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SPEED CONTROL OF BLDC MOTOR USING PWM SIGNAL OF AN ARDUINO

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Abstract -This paper describes the working of the Speed Control of BLDC Motor using Arduino and PWM Technique. Brushless DC (BLDC) motors are becoming more common in a variety of motor applications such as fans, pumps, automotive drives & robotic automations. We have a lot of technologies that can be used to control the speed of BLDC motor. BLDC motor have many advantages than brushed DC motors and induction motors such as better speed-torque characteristics, high dynamic response, long operating life, noiseless operation which can be considered the most dominant electric motor. We have seen various techniques to control Brushless Direct Current (BLDC) motor like techniques using mobile application, Bluetooth module, by sending SMS from mobile phone, etc. But for those technologies there are different mythology and platforms. And these types of systems are very much expensive. Because of this these expensive systems are not affordable by everyone. Our main aim to design a system which is advanced, useful, easy to handle and cheapest. That's why we are control the speed of BLDC motor using Arduino& PWM technique.

Keywords**:**Arduino, PWM, Bluetooth, BLDC Motor, Robotic Automation.

1. 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 archived 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 sensored and sensor-less control.

2. HARDWARE REQUIREMENT

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

2.1 Arduino Uno Board

The Arduino Uno is an open-source microcontroller board based on the microchip ATmega328p microcontroller.Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.The Arduino Uno is a microcontroller board which is based on the ATmega328. It has 14 digital input/output pins (in which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz ceramic resonator, a USB connection, a power jack, an ICS header, and a reset button. It contains everything that needed to support the microcontroller; simply connect it to a computer through USB cable or power it to get started with an AC to DC adapter or battery. The Arduino Uno can be powered with an external power supply or via a USB connection.

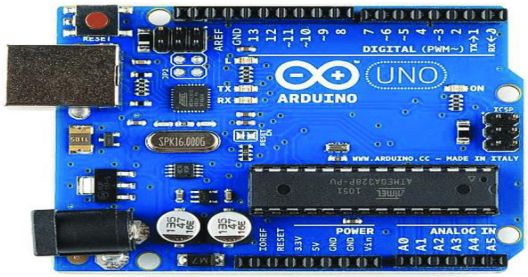

FIG: Arduino Uno Board

2.2 BLDC Motor

A brushless DC electric motor (BLDC Motor or BL Motor) also known as electronically commutated motor (ECM or EC Motor) and synchronous DC motors.Synchronous motors powered by Direct Current (DC) electricity via an inverter or switching power supply which produces electricity in the form of alternating current (AC) to drive each phase of the motor via a closed loop controller. The brushless motors are generally controlled by a three phase power semiconductor bridge. The controller provides pulses of current to the motor windings that control the speed and torque of the motor.This control system replaces the commutator(brushes) used in many conventional electric motors. A brushless dc motor is defined as a synchronous permanent machine with rotor position feedback.

FIG: BLDC Motor

2.3ESC(Electronic Speed Controller)

A brushless motor requires a different operating principle to control the speed. ESC is an electronic circuit that controls and regulates the speed of an electric motor. An electronic speed control follows a speed reference signal (derived from a throttle lever, joystick or other manual input) and varies the switching rate of a network of FETs. By adjusting the duty cycle or switching frequency of the transistors, the speed of the motor is changed. Brushless ESC systems basically create a tri-phase AC power output of limited voltage from an onboard DC power input, to run brushless motors by sending a sequence of AC signals generated from the ESC's circuitry, employing very low impedance for rotation.

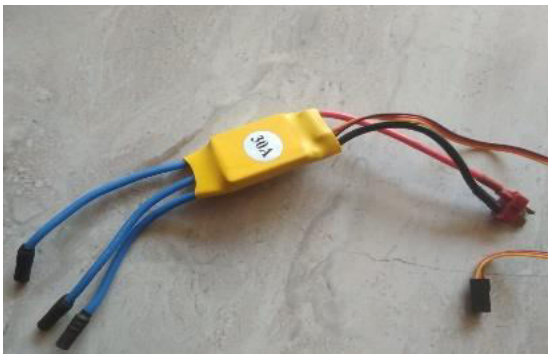

FIG: ESC (Electronic Speed Controller)

3. CONTROL STRATEGY

PWM technique is one of the most popular speed control techniques for BLDC motor. In this technique a high frequency chopper signal with specific duty cycle is multiplied by switching signals.Therefore, it is possible to adjust output voltage of inverter by controlling duty cycle of

switching pulses of inverter. The disadvantages of analog methods are that they are prone to noise and they change with voltage and temperature change.

