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Research Article

PERFORMANCE COMPARISON OF INFRARED (IR) AND RADIO FREQUENCY (RF) BASED CONTROL OF ROBOTIC CAR

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ABSTRACT

Remote controlled robotic vehicles are continuously finding novel applications in various industries. Accurate control of the robotic vehicle over a reasonable distance is considered as a very important aspect for almost all applications. There are various modes of communication between the transmitter and a receiver such as through Wi-Fi, Bluetooth, Infra-Red (IR) and Radio Frequency (RF). This paper discusses both Infrared and Radio Frequency as the communication mode. This paper elucidates the applications of these two popular techniques. It clearly justifies and supports the efficient use of Radio Frequency over Infrared for wireless communication, through in-depth analysis of both the techniques on various figures of merits.

INTRODUCTION

Increasing speed of innovation in the field of automation has raised the trend of using robotics for various applications. It is evident that the use of wireless remote controlled devices becomes essential to enable the robots to be controlled from distance and with more accuracy. The robots are mainly classified into two categories: Autonomous robots like line sensing or edge sensing and remote controlled robots. The remote controlled robot is basically a robot operating from far range. Here, the remote is the transmitter device, while a receiver is with the robot, through which the motion of robotic vehicle is controlled. For the programming purpose Induino R3 microcontroller board is used.

In this paper, performance of the robot using Infrared and using radio frequency is discussed and later on we have classified the difference between them and application of each in the present world.

IR Based Robot

Induino R3

The Induino R3 is a Arduino Rev3 Clone with a ATmega328 microcontroller loaded with Arduino UNO bootloader. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. It is completely compatible with all arduino shields mechanically. [9]

Figure 1 Induino Board

TSOP1738

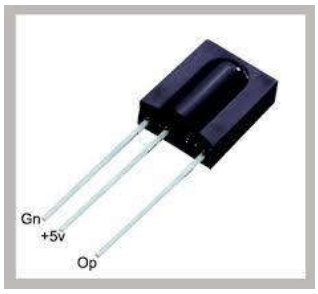

Figure 2 TSOP 1738

TSOP1738 is a commonly used IR receiver for Infrared remote control systems. These are available with different carrier frequencies. Here, TSOP1738 is inbuilt in the Induino board. Its carrier frequency is 38 KHz. It has three terminals

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as positive negative & output. The output terminal gets values from the remote and these values can be examined in serial port.

L293D

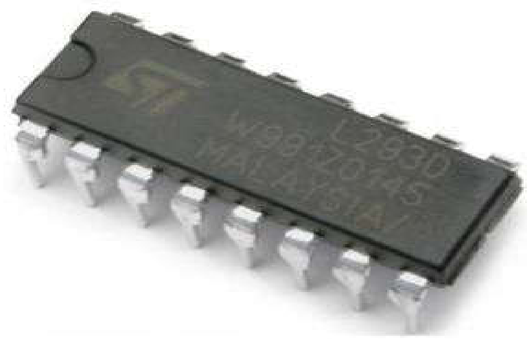

Figure 3 L293D IC

The L293D devices are quadruple high-current half-H drivers. The L293D provides bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. This device is designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high- current/high-voltage loads.

Block Diagram

The DC motors here are driven by L293D motor driver IC in both the directions. The signals are sent through an IR Remote to the IR receiver TSOP1738. This IR receiver receives signals from the remote which is further sent to the Induino R3 controller which has a code through which the motor is driven when specific buttons are pressed. The block diagram is shown in the figure.4.

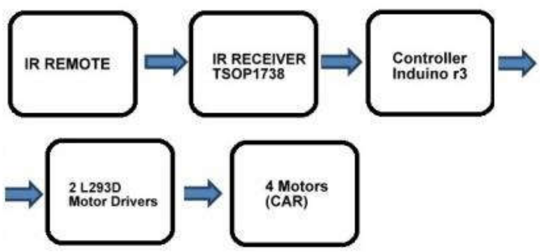

Figure 4 Block Diagram for Infrared (IR)

