IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 8, Issue 2, April - May, 2020
ISSN: 2320 – 8791 (Impact Factor: 2.317)
www.ijreat.org

PI SKATE - AN ELECTRIC SKATEBOARD

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Abstract

Environmental protection and energy conservations are the main concern of 21st century which has now accelerated into developing electric vehicle technology. The electric vehicles (referred to as EVs) offer zero emission and provide a new industrial sector for development and invention. It is being designed suitably for any type of road conditions and to reduce the efforts of a rider to drive skateboard easily. Currently the permanent magnet brush-less DC motors are current choice of automobile industries and researchers because of its high- power density, compact size, reliability, and noise free and minimum maintenance requirements. It deals with the fabrication of electric skateboard which mainly includes assembly of skateboard and electric hub motor drive and designing the controllers. Thus, the final stage is to improve the design model of the electric skateboard for off road conditions. The objective of this project is to improve the driving mode of skateboard on off road condition by centralized electric wheel on the board and to reduces the effort of skateboard even on uphill area and improve sensitivity of the skateboard with dependence on non- renewable resources using latest technology. The implementation involves development of Electric-Skateboard that runs on battery as well as manual propulsion of vehicle.

Keywords - Environmental protection; Energy Conservation; Electric vehicles; Electric Skateboard; Zero Emission; Non-renewable resources;

I. INTRODUCTION

Around 93% of today's automobile vehicles run on petroleum-based product, which are estimated to be depleted by 2050.For the preservation of gasoline for future use and increasing the efficiency of vehicle, an electric vehicle can be a major breakthrough. An electric vehicle is efficient and pollution free at low speed conditions mainly in high traffic areas. But charging the battery is time consuming. Moreover, it cannot provide high power required during high speed conditions or in slopes of hilly areas. Gasoline engine provides its efficiency in highways at higher speeds and waste a lot of energy in urban areas. A hybrid vehicle solves these problems faced by gasoline vehicles as well as electric vehicle by combining their advantages and use both the power sources at their efficient conditions [1].

II. MOTIVATION

The electric bicycle, electric moped and electric micro-car were described as vehicles of a general character. This process is leading to a small way of fighting the pollution and global warming. Initiatives like this taken by people are also leading to reduced consumption of gasoline. But the cost of electric bikes or electric scooters or eco-friendly cars [2] is in the range of thousands of dollars and they also do not solve the problem of traffic congestion and parking chaos. So electric skateboards came into the picture due to their compactness and portability. This project aims to design an electric skateboard that is propelled electrically and controlled via Bluetooth that can reach a speed of up to 30 km/h. The existing products are priced over 40000 INR and this project aims to make the cost minimum and affordable to all the family classes.

III. PROBLEM STATEMENT

As the world's population is increasing, the number of vehicles is also increasing throughout the world. This in turn is drastically increasing the pollution and global warming. So, there is a need for an eco-friendly method of transportation. With the invent of electric cars and scooters, this problem is being taken care of slowly but another major problem is forgotten that is the increase in vehicle density in the streets. So, there is a need for a transport system that addresses both these issues simultaneously and to ease the lives of the people[3].

IV. OBJECTIVES

To build an electronic skateboard that contains a GPM3248A core, brushless DC motor and an ESC [4] to control the acceleration and retardation without any human effort. The whole concept of this design is to create an eco-friendly mode of transport that helps cut down the gasoline consumption, traffic congestion in the streets and easy maintenance.

Many companies have come up with their own method of eco-friendly mode of transport by making cars and mopeds; Pi-skate is designed in a manner to be advantageous when compared to these. Firstly, the initial cost of purchase of these mopeds and cars are high averaging about 80000-200000 INR whereas Pi-skate aims to hit the market at the price of around 15000 INR. Secondly, these vehicles also need high maintenance but Pi-skate aims at very less maintenance. Thirdly, the cost of repair of these existing products are high whereas Pi-skate's major aim is to be available at low cost with enhanced performance.

As mentioned earlier, there are electronic skateboards available but some are too expensive costing over $500 and some cheaper ones have non- optimal speed range. Pi-skate is designed to operate at optimal speeds for urban areas as well as off-roading capabilities with an affordable price for all family classes in the society.

Operational speeds: -
Minimum speed- 0 Km/Hr.
Maximum speed- 26 Km/Hr.

The average pollution contribution by a two-wheeler with a single passenger is 260 grams of CO2 equivalent per kilometer. By replacing the use of a two-wheeler by person during traveling of short distances or in campus movement, this global warming emission can be cut down. This will go a large way in cutting down the greenhouse gases emission up to about 20% if all the single passenger two-wheelers are eliminated in case of short distance travel or off road traveling when compared to the current vehicle system.

