Wireless Control of Speed & Direction of a DC motor & a DC Servo Motor using IR Remote

Naveen Lalwani[1], Karan Rawlani[1], Anmol Saxena[1], Sulakshana Chakraborty[1]
[1]School of Electrical Engineering, Vellore Institute of Technology, Vellore-632014, Tamil Nadu, India

The aim of this project is to design wireless control of speed and direction of a dc motor and a dc servo motor using IR remote. It will perform the following functions: Adjusting speed in percentage of rated value, controlling direction of rotation. The programming would be done using Arduino IDE. The main processing module is Arduino Uno, a microcontroller based on the ATMega328P with features like Analog to Digital signal conversion, and Pulse Width Modulation, which is used along with L293D to drive the motor. It is based on the principle that the power applied to the motor can be controlled by regulating the voltage across the motor terminals using PWM technique and hence controlling the speed and direction.

***Index Terms* — Pulse Width Modulation, TSOP-1738 module, L293D Motor Driver, Arduino Uno**

I. INTRODUCTION

THE PROJECT was undertaken in order to come up with a viable and compact solution for the speed and direction control of DC motor of type: Servo and Geared, together in an integrated manner through an IR remote controller, which could simultaneously control both the motors as per the entitled buttons, for starting individual motor, for providing with the desired speed and, angle control, in case of Servo motor, and direction control, as well. Here, speed control is made possible by applying Pulse Width Modulation to the voltage being provided through Arduino Uno microcontroller using analogWrite() function.

II. METHODOLOGY

A. Writing the Code:

The hex codes corresponding to the buttons on the IR remote controller were noted down. Initial tests were conducted to determine that components being employed are functioning properly. PWM pins on the microcontroller board are provided for direction as well as speed control. For speed control, HEX values corresponding to duty cycles for generating pulsating voltage signals, which results in different speeds of rotation, at the terminals of the motor, are noted down for employing in the code. Library corresponding to IR remote interfacing with Arduino through the TSOP-1738 module, was integrated in the library database in the IDE provided. A switch-case providing the option to switch to the desired mode is utilized with delays incorporated between, acquired by hit and trial method.

B. Component essentials

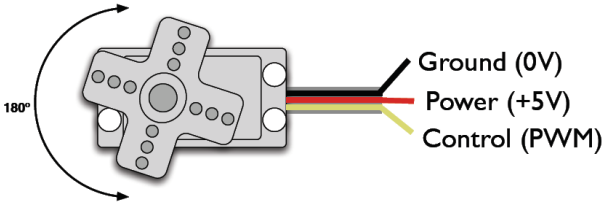
I. DC MOTORS

DC (Direct Current) Motors are two wire (power & ground), continuous rotation motors. When you supply power, a DC motor will start spinning until that power is removed. Most DC motors run at a high RPM (revolutions per minute), examples being computer cooling fans, or radio controlled car wheels.

The speed of DC motors is controlled using pulse width modulation (PWM), a technique of rapidly pulsating the power on and off. The percentage of time spent cycling the on/off ratio determines the speed of the motor, e.g. if the power is cycled at 50% (half on, half off), then the motor will spin at half the speed of 100% (fully on). Each pulse is so rapid that the motor appears to be continuously spinning with no stuttering.

2. SERVO MOTOR

Servo motors are generally an assembly of four things: a DC motor, a gearing set, a control circuit and a position-sensor.



The position of servo motors can be controlled more precisely than those of standard DC motors, and they usually have three

wires (power, ground & control). Power to servo motors is constantly applied, with the servo control circuit regulating the draw to drive the motor. Servo motors are designed for more specific tasks where position needs to be defined accurately such as controlling the rudder on a boat or moving a robotic arm or robot leg within a certain range.

Servo motors do not rotate freely like a standard DC motor. Instead the angle of rotation is limited to 180 Degrees (or so) back and forth. Servo motors receive a control signal that represents an output position and applies power to the DC motor until the shaft turns to the correct position, determined by the position sensor.