Circuit Diagram

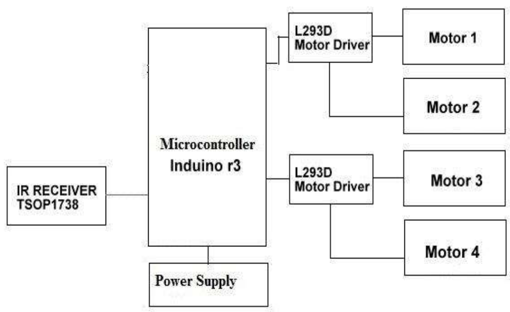

Figure 5 Circuit Diagram for Infrared (IR)

Hardware Implementation

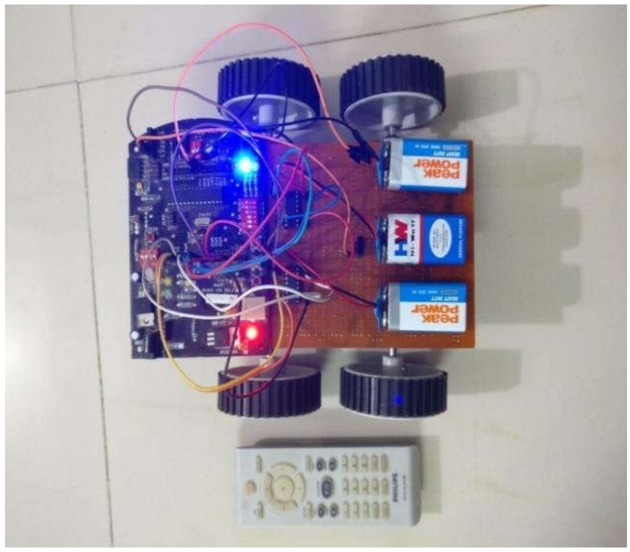

Figure 6 Hardware Implementation for Infrared

Here, Infrared is used as communicating medium to run the robot. Two L293D motor drivers are used to run four DC motors. These motors are controlled by Induino R3 microcontroller as shown in Figure

The microcontroller gets signals from IR receiver TSOP1738 mounted on robotic vehicle. The TSOP1738 gets signals from an IR remote. There are various operations assigned to the remote buttons such as forward, reverse, left and right turns with variable speed. Also there is a stop button which stops the motion of the vehicle. The L293d and Microcontroller board gets supply from a 9V battery.

RF Based Robot

RF Modules

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this system, the digital data is represented as variations in the amplitude of carrier wave. It is known amplitude shift keying modulation. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected. The transmission occurs in the range of 1Kbps - 10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. Here, HT12E-HT12D, HT640-HT648 ICs are used.

Features

1. LED for data receiver indicator.
2. 7805 for regulated 5v power supply.
3. On/Off switch.
4. 434 MHz frequency.

Transmitter modules

An RF transmitter module is a small PCB sub-assembly capable of transmitting a radio wave and modulating that wave to carry date. When logic 0 applied to transmitter then there is no power supply in transmitter. When logic 1 is applied to transmitter then transmitter is ON and there is a high power supply in the range of 4.5mA with 3V voltage supply HT12E Encoder IC will convert the 4 bit parallel data given to pins D0 – D3 to serial data and will be available

Figure 7 Transmitter

Receiver modules

An RF receiver module receives the modulated RF signal, and demodulates it. RF Receiver receives the data transmitted using RF Transmitter. HT12D decoder will convert the received serial data to 4 bit parallel data D0-D3. The LED connected to the above circuit glows when valid data transmission occurs from transmitter to receiver. 51KΩ resistor will provide the necessary resistance required for the internal oscillator of the HT12D.

Figure 8 Receiver

L293D Module:

[4] H-bridge driver IC is used in the L293D module. By connecting two dc motor to this 16 pin IC L293D we can move car in any direction. The rotational speed of a DC motor depends on voltage, and the torque depends upon current. Speed control is obtained by variable supply voltage, resistors or electronic controls. Generally systems have microcontroller for varying the speed by changing pulse width of pulse going from controller to motor driver.

