CONTROL OF REALTIME BLDC MOTOR WITH EMBEDDED TECHNOLOGY FOR HOVERBOARD PRECISION STOPPING

[1] V. Harsh Sai Gupta ,[2] Tekumalla Krishna Sree Charan, [3] S. Ravi kumar

[1,2] UG Students, B. Tech, ECE Department , [3] Assistant Professor, Vignan's Institute Of Information Technology , Visakhapatnam, India

ABSTRACT:

research proposes the development of a control system for real-time precision stopping of This a Brushless DC (BLDC) motor used in a hoverboard. The proposed system utilizes embedded technology to achieve accurate and efficient motor control, enabling the hoverboard to come to a stop quickly and smoothly. The control system is implemented using a microcontroller and customized motor driver circuitry, and the motor speed and direction are monitored using feedback from a Hall effect sensor. The proposed system's performance is evaluated through simulation and experimentation, and the results demonstrate that it is capable of achieving precise and rapid stopping of the hoverboard, providing a safer and more efficient mode of transportation.

Index Terms - BLDC motor control , Embedded technology, Real-time control, Hoverboard, Precision stopping .

INTRODUCTION :

The hoverboard is a popular self-balancing transportation device that utilizes a Brushless DC (BLDC) motor for its propulsion. However, one of the key challenges in hoverboard design is achieving precise and rapid stopping of the motor. Inadequate stopping performance can lead to accidents and injuries, making it crucial to develop a control system that can ensure safe and efficient stopping. This research proposes a novel control system for real-time precision stopping of a BLDC motor used in a hoverboard. The proposed system utilizes embedded technology to achieve accurate and efficient motor control, enabling the hoverboard to come to a stop quickly and smoothly. The control system is implemented using a microcontroller and customized motor driver circuitry, and the motor speed and direction are monitored using feedback from a Hall effect sensor. The objective of this research is to develop and evaluate the performance of the proposed control system, which can provide a safer and more efficient mode of transportation. The performance of the proposed system is evaluated through simulation and experimentation, and the results demonstrate that it is capable of achieving precise and rapid stopping of the hoverboard.

DESIGN AND IMPLEMENTATION :

1.HARDWARE DESIGN:

The hardware design of the proposed control system for precision stopping of a BLDC motor used in a hoverboard includes the following components:

1. Microcontroller: The microcontroller is the heart of the control system and is responsible for controlling the motor driver circuitry and monitoring the feedback from the Hall effect sensor. It is programmed to implement the control algorithm and execute the necessary calculations.

2. Motor driver circuitry: The motor driver circuitry is designed to provide precise and efficient control of the BLDC motor. It includes high-power transistors that switch the motor phases on and off based on the signals received from the microcontroller.

3. Hall effect sensor: The Hall effect sensor is used to provide feedback on the motor speed and direction. It detects changes in the magnetic field generated by the motor and converts them into electrical signals that are sent to the microcontroller.

4. Power supply: The power supply provides the necessary voltage and current to the microcontroller, motor driver circuitry, and Hall effect sensor.

The hardware design is optimized for high performance, low power consumption, and compact size, making it suitable for integration into a hoverboard. The components are carefully selected and tested to ensure compatibility and reliability in the operating conditions of the hoverboard.

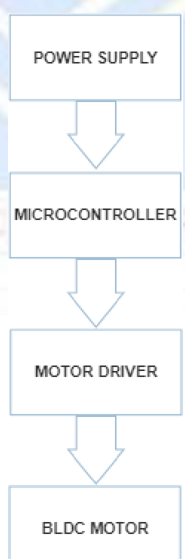

Fig.1. The schematic diagram for speed and direction control of a BLDC Motor

1.1 PWM TECHNIQUE:

PWM is a technique used to control the speed and direction of a BLDC motor by switching the power on and off at a high frequency, with the width of the on-time determined by the desired motor speed. The duty cycle of the PWM signal determines thepercentage of time the power is switched on.PWM is a simple and efficient way to control the BLDC motor speed and direction. It allows for precise control of the motor and efficient use of power. Moreover, it enables smooth and rapid stopping, making it suitable for use in hoverboards and other applications where precise motor control is essential.

