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PWM Signal Based Speed Controlling of Brushless DC Motor Using Arduino

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ABSTRACT -This paper describes the overall working and implementation of the speed control of BLDC motor using PWM signal of an Arduino Uno board. Brushless Direct Current (BLDC) motor are more popular in a variety of motor applications such as pumps, fans, automotive drives and robotic automations, electric cars, bikes, etc. instead of brushed motors. Because brushless motors have some advantages over brushed DC motors including high torque to weight ratio, increased reliability, reduced noise, elimination of ionizing sparks from the commutator, etc. We have lot of technologies to control the speed of BLDC motor. The various techniques to control the speed of BLDC motor are using mobile applications, Bluetooth module, by using GSM modem, by sending SMS from mobile phone, etc. But these systems are expensive & difficult to handle and for those technologies there are different mythology and platforms. These types of expensive systems are not affordable by everyone. Our main aim to design a system using Arduino uno board and PWM signal to control BLDC motor speed. System is to be advanced, useful, easy to handle and cheapest.

KEYWORDS: Arduino, PWM, Bluetooth, BLDC Motor, Robotic Automation, Commutator.

I. INTRODUCTION

A Brushless Direct Current (BLDC) electric motor is also known as an Electronically Commutated Motor (ECM or EC Motor) or synchronous motor because it uses direct current (DC) electric power supply. BLDC motor uses an electronic closed loop controller to switch DC currents to the motor windings producing magnetic fields. Permanent magnet excited BLDC motors are becoming increasingly attractive in a large number of applications. The reason for their increased popularity is better speed versus torque characteristics, long operating life. The BLDC motors are useful in applications where space and weight are critical factors. Unlike a brushed DC motors, the commutation of a BLDC motors is controlled electronically.

Brushless DC motors has various applications used in industries like in drilling, lathes, spinning, electric bikes, etc. because of its performance advantages such as reduced size, low cost, reduced torque ripples, high efficiency, increased torque-current ratio, low maintenance, low noises & good control characteristics over a wide range in torque-speed plan. BLDC Motors is widely used in small and medium size electric vehicles. The speed control of brushless DC motors is achieved by varying the duty cycles of PWM pulses and delivered the desired output to the BLDC motor to control the speed. The main differences between brushless DC motor controllers are the types of control algorithms that are implemented on their microcontrollers. The two main types of control algorithms are sensed and sensorless control.

1. HARDWARE REQUIREMENT

- Arduino Uno Board
- BLDC Motor
- ESC
- Potentiometer
- 12V DC Battery
- Connecting wires

2. SOFTWARE REQUIREMENT

- Arduino IDE Software

II. METHODOLOGY

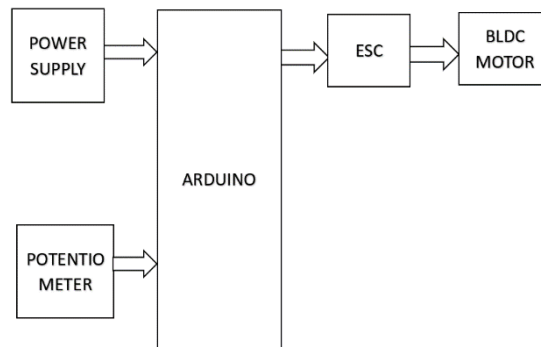


FIG: Block diagram of purpose system.

We are designing Speed control of Brushless Direct Current (BLDC) motor using PWM signal of an Arduino Uno board. This system consists of Arduino Uno Board, BLDC Motor, ESC (Electronic Speed Controller), Potentiometer, 12V DC Battery. ESC is a Electronic Speed Controller which is of 30A. It is a motor driver circuit. ESC is used to change the speed of an electric motor. This motor driver circuit is most frequently used for brushless motors providing an electronically produced 3-phase electric power low voltage source of energy for the motor. BLDC is a brushless DC motor do not have brushes because this BLDC motors do not make use of commutation. It uses electrical commutation to deliver the current which produces an AC electric signal causing the motor to drive. In this motors, the permanent magnets attach to the rotor and the current carrying conductors or armature windings are located on the stator. Potentiometer is used to increase decrease or vary the speed of BLDC motor and power supply is used to power the motor.