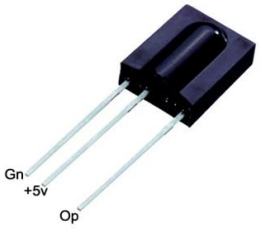
PWM is used for the control signal of servo motors. However, unlike DC motors it's the duration of the positive pulse that determines the position, rather than speed, of the servo shaft. A neutral pulse value dependent on the servo (usually around 1.5ms) keeps the servo shaft in the center position. Increasing that pulse value will make the servo turn clockwise, and a shorter pulse will turn the shaft anticlockwise. The servo control pulse is usually repeated every 20 milliseconds, essentially telling the servo where to go, even if that means remaining in the same position.

When a servo is commanded to move, it will move to the position and hold that position, even if external force pushes against it. The servo will resist from moving out of that position, with the maximum amount of resistive force the servo can exert being the torque rating of that servo.

The motors were tested directly by interfacing them with the microcontroller.

3. IR SENSOR

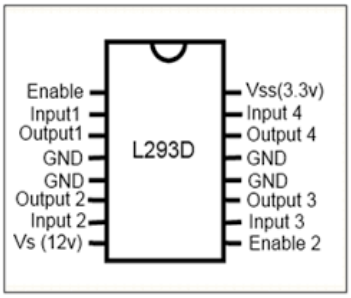
An IR sensor is a device which detects IR radiation falling on it. There are numerous types of IR sensors that are built and can be built depending on the application. Proximity sensors (Used in Touch Screen phones and Edge Avoiding Robots), contrast sensors (Used in Line Following Robots) and obstruction counters/sensors (Used for counting goods and in Burglar Alarms) are some examples, which use IR sensors.
TSOP 1738



TSOP 1738 is the Infrared receiver Module used in remote control applications. It is a versatile sensor that receives the coded Infrared pulses from the transmitter and directs the functions of the device. TSOP 1738 sensor is designed to receive IR rays pulsating in the 38 KHz and hence the number 1738. It has a circuitry inside a black colored filter case. The black colored filter case prevents the effect of sunlight and other lights on the Photodiode present inside. There is a PIN Photodiode inside the module which is the receiver of the Infrared rays from the transmitter. In addition to the Photodiode, there are signal amplifiers, AGC (Automatic Gain Control), output driver, etc. inside the module.

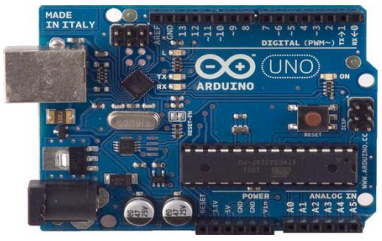
TSOP 1738 requires 5 volts maximum and above this, the device will be damaged. So a well regulated 5 volt supply is necessary for its proper function. Normally when it is in the ideal state without receiving the IR rays, its output source 5 volts. When the module receives, IR rays, it sinks current and output turns low to zero volts. According the coded IR pulses from the remote handset, the output of the sensor turns low and high alternatively. The speed of this transition depends on the bandwidth of the coded pulses.

4. L293D IC



L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC.Dual H-bridge Motor Driver integrated circuit (IC).
It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence, H-bridge IC are ideal for driving a DC motor.

5. ARDUINO UNO



Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6

can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

III. WORKING PRINCIPLE

A. DC MOTOR SPEED CONTROL

For speed control of dc motor many methods are available which are either be a mechanical or electrical for example armature control, field control, flux control method etc but this methods required large size hardware to implement. So for easy control of speed and the direction control of dc motor the wireless speed and direction control of dc motor by using radio frequency technique is very much essential and economical to used. For variable dc voltage we can used a controlled rectifiers which are converted a variable dc voltage from fixed dc voltage. Due to their ability to supply a continuously variable dc voltage. Many analog and digital chips are used in firing or controlling circuits but transistor and thyristor control are more accessible due to their innumerable application in various industry. Recent development in the area of semiconductor technology have made faster, very small size microprocessors and microcontroller are available at in much reduced cost. The microcontroller can provide a controlling of width of pulse provide to a controlling a voltage of motor terminal simultaneously the speed of motor can controlled. For that purpose the Pulse Width Modulation phenomena is used for controlling the width of pulse.

