are presented in the below chart.



Processors:

Different processors used in embedded systems are microprocessor, (DSP) Digital Signal Processor, microcontroller, RISC processor, ASIP processor, Arm processor and ASSP processor.

Embedding a Microprocessor:

Microprocessor is a general purpose processor, which can be embedded on a VLSI chip. The different streams of microprocessors used in embedded systems are given in the table

Stream	Microprocessor Family	Source	CISC or RISC or Both Features
Stream 1	68HCxx	Motorola	CISC
Stream 2	80x86	Intel	CISC
Stream 3	SPARC	Sun	RISC
Stream 4	ARM	ARM	RISC with CISC functionality

BATTERY:

An electrical battery is a combination of one or more electrochemical cells, used to convert stored chemical energy into electrical energy. The battery has become a common power source for many household and industrial applications.

Batteries may be used once and discarded, or recharged for years as in standby power applications. Miniature cells are used to power devices such as hearing aids and wristwatches; larger batteries provide standby power for telephone exchanges or computer data centers.

Principle of operation:

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions (negatively charged ions) migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cations (positively charged ions) migrate, i.e., the cathode or positive electrode. In the redox reaction that powers the battery, cations are reduced (electrons are added) at the cathode, while anions are oxidized (electrons are removed) at the anode. The electrodes do not touch each other but are electrically connected by the electrolyte. Some cells use two half-cells with different electrolytes. A separator between half cells allows ions to flow, but prevents mixing of the electrolytes.

EXPLANATION:

The metal detection robot project can be divided into sections:

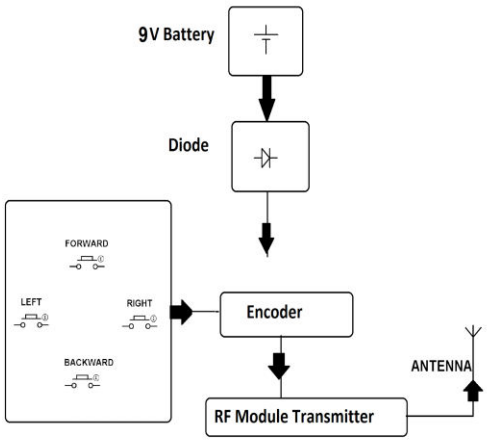
1) Transmitter section

2) Receiver section.

TRANSMITTER SECTION:

The transmitter section consists of RF encoder, RF transmitter and Push buttons. RF encoder IC used here is HT12E.It is an 18 pin IC .The 4-bit binary input is applied to the decoder through the AD0, AD1, AD2, AD3 pins. The TE pin enables the transmission when it is low.A0-A7 are the address pins used for secured transmission. These pins are connected to ground in the transmitter circuit. The 4-bit data is transmitted to the RF transmitter parallelly. This is transmitted to the RF receiver serially. Input is given to the encoder through buttons. The RF pair operates with a frequency of 434 kHz.

Transmitter



RECEIVER SECTION:

Receiver section consists of AT89c51 microcontroller, RF decoder, RF receiver, metal detector, buzzer, L293d IC and robot.

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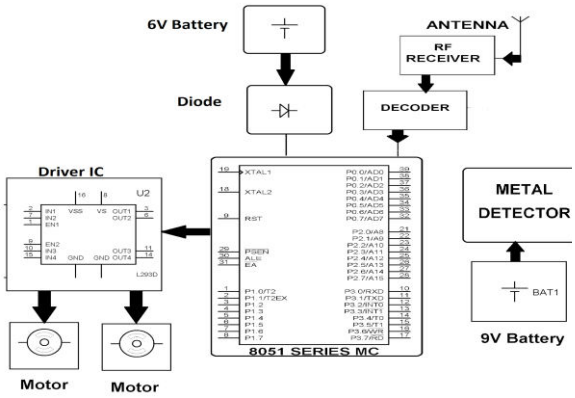
The data received is applied to the RF decoder. The RF decoder used here is HT12D. Decoded inputs are connected port 2 of the microcontroller. The four data pins D0-D3 are connected to the Port P2.0 – P2.3.The decoded data is applied to the microcontroller which controls the movement of the robot. The buzzer is connected to the port 3.4 and this rings when any metal is detected in its path.