V. OBJECTIVES

1. Block Diagram

The Bluetooth Remote control is the actual source of control for the electric skateboard. It is used for send the actuating signal to the GPM3248A controller. The controller receives the electric signal form the Bluetooth controller and the energy signal form the Battery as shown in Fig,1. The Battery is used to drive both the controller and the motor. The input power is given to the pin number 40 of the GPM3248A Controller and the pin number 14 is grounded [5].

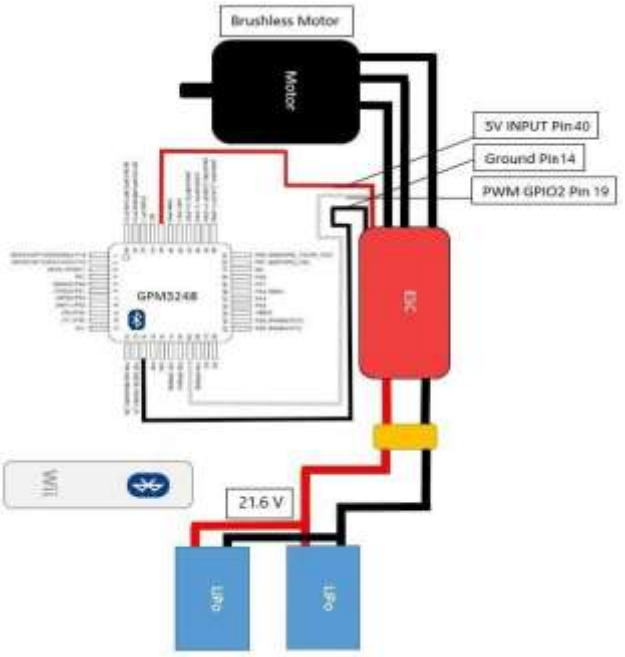

Fig 1. Block Diagram for Electric Skateboard

The PWM output from the controller is given to the ESC which intern controls the mechanical action of the motor. The Battery used is of 22.2 Volts.

The actuating signal from the Bluetooth remote is sent to the controller. The Controller controls the operation of the ESC intern controls the speed for the Electric brushless motor.

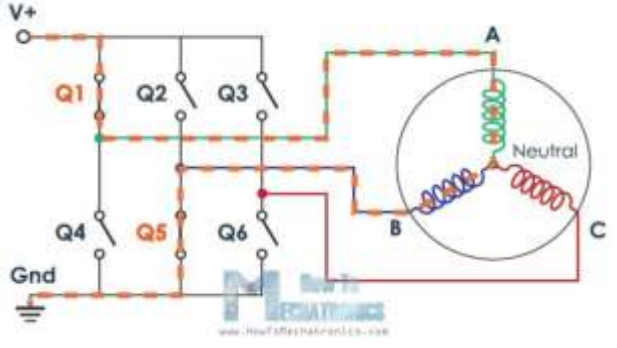

Fig 2. Working of BLDC

An ESC or an Electronic Speed Controller [6] controls the brushless motor movement or speed as shown in Fig.2 by activating the appropriate MOSFETs to create the rotating magnetic field so that the motor rotates. The higher the frequency or the quicker the ESC goes through the 6 intervals, the higher the speed of the motor will be.

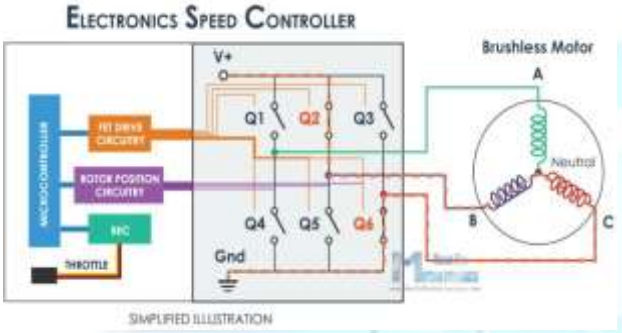

Fig 3. ESC connected to BLDC

As the rotors permanent magnets rotate the Hall-effect sensors sense the magnetic field and generate a logic "high" for one magnetic pole or logic "low" for the opposite pole. According to this information the ESC knows when to activate the next commutation sequence or interval as shown in Fig.3.

So, when the moving magnetic field of the rotor pass through the free coil, or the one that's not active, it will induce a current flow in coil and as result a voltage drop will occur in that coil. The ESC captures these voltage drops as they occur and based on them it predicts or calculates when the next interval should take place [6]. The motor converts the electrical energy into mechanical energy producing torque for the movement of the wheels. In order to gain more torque an electric gear box is used.

This mechanical movement is used to rotate the wheels and accelerate the electric skateboard.

2. Design

Battery:

Battery Specification 6S i.e., each cell gives output of 3.6 V (+/- 5%).

⇨ 6*3.6 = 21.6 V

Total o/p voltage of the battery is 21.6 V [7]. By considering error rate o/p would be 20 to 24V.