According to the speed equation of a DC motor we can write,

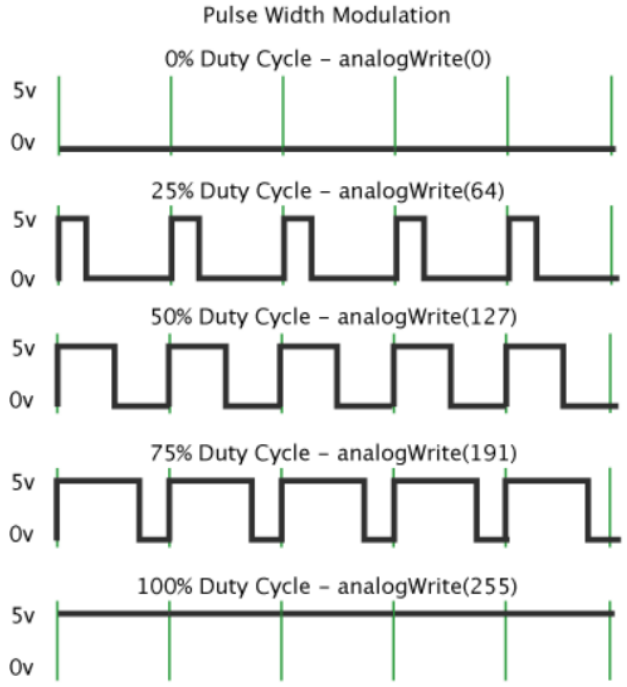
$$N\alpha\frac{E_b}{\varphi}\alpha\frac{V-I_aR_a}{\varphi} \qquad \ldots\text{eq.(1)}$$

The factors Z, P, A are constants for a DC motor.
But as the value of armature resistance R_a and series field resistance R_{se} is very small, the drop $I_a R_a$ and $(R_a + R_{se})$ is very small compared to applied voltage V. Hence neglecting these voltage drops the speed equation can be modified as,

$$N\alpha\frac{V}{\varphi}\text{as}E_b = V$$

B. PULSE WIDTH MODULATION

Pulse Width Modulation variable speed drives are fast applied in various new industrial application that required higher performance, reliable, easy control as well as economical purpose. In most of the application Sinusoidal Pulse-Width Modulation have been used. For direction control of dc motor we can simply change the input terminal of dc motor the direction will be change but this is not possible at running time as well as not safety operation. So for these direction control of dc motor we can used a H-Bridge circuit. It is made up from four transistor switches. Hence the microcontroller can send a signal to constant voltage supply and h-bridge can control the direction of dc motor.



IV. LIMITATIONS

With the help of analogWrite() function, we can vary only the duty cycle but not the frequency of the supply.
The presence of IR sensor limits the range to 15 feet approximately and also its operation's success is based highly upon the arrangement of obstacles in front of the IR sensor.

There is a bit-banging pulse-width modulation technique which can be employed through Arduino. Thus, helping us out for obtaining desired frequency.

Instead of IR sensors we can utilize other wireless technologies for extending the range. E.g. Bluetooth modules can also be utilized for the same.

V. OBSERVATIONS

- L293D motor driver IC has been used instead of H bridge constructed using transistors because of the power losses. This is because the loss of power due to switching is more in transistors as compared to N-MOSFET. Moreover usage of IC along with N-MOSFET reduces potential drop across them and hence makes the motor driver circuit a more efficient option.

- PWM vs Potentiometer

PWM technique has been involved instead of using a potentiometer because power losses due to potentiometer is more in controlling of DC motor. The power consumed by using PWM technique is found to be constant i.e. 90mW (10 mA at 9 Volts) while that due to potentiometer varies with resistance

Voltage(V)	Current(mA)	Power loss(mW)
4.5	53	238.5
5.5	63	220.5

Table 1: Power loss across potentiometer

VI. CONCLUSION

Therefore, the wireless control of speed & direction of a DC motor & a DC servo motor using IR remote has been achieved using PWM technique and has been found to be better than potentiometer at controlling speed of DC motor.

REFERENCES

- **Wireless Speed and Direction Control of Dc Motor by Using Radio Frequency Technology** *Ankesh N.Nichat, Sheikh Kadir Ali ,Yogesh D. Solanke, Amit M. Dodke*
- **Speed and Direction Control of DC Motor Without using Microcontroller** *N.Bagyalakshmi1, R.Abinaya Assistant Professor, Department of EIE, Adhiyamaan College of Engineering, Hosur, Tamil Nadu, India, U.G. Student, Department of EIE, Adhiyamaan College of Engineering, Hosur, Tamil Nadu, India*