Receiver



Hardware Specifications

- 8051 series Microcontroller
- Diodes
- RF Transmitter/Receiver
- LED
- DC Motors
- Motor Driver
- Metal Detector Coil
- Voltage Regulators
- Push Buttons

Software Specifications

- Keil µVision IDE
- MC Programming Language: Embedded C

WORKING:

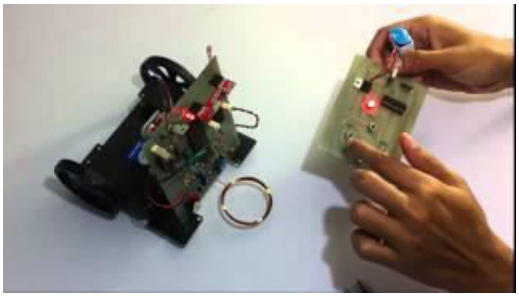
- Initially burn the code into the microcontroller using flash magic.
- Now switch on the power supply for the circuit.
- Now send the command '1' using the transmitter.
- This is transmitted to the receiver.
- At the receiver side receiver receives these commands and moves the robot according to the commands.
- The following commands moves the robot in the specified directions
    - Forward
    - Backward
    - Left
    - Right
- While robot is moving if any metal is detected in its path, the robot stops there ringing the buzzer.
- Again it starts moving when the commands are sent from the transmitter

Materials and Methods:

- **Microcontroller:** The microcontroller is the brain of the system and controls the movement of the robot and the operation of the metal detector sensor. Common microcontrollers used in RF-controlled robotic vehicles include Arduino and Raspberry Pi.
- **RF module:** The RF module is used to receive signals from the remote controller and transmit them to the microcontroller. Common RF modules used in RF-controlled robotic vehicles include the nRF24L01 module and the HC-12 module.
- **Motor driver:** The motor driver controls the movement of the robot's wheels. Common motor drivers used in RF-controlled robotic vehicles include the L293D motor driver and the TB6612FNG motor driver.
- **Metal detector sensor**: The metal detector sensor is used to detect the presence of metal in the

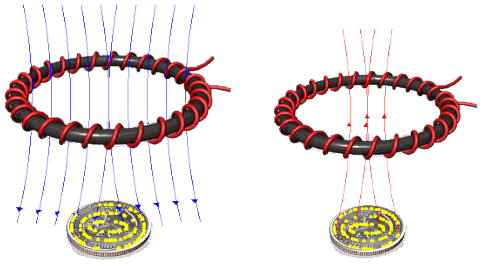
robot's surroundings. Common metal detector sensors used in RF-controlled robotic vehicles include electromagnetic induction detectors and pulse induction detectors.

- **Power supply**: The power supply provides the necessary voltage and current to operate the system. Common power supplies used in RF-controlled robotic vehicles include batteries or a DC power supply.



METAL DETECTOR

The operation of metal detectors is based upon the principles of electromagnetic induction. Metal detectors contain one or more inductor coils that are used to interact with metallic elements on the ground. The single-coil detector illustrated below is a simplified version of one used in a real metal detector. A pulsing current is applied to the coil, which then induces a magnetic field shown in blue. When the magnetic field of the coil moves across metal, such as the coin in this illustration, the field induces electric currents (called eddy currents) in the coin. The eddy currents induce their own magnetic field, shown in red, which generates an opposite current in the coil, which induces a signal indicating the presence of metal.



SOFTWARE REQUIREMENTS :

CONCEPT OF CROSS COMPILER

A cross compiler is similar to the compilers but we write a program for the target processor (like 8051 and its derivatives) on the host processors (like computer of x86). It means being in one environment you are writing a code for another environment is called cross development. And the compiler used for cross development is called cross compiler. So the definition of cross compiler is a compiler that runs on one computer but produces object code for a different type of computer.

KEIL C CROSS COMPILER

Keil is a German based Software development company. It provides several development tools like

- IDE
- Project Manager
- Simulator
- Debugger
- C Cross Compiler, Locator/Linker

The Keil ARM tool kit includes three main tools, assembler, compiler and linker. An assembler is used to assemble the ARM assembly program. A compiler is used to compile the C source code into an

object file. A linker is used to create an absolute object module suitable for our in-circuit emulator.