% duty cycle= (ton/ (ton + toff)) *100 ton - on time.toff - off time.

ton + toff - total time

The speed increases with increases in duty cycle. The input supply may analog or digital signal. At various duty cycle the waveforms generated showing are shown in Fig.2

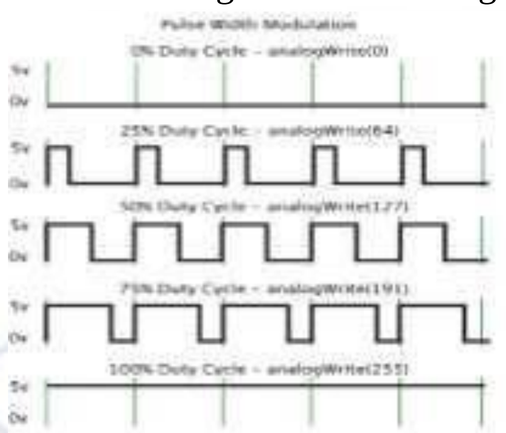

Fig.2 Pulse Width Modulation

HARDWARE COMPONENTS:

The mainly used hardware components are NodeMcu ,Brushless DC Motors(12-36v) 500W,Hub motor with Hall Effect sensor cable and battery for power supply .

A . NODE MCU

NodeMCU is an open-source development board based on the ESP8266 WiFi module with built-in WiFi capabilities and GPIO pins for connecting external devices. It has an embedded Lua scripting language interpreter for rapid IoT application development and is compatible with various development environments. NodeMCU is a popular choice forhobbyists, students, and professionals for its ease of use and low cost.

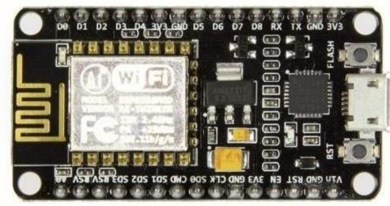

FIG3.NODE MCU (ESP8266 WIFI MODULE)

The specifications of NODEMCU are-

Microcontroller: ESP8266Clock speed: 80 MHz Flash memory: 4 MB SRAM: 64 KB

WiFi: 802.11 b/g/n GPIO pins: up to 17 ADC pins: up to 1 USB: micro USB Operating

voltage: 3.3V

Dimensions: 49mm x 24mm

Note that there may be variations in specifications depending on the specific version of NodeMCU used.

B. BRUSHLESS DC MOTORS

Brushless DC motor does not have any brushes. these motors are capable of producing high torques efficiently. In these motors there are permanent magnets rotating around a stationary armature. By using this permanent magnet the current to the armature has been fed. These BLDC motors are used widely due to their smooth operation.

Some of the advantages of BLDC Motors are-

High Rotating Speed – BLDC motors are able to operate at speeds above 11,000 rpm under both loaded condition and unloaded condition.

They can be accelerated and decelerated quickly due to low inertia.

High Power – BLDC motors have the high running torque per inch cube as compared to any DC motor.

High Reliability – Absence of brushes results in more reliable and higher life expectancies of over 11,000 hours.

Fig. 4 . Brushless DC Motor

BLDC HOVERBOARD APPLICATIONS

1. Personal transportation: The precision stopping approach can be applied to hoverboards used for personal transportation, ensuring safe and controlled deceleration when approaching obstacles or stopping.

2. Delivery robots: Autonomous robots used for delivering packages and goods can use the precision stopping approach to ensure accurate stopping when reaching a destination.

3. Industrial automation: The control algorithm can be applied to BLDC motors used in various industrial automation applications, such as robotic arms or conveyors, to achieve precise control and stopping.