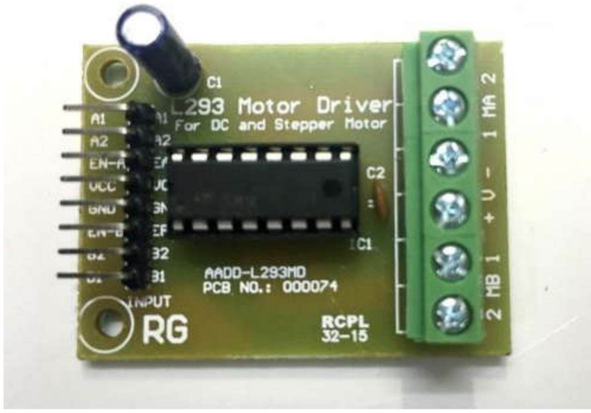

Figure 9 L293d Module

DC motor

Fugure.10 Motor

Electric machines are for converting energy. Motors convert electrical energy into mechanical energy. Electric motor is used to power hundreds of devices we use in everyday life. An example of small motor applications includes motors used in automobiles, robot, hand power tools and food blenders. DC motor needs 530mA current for operation. This system is using L239D which provide 600mA output current.

Battery

Features

1. Maintenance free (no water topping-up required).
2. Acid free
3. Low self-discharge rate, less than 3% loss per month.
4. Can be used in any orientation (excluding used inverted).
5. Absorbent Glass Mat technology for efficient gas recombination.

Figure 11 12V, 1.2A Battery

Specifications

Nominal Voltage	12.0 v
Nominal Capacity	1.2 Ah, 1200 mAh
Max. Charging current	0.36 A
Max. Discharging curren	18 A max
Dimension (LxWxH)	97mm x 43mm x 52mm
Weight	1.3 lb (590g)
Terminal	T1

Block Diagram

As discussed in chapter 1 the basic components required for this project are:

1. Induino R3
2. RF Transmitter module
3. RF Receiver module
4. Four DC motors.
5. L298D motor driver.
6. 12V Lithium ion battery.
7. Chassis (Body of the robot).
8. Four wheels.
9. Jumper and hook up wires.

The DC motors here are driven by L293D motor driver IC in both the directions. The signals are sent through an RF Transmitter to the RF receiver. This RF receiver receives signals from the remote which is further sent to the Induino R3 controller which has a code through which the motor is driven when specific buttons are pressed which are defined for forward, reverse motions and left, right turns.

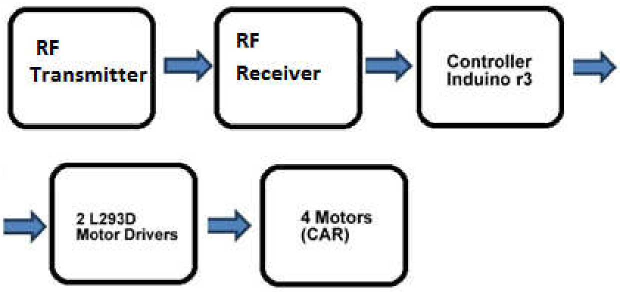

Figure.12 Block Diagram for Radio Frequency

Circuit diagram

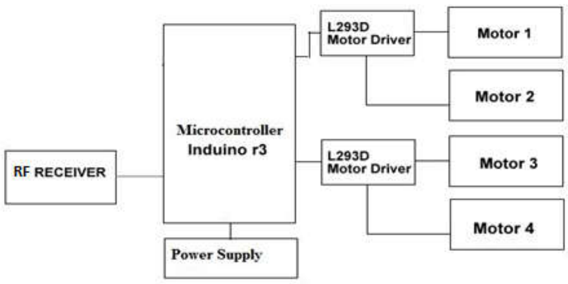

Figure.13 Circuit Diagram for Radio Frequency

Hardware implementation:

Here, Induino board is connected with L293D motor driver as well as RF Receiver module. Moreover, this motor driver is connected to the DC motors as shown in FIGURE 15. The motor driver gets the supply from 12V, 1.5A battery. The Induino gets the 5V supply from the motor driver.

Working

The chassis is supported with two wheels on left and 2 wheels on right side of the chassis. A RF module is used to receive the signals from the RF Transmitter and Induino R3 is used for controlling the four DC motors. The RF receiver module is mounted on the chassis with the Induino board and motor driver L293D. This motor driver is used to operate the two front DC motors and other two motors are shorted with front two DC motors. First of all the RF modules were checked, battery was connected to both the receiver module and the transmitter module and the indicating lights identified on the receiver according to the transmitter.