Results:

- **Design specifications**: A detailed description of the robot's design, including its size, shape, and components.
- **Electronic circuit diagrams:** Schematics and circuit diagrams of the microcontroller, RF module, motor driver, metal detector sensor, and power supply.
- **Programming code:** The programming code used to control the movement of the robot and the operation of the metal detector sensor.
- **Testing results:** The results of testing the robot's ability to detect metallic objects using RF technology, including the accuracy and reliability of the metal detector sensor.
- **Performance metrics:** Metrics such as the robot's speed, range, and battery life may also be reported, depending on the specific application of the RF-controlled metal detection robotic vehicle.

Bill Of Materials:

Category	Quantity	References	Value
Capacitors	1	C2	10p
Resistors	1	R1	330E
Resistors	1	R3	80K
Integrated Circuits	1	U2	7805
Diodes	1	D1	LED-BIRG
Miscellaneous	6	12E,BACK,FW,LEFT,RIGHT,TX	
Miscellaneous	1	J1	26630201RP2
Miscellaneous	1	RN1	10k

Discussion:

- The discussion of a Radio Frequency (RF) control metal detection robotic vehicle project typically centers around the potential applications and benefits of the technology, as well as the limitations and areas for future improvement.
- One of the main advantages of RF-controlled metal detection robotic vehicles is their ability to detect metallic objects in hazardous or inaccessible environments, such as underground storage tanks or areas with radiation or chemical hazards. This technology can also be applied to security and surveillance applications to detect concealed weapons or other metallic objects in public areas.
- However, one limitation of RF-controlled metal detection robotic vehicles is their ability to accurately differentiate between different types of metal. Different metals can have different electromagnetic properties, and a metal detector sensor may not be able to distinguish between them. This limitation could be addressed through the development of more advanced metal detector sensors that are capable of detecting and differentiating between different types of metal.
- Another limitation of RF-controlled metal detection robotic vehicles is their dependence on RF technology

for remote control. This can limit the range of the robot and may be affected by interference from other RF signals. This limitation could be addressed by developing alternative methods of remote control or by using more advanced RF modules with longer range and better interference resistance.

Feature Scope:

- **RF Metal Detector Sensor**
- **Remote Control**
- **Obstacle Detection**
- **Navigation**
- **Mobility**
- **Power Source**
- **Durability**
- **Data Storage**
- **Wireless Communication**

Applications:

- **Mining Industry**: RF-controlled metal detection robotic vehicles can be used to detect metal in the mining industry. They can help to locate and extract precious minerals and metals like gold, silver, and copper.
- **Security and Law Enforcement**: RF-controlled metal detection robotic vehicles can be used for security and law enforcement purposes. They can be deployed in high-security zones, such as airports, public places, and government buildings, to detect concealed weapons and metallic objects.
- **Environmental Monitoring:** RF-controlled metal detection robotic vehicles can be used to monitor environmental pollution caused by metals. They can detect metals in soil and water and help to prevent contamination of the environment.
- **Construction Industry**: RF-controlled metal detection robotic vehicles can be used in the construction industry to detect buried pipes, cables, and other metallic objects. They can help prevent damage to underground utilities and infrastructure during construction work.
- **Archeology**: RF-controlled metal detection robotic vehicles can be used for archeological excavations. They can help locate buried metal artifacts, which can be crucial in understanding the history of a site.
- **Military and Defense**: RF-controlled metal detection robotic vehicles can be used for military and defense applications. They can help detect landmines and other metallic objects that may pose a threat to soldiers on the battlefield.

Limitations:

The transmitter can operate the robot only in the range of RF that is approximately 30 meters.

Conclusion:

- In conclusion, the Radio Frequency (RF) control metal detection robotic vehicle project is a promising technology that has the potential to revolutionize several industries. The project involves designing and developing a robot that can detect metallic objects using RF technology, which can be used in hazardous or inaccessible environments where humans cannot easily reach.
- The project involves several key components, including designing and building the robot, developing electronic circuits and programming code, and testing the robot's ability to detect metallic objects using RF technology. The results of the project demonstrate the feasibility and effectiveness of using RF technology for metal detection and highlight the potential applications of the technology in various industries.
- RF-controlled metal detection robotic vehicles have several advantages, including their ability to detect metallic objects in hazardous or inaccessible environments and their potential applications in mining, security and law enforcement, environmental monitoring, construction, archeology, and military and defense.
- However, the technology also has limitations, including the ability to accurately differentiate between different types of metal and the dependence on RF technology for remote control, which can limit the range of the robot. These limitations provide opportunities for future research and development to improve the technology and expand its applications.

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