Speed Calculation:

Total RPM expected from the BLDC is

RPM(Max) = KV (of Motor) * V (of Battery)
= 220 * 21.6

Max RPM = 4752 rpm

Diameter of the wheel used in the board=74mm
=7.4cm

Circumference = 2 * pi * r
= 2 * 3.14 * 3.7
= 23.23 cm
= 0.232 m

Speed is calculated as rpm * circumference per min
= 4752 * 0.232 per min
=1.102 meters per min
= 66 Kmph

66 Kmph is the maximum speed which is ideal. But practically we are expecting it 45 to 50%, which is almost around 30 Kmph.

So maximum speed at which the skateboard can be operated with load is around 30 Kmph with smooth surface. The speed also depends upon the various other factors.

VI. HARDWARE DESCRIPTION

1. GPM3248A

GPM3248A, a highly integrated micro controller, integrates a pipelined 1T 8051 CPU, 1K/512/256-byte XRAM, 256-byte IDM SRAM, and 32/16/8K-byte program Flash memory. It includes 34 programmable multi-functional I/Os, Timer0/1/2, UART0, SPI (master), Motor control unit with built-in OP and comparators, audio and one up to 8-channel of 12-bit ADC for general-purpose application as shown in Fig.4. It operates over a wide voltage range of 2.4V - 5.5V with different clock sources. It has two modes in power management unit. Moreover, there is one on-chip debug circuit with two pins to facilitate full speed in-system debug.

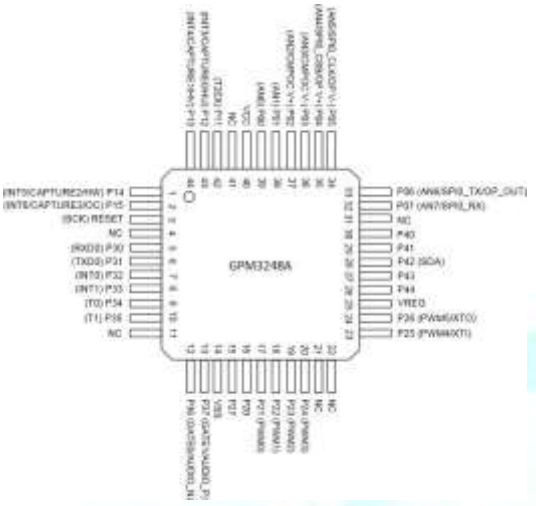

Fig 4. GPM3248A Pin Diagram

2. Electronic Speed Control

An ESC can be a stand-alone unit which plugs into the receiver's throttle control channel or incorporated into the receiver itself, as is the case in most toy grade R/C vehicles. The typical ESC used in skateboard is shown in Fig.5.

Some R/C manufacturers that install proprietary hobby grade electronics in their entry-level vehicles, vessels or aircraft use on board electronics that combine the two on a single circuit board. The BLDC motor is electrically commutated by power switches instead of brushes and it can be controlled by esc. The basic difference between them is that in a brushless motor, the rotor itself contains the permanent magnets and the electromagnets move to the stator which is quite opposite as seen in a brushed motor.

Fig 5. ESC

3. Bluetooth Remote

A Bluetooth technology is a high-speed low powered wireless technology link that is designed to connect phones or other portable equipment together. It is a specification (IEEE 802.15. 1) for the use of low power radio communications to link phones, computers and other network devices over short distance without wires.

Bluetooth is a standardized protocol for sending and receiving data via a 2.4GHz wireless link. It's a secure protocol, and it's perfect for short-range(<100m), low-power, low-cost, wireless transmissions between electronic devices.

The Bluetooth Remote, also known colloquially as the Bluetooth remote, is the primary game controller for Nintendo's Wii home video game console. Most people don't know that the Wii mote communicates with the Wii via a Bluetooth wireless link. The Bluetooth controller is a Broadcom 2042 chip, which is designed to be used with devices which follow the Bluetooth Human Interface Device (HID) standard, such as keyboards and mice.

Operation:

Fig 6. Bluetooth Remote with Controls

Start: when slide “power switch”, the “Forward indicator” will be light (red indicator). The above Fig.6 shown the controls in the remote.

FORWARD AND BACKWARD MODE:

1. If want move forward, push the "start/brake switch" and hold on the position, the skateboard will keep moving forward; loosen your grip, the speed will slow down, pull the back of key, it will bebreak.
2. Switch the driving model to "backward/charging indicator", do the same operation as forward step.

SLOW & FAST MODE:

1. Before start the skateboard, the switch key is on the right side, it's the "high gear" mode.
2. Switch key to right side, it will be in "slow" mode. We strongly suggest beginner keep use of beginner model.