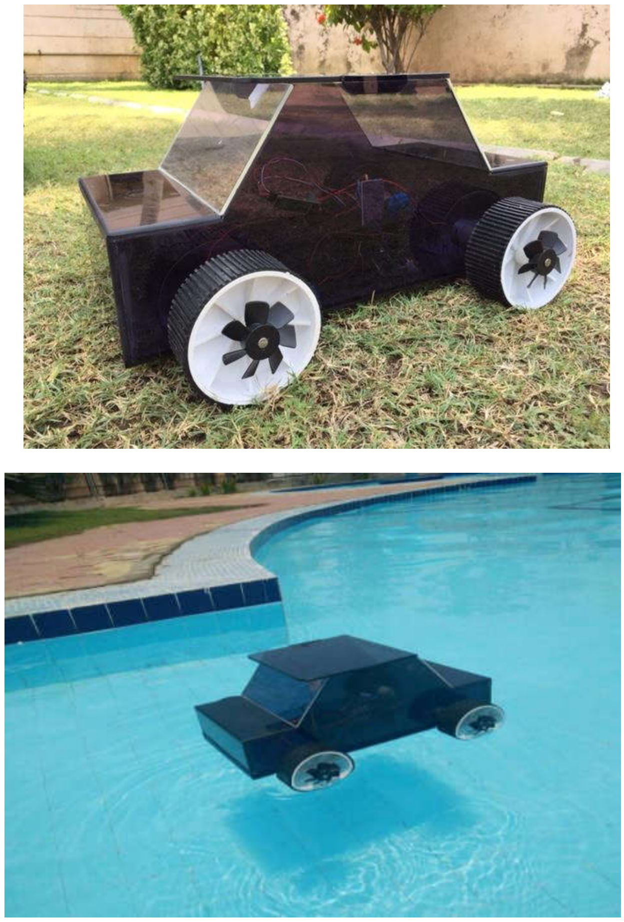

Figure 14 Hardware Implementation for radio Frequency

Then code was uploaded for two motors, which are connected with Induino. There are four push buttons on the transmitter module. All push buttons give digital values either 0 or 1. So button no. 1 is used for forward motion, button no. 2 for left turn, button no 3 for right turn and button no. 4 for reverse motion. And car will stop as soon as both button no.1 and button no.2 are pressed together. As shown in the Figure 14, this car can be useful in both the surfaces: terrestrial and water. Flappers are connected with the tyres, so it will move faster in water.

In this hardware implementation acrylic material is used for the outer body which is semi-transparent and front and rear part is fully transparent.

Infrared (IR) V/S Radio Frequency (RF) Infrared:

The simplest way to understand how an IR remote control works is to think of it as a "flashlight". In order for a flashlight to work correctly for user, user must point it in the direction user want to see. The same way for an IR remote control, infrared remotes emit light from the front of them, therefore user must point them directly at the hardware user are trying to control.

The hardware has what is known as an "IR pickup" on the front of it, which takes the different frequencies of light which is coming from the remote and interprets them as "commands". Just about every remote that comes with any piece of A/V equipment these days uses an IR based control system. This type of system works great if all of user's hardware is sitting at eye level and directly in front of user and there should be no obstructions between user and the hardware

Radio Frequency

The simplest way to think of an RF remote control is to compare it to a walkie-talkie. If I have a walkie-talkie in one room, and you have one on the same channel in another room, still we can communicate with each other, although of the fact that there are walls and other obstructions between us.

That is exactly what an RF control system can do for user and A/V equipment. It can allow user to place your hardware behind the solid doors of a cabinet, or even in a closet in a hallway or another room, and still have the ability to control it. The best part is that user don't have to point the remote at any of the hardware. This is because with every button press on an RF transmitter, that "command" is sent via radio frequency to an RF receiver, which in turn translates the command into IR, and out to the piece of equipment you are trying to control.

CONCLUSION

This Remote Controlled Vehicle using RF includes advantages such as robust control, minimum interference and a larger working range, which are impossible with Infrared. This table (figure: 15) clearly justifies and supports the efficient use of Radio Frequency over Infrared for wireless communication. [5]

Figure15 Comparison between IR and RF

	IR	RF
Inexpensive	✓	
Long distance		✓
Can signals pass through walls		✓
Difficult to intercept	✓	
Needs line-of-sight	✓	
Crowded frequency bandwidth		✓

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