4. Electric vehicles: The precision stopping approach can be applied to BLDC motors used in electric vehicles, such as e-bikes or scooters, to ensure safe and controlled deceleration.

Overall, the control of real-time BLDC motor with embedded technology for hoverboard precision stopping has wide-ranging potential applications in various industries and areas of technology.

SOURCE CODE FOR BLDC MOTOR FOR HOVERBOARD PRECISION STOPPING

```
int m1_EL_Start_Stop= D1; //EL //D1int m1_ZF_Direction=D2; // ZF //D2 int
m1_Signal_hall=D6; //Hall //D6 int m1_VR_speed=D7; //VR //D7
int pos=0;
int steps=400; int speed1=200;
String direction1;
/*
void plus()
{
 pos++; //count stepsSerial.println(pos); if(pos>=steps)
{
```

```
digitalWrite(m1_EL_Start_Stop,LOW); pos=0;
}
}
*/
void setup()
{
Serial.begin(115200);
pinMode(m1_EL_Start_Stop, OUTPUT);//stop/start - EL
//pinMode(m1_Signal_hall, INPUT); //plus - Signal pinMode(m1_ZF_Direction, OUTPUT);
//direction - ZF
//Hall sensor detection - Count steps
//attachInterrupt(digitalPinToInterrupt(m1_Signal_hall), plus, CHANGE);
}
void loop()
{
while (Serial.available())
{
delay(10);
char c = Serial.read();if (c == '#')
{
reak;
}
direction1 += c;
}
if (direction1.length() > 0)
{
if(direction1=="forward" && pos<steps)
{
Serial.println("forward"); analogWrite(m1_VR_speed, speed1);
digitalWrite(m1_EL_Start_Stop,LOW);delay(1000); digitalWrite(m1_ZF_Direction,HIGH);
delay(1000); digitalWrite(m1_EL_Start_Stop,HIGH);
}
else if(direction1=="backword" && pos<steps)
{
Serial.println("backword"); analogWrite(m1_VR_speed, speed1);
digitalWrite(m1_EL_Start_Stop,LOW);delay(1000); digitalWrite(m1_ZF_Direction,LOW);
delay(1000); digitalWrite(m1_EL_Start_Stop,HIGH);
}
else if(direction1=="Stop")
{
 Serial.println("Stop"); digitalWrite(m1_EL_Start_Stop,LOW);pos=0;
}
direction1=""; //Reset the variable after initiating
}
}
```

RESULT

The successful implementation of such a system would enable precise control of the BLDC motor and efficient stopping of the hoverboard. This would be achieved through the use of an appropriate PWM technique, feedback control from Hall effect sensors, and a suitable control algorithm running on an embedded system such as NodeMCU.The performance of the system would depend on several factors such as the quality of the components used, the precision of the sensor feedback, and the effectiveness of the control algorithm. So, Hoverboard that is safer and more efficient for users.

Input	Command	Speed	Voltage
1	Motor Clockwise	0	0.07V
2	Motor Clockwise	33 rpm	0.70V
3	Motor Clockwise	60 rpm	1.36V
4	Motor Anti Clockwise	0	0.07V
5	Motor Clockwise	33rpm	0.7V
6	Motor Anti Clockwise	60rpm	1.36V
0	Motor Off	0	0

Table I .Results

CONCLUSION

The BLDC motors are widely used in hoverboards due to their high efficiency and low maintenance requirements. Achieving precision stopping of hoverboards is essential for ensuring user safety and improving ride quality. Real-time control of BLDC motors with embedded technology has been developed to achieve precision stopping and improve overall ride stability. Various control algorithms and strategies have been proposed in the literature to achieve precision stopping, such as PID control, fuzzy logic control, sliding mode control, and predictive control. These control strategies have been implemented in embedded systems using microcontrollers, digital signal processors, and field- programmable gate arrays. The development of a precise control system for BLDC motors with embedded technology has led to safer and more reliable hoverboard performance, and has also paved the way for future developments in electric mobility.

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