4. BLOCK DIAGRAM

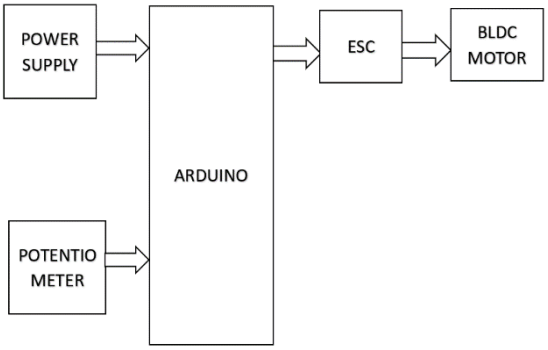

FIG: Block diagram of purpose system.

We are designing Speed control of Brushless Direct Current (BLDC) motor using Arduino& PWM technique. There are different techniques to control the speed of BLDC motor but they are quite expensive and have some limitations to operate. That's why we are using Arduinouno board and PWM technique which is advanced, cheaper in price to use in many appliances, robotics automation, many small-scale industries, etc.

This system consists of Arduino Uno Board, BLDC Motor, ESC (Electronic Speed Controller), Potentiometer, 12V DC Battery. ESC is connected between BLDC motor and Arduino. It is a motor driver circuit which is used to change the speed of an electric motor. This ESC provides regulated 5V to power the Arduino. BLDC motor consist of two parts i.e. stator and rotor. To rotate the BLDC motor, the stator winding should be energized in a sequence. To control or change the speed of motor we used potentiometer. The potentiometer connected to Arduino for controlling the motor speed. With the help of potentiometer, we can control the current which is transfer to drive BLDC motor in the form of PWM waves.

5. WORKING

The speed control of BLDC motor using Arduino& PWM technique consist of BLDC motor, ESC (Electronic speed controller), Arduino Uno Board, potentiometer, 12v dc power supply. ESC is connected between Arduino& BLDC motor to controls and regulates the speed of a motor. On one side of ESC, it has three wires that controls the three phases of the motor current & on the other side it has VCC & GND; & there is another set of three wires that is signal line, +5V and GND. This feature of 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.

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. To control the speed of motor, connect Potentiometer to Arduino. By using the potentiometer, we can change or increase/decrease the speed of BLDC motor.

6. GENERATING PWM SIGNAL FOR CONTROLLING THE SPEED OF BLDC MOTOR

The Arduino can produce PWM signal the pins which supports PWM are 3, 5, 6, 9, 10, 11 the frequency of PWM produces by these pins are 490 Hz. In a Brushless DC Motor controller, either a Hall Effect Sensor or Back EMF (Electromotive Force) is used to identify the position of the rotor. Understanding the orientation of the rotor is crucial to operating the Brushless DC Motor. The Hall Effect uses three hall sensors within the Brushless DC Motor to help detect the position of the rotor. To increase or decrease the duty cycle user can get the speed of motor exactly they want. This increasing and decreasing duty cycle can possible through the timers of the Arduino. If you want to change the frequency you can overwrite its register via coding and then the frequency will be changed.

- Code for Arduino to run BLDC Motor

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

```
Servo esc;

Void setup()

{

esc.attach(8);

esc.writeMicroseconds(1000);

Serial.begin(9600);

}

Void loop()

{

intval;

val = analogRead(A0);

val = map (val, 0, 1023, 1000, 2000);

esc.writeMicroseconds(val);

}
```

7. 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.

8. CONCLUSION

The main aim of this paper is to modelling, simulation and implementation of hardware which is required to control the speed of BLDC motor using Arduino. In this paper we are studied about all 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 ArduinounoR3 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, the hardware implementation to control the speed of BLDC motor using PWM signal of an Arduino and the code for Arduino to run the BLDC motor was successfully upload in an Arduino Uno Board.

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