4. Brushless DC Motor

Brushless DC motors are common in industrial applications across the world. At the most basic level, there are brushed and brushless motors and there are DC and AC motors. Brushless DC motors, as you may imagine, do not contain brushes and use a DC current.

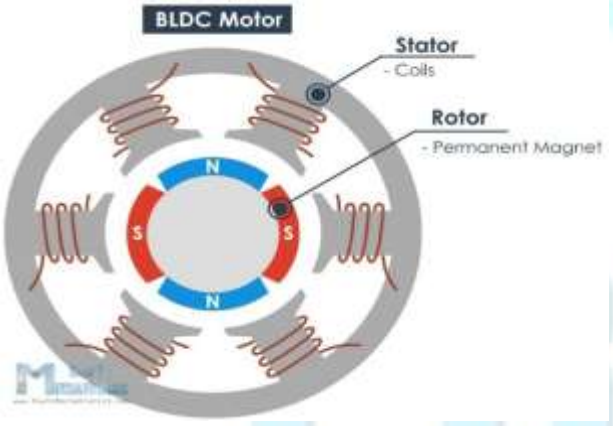

Fig 7. Poles of BLDC

It often helps to explain how a brushed DC motor works first, as they were used for some time before brushless DC motors were available. A brushed DC motor has permanent magnets on the outside of its structure, with a spinning armature on the inside as shown in Fig.7. The permanent magnets, which are stationary on the outside, are called the stator. The armature which rotates and contains an electromagnet is called the rotor.

Brushless DC motors typically have an efficiency of 85-90%, while brushed motors are usually only 75-80% efficient. Brushes eventually wear out, sometimes causing dangerous sparking, limiting the lifespan of a brushed motor. Brushless DC motors are quiet, lighter and have much longer lifespans. Because computers control the electrical current, brushless DC motors can achieve much more precise motion control. Because of all these advantages, brushless DC motors are often used in modern devices where low noise and low heat are required, especially in devices that run continuously. Brushless DC motors provide several distinct advantages over other types of electric motors, which is why they’ve made their way into so many household items and may be a major factor in the growth of service robots inside and outside of the industrial sector.

5. Battery

Batteries operate by converting chemical energy into electrical energy through electrochemical discharge reactions. Batteries are composed of one or more cells, each containing a positive electrode, negative electrode, separator, and electrolyte.

For this project we are using secondary cells as shown in Fig.8 that is rechargeable and require a DC charging source to restore reactants to their fully charged state.

Fig 8. 6S/1P Battery

Specifications:

Size: 165 x 95 x 25
Weight: 826g
MAH: 6300

N° of cells: 6S/1P
Nominal Volt: 21.6V
Max discharge: 35C
Wires: Silicone 8AWG
Battery connectors: NO
Balanced plug: YES

VII. SOFTWARE DESCRIPTION

1. Python

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

Python is dynamically typed and garbage collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library.

2. Python IDE-Visual studio code

Visual Studio Code is a source-code editor developed by Microsoft for Windows, Linux and macOS. It includes embedded Git and support for debugging, syntax highlighting, intelligent code completion, snippets, and code refactoring. It is highly customizable, allowing users to change the theme, keyboard shortcuts, preferences, and install extensions that add additional functionality. The source code is free and open-source, released under the permissive MIT License. The compiled binaries are freeware for any use.

VIII. RESULT

The Fig.9 is an observation made between the expected theoretical values and the implemented practical values. These practical values can vary based on the type of surface as well as the amount of surface friction.

FACTOR	PRACTICAL	THEORITICAL (expected)
Speed	Mode1:28kmph* Mode2:20kmph* (*varies with the type of surface)	30kmph 25kmph
Battery discharge (full load)	Approx. 30 min on mode 1 45min on mode 2	Estimated around at 45min to 1.05hrs
On Road distance	Approx. 15km* max 10km min with full battery. (*varies with the type of surface)	Max of around 20km

Fig 9. Tabular Column for Observation

IX. CONCLUSION

The PiSkate - electrically controlled skateboard helps avoid the pollution and global warming and its disastrous effects on the society. It reduces human effort and the inability to travel on a skateboard by providing the rider an access of acceleration through Bluetooth remote. It aims at ease transportation for in and around campus and short distance travels. Unlike the electric 2-wheelers and 4-wheelers, the charging is made easy. PiSkate can achieve a speed up to 30Km/h. PiSkate also helps reduce the vehicle density on the streets and also avoid looking for parking space and having to secure the parked vehicles. PiSkate is also beginner friendly and is affordable to all family classes in the society.

X. FUTURE SCOPE

The addition of automation to a skateboard reduces human effort and stress in travelling on roads or off roads or in campus movement. This greatly addresses the problems mentioned in the previous chapters. It also helps to reduce the traffic congestion on the streets once fully deployed thought the city [8].

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