ESC is connected between Arduino & BLDC motor. On one side of ESC, it has three wires that controls the three phases of the motor current. Connect the BLDC motor to these three outputs of ESC. Here, the polarity doesn't matter. If you switch any 2 of the 3 wires, the motor will rotate in opposite direction & on the other side of ESC it has VCC (+) and Ground (-) for powering. VCC is of red wire and Ground is of black wire. Connect the '+' and '-' of battery to the red (+) and black (-) wires of ESC respectively. And there is another set of three wires i.e., 3pin servo cable coming out of the ESC which is signal line (yellow), +5V (red) and Ground (brown). This feature of ESC circuit is called Battery Eliminator Circuit. Because it Eliminates the need of separate battery for the microcontroller. This ESC provides regulated 5V to power the Arduino. Connect the brown cable which is Ground to the 'GND' pin of an Arduino, connect the yellow cable which is signal line to any digital pin, we are connected it to pin no. 8.

A BLDC motor consist of two parts-

- 1) Stator – consist of coils.
- 2) Rotor – Permanent magnet with 4 poles.

Apply current through coils generates magnetic field and the place of poles depends on the current direction. If we apply appropriate current, the coil will generate magnetic field that attracts the rotors permanent magnet. Now if we activate each coil one after another, the rotor will keep rotating because of the force interaction between the permanent magnet. To rotate the BLDC motor, the stator winding should be energized in a sequence. BLDC motor produces an AC/bidirectional electric current to drive each phase of the motor via a closed loop controller.

To control the speed of motor, connect Potentiometer to Arduino. It has three terminals Its output is connected to the analogue pin A0 of the Arduino, another terminal is connected to +5V and last one is connected to ground. This 10KΩ potentiometer is used to vary the speed of motor.

Now connect the Arduino to the PC using the USB type B cable. Open Arduino IDE software, write code and select the following tools-

Board: Arduino Uno

Port: COM15

Code:

```
#include <Servo.h>
```

```
Servo esc;
```



```
Void setup()
{
  esc.attach(8);
  esc.writeMicroseconds(1000);
  Serial.begin(9600);
}
Void loop()
{
  int val;
  val = analogRead(A0);
  val = map(val, 0, 1023, 1000, 2000);
  esc.writeMicroseconds(val);
}
```

Click on save button to save the code, now verify the code and then upload the code by clicking on upload button. The Arduino can produce PWM signal, the pins which supports PWM are 3, 5, 6, 9, 10, 11. By increasing or decreasing the duty cycles of PWM signal using potentiometer user can get the speed of motor exactly they want.

III. RESULT

In this project we are control or increase decrease the speed of BLDC motor using PWM signal of an Arduino Uno board. By using the duty cycles of PWM waves we can determine the speed of the BLDC motor. The desired speed can be obtained by changing the duty cycle. And we can change the duty cycles of PWM signal using the potentiometer. As a result of this project, speed response and performance evaluation has been verified with different speed.

IV. CONCLUSION

The main aim of this paper is to run the code in Arduino Uno board using software and implementation of hardware which is required to control the speed of BLDC motor using Arduino. In this paper we are successfully connected the components like Arduino Uno board, ESC (Electronic speed controller), BLDC (Brushless Direct Current) motor, potentiometer and about PWM signal. The duty cycle of PWM signal determines the speed of the BLDC motor. The required speed can be obtained by changing the duty cycle of PWM waves. This duty cycles can be changed by using the potentiometer. The PWM in Arduino Uno is used to control the duty cycle of BLDC motor to successfully vary the speed of BLDC motor. We can increase and decrease the speed of BLDC Motor using potentiometer. Hence, we are successfully implementing the hardware components which is required to control the speed of BLDC motor using PWM signal of an Arduino and the code for Arduino to run the BLDC motor was upload in an Arduino Uno Board. Hence, we are successfully run the Brushless Direct Current (BLDC) Motor using PWM Signal of an Arduino Uno Board.

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