ELECTRIC HOVERBOARD

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Abstract: A hoverboard is a self-balancing personal transporter consisting of two motorized wheels with a typical gyroscopic-stabilized system. Emissions from internal combustion vehicles are on the rise every day. Urban vehicular traffic has increased tremendously over the years. Traffic congestion leads to higher vehicle emissions and lower ambient air quality. There can be no immediate solution to this issue, but another solution for conventional personal transport is Hoverboard. So the hoverboards are becoming more popular day by day. But the complex electronics like accelerometer and gyroscope make it too expensive. This project involves the design, analysis, and fabrication of an electric three-wheeled hovercraft. The system moves back and forth using the DPDT switch. A small wheel is used to balance the vehicle such that a gyroscope is not needed for balancing purposes. This project work aims to build a low-cost and efficient Hoverboard.

Keywords—self-balancing, DPDT Switch, low cost

I. INTRODUCTION

Air pollution is a major environmental problem in cities where most people are exposed to poor air quality. Rapid urbanization in India has led to significant growth in the number of ICE vehicles. As vehicle traffic continues to grow and congestion increases, vehicles have become the primary source of air pollution in urban India. The country has taken several measures to improve its quality in cities. These include improving fuel quality, drafting the necessary legislation and applying vehicle emission standards, improving traffic planning and management, etc.

Shortage of fossil fuel and the expansion of pollution and fuel rate makes electric vehicles (EV) more popular on transportation. Compact electric vehicles are gaining some attention from the urban public, personal transporters include all types of bicycles, Segway, hoverboard, e – scooter, e-bikes, etc… are widely used. But the main disadvantage of these electric vehicles is their high cost. A Hoverboard with 3 wheels, which is powered by two engines mounted as part of the Hoverboard. The DPDT switches control the board's direction and movement. The vehicle has battery-operated electric motors. It is balanced through a small bearing wheel. No micro-controller, gyroscope, or sensor is used. The rider accelerates or decelerates by using Speed governor.

II. BLOCK DIAGRAM

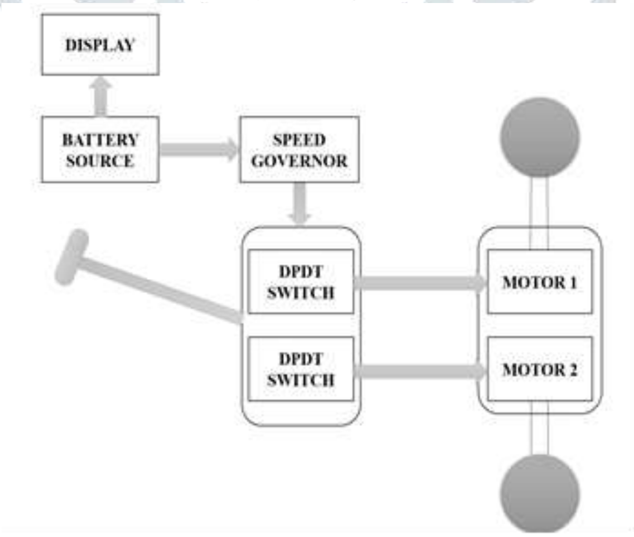

Fig 1: Block diagram

The hoverboard contains two wheels, two BLDC motors, two DPDT switches, a Speed governor, battery source, and a display. The main power supply is the battery. The two motors used here will drive the wheels. DPDT switches are used to drive the hoverboard. The speed governor will help to control the speed of the motors. The display provided in the system will help to know the charge left in the battery. Here we are using two batteries and those are connected in series to power the motors.

III. COMPONENTS

3.1. Frame

It is the main part of the hoverboard. It is made of rectangular wood material. It is designed to ensure the safety of the driver and a robust standing platform and to protect the electrical system and components.

3.2. Handle and shaft

The handle is fixed to the frame and serves as a holder for the driver. It is that part where the control switches, speed governor, and display are attached. And shaft is a vertical axle or support which controls the handle for the vehicle.

3.3. Motor

Here we are using two 24V, 6.25A, 150W BLDC motors. Since BLDC motors are used, there is no need for brushes and commutators. Ther by, avoid the spark and provide the stable operation.

3.4. Battery

We will use two batteries of 12V and 9 Ah each connected in series to power 2 motors with DC. They are lead-acid batteries.

3.5. DPDT Switch

Double Pole Double Throw (DPDT) switch. This serves to guide the direction of rotation of the hoverboard. By operating the switch the direction of the vehicle can be controlled. The connector wires connect the switch to the motor.

3.6. Speed governor

The DC motor speed controller can control the direction of a DC motor using a DC voltage modulated in pulse width (PWM) with a Duty Cycle fully adjustable from 10% to 100%.

3.7. Wheel

Tires are designed to support the weight of the vehicle, convey traction, torque, and braking forces to the road surface, and maintain and alter the direction of travel. And these are places just after the motor.

3.8. Display

Here we use a digital display to check the charge of the battery.

3.9. Supporting wheel

The purpose of a small supporting wheel is to balance properly; there is no need for a gyroscope for the balancing purpose. This will help to eliminate the complex electronic components from the board.

3.10. Braking system

The brakes are used to immobilize the vehicle as required. Here we use a disc brake system.

3.11. Chain drive

A chain arrangement is an endless chain coiled around two pinions. The C Plates chain consists of several links linked by spindle joints while the sprockets are gear wheels with a special profile for the teeth. The chain runs between the belt and the gearbox. For all automobiles especially two-wheelers the chain drive is used for transmission power generated by the engine to the rear wheel.

3.12. Sprocket

The pinion is used to transmit a rotary movement between two shafts when the gears are unsuitable or to give a linear movement to a runway strip. etc.

3.13. Battery charger

Here we use a battery charger for recharging the hoverboard battery. The input voltage of the charger is 110 – 240 V.

IV. CIRCUIT DIAGRAM

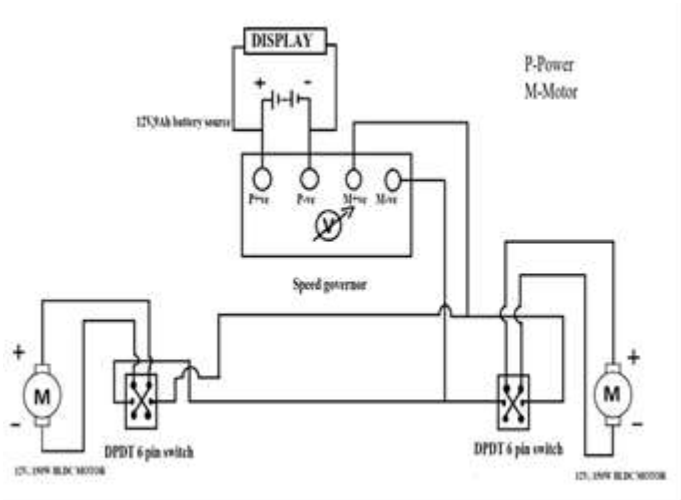

Fig 2: circuit diagram of the system

This is the circuit diagram of our project. Here we are using two BLDC motors, two 6 pin DPDT switches, a speed governor, a battery source, and a display. In the DPDT switches, the motor positive terminals (1 & 6) are shorted and the motor negative terminals (2 & 5) are shorted together. The 3rd pin of the 1st DPDT switch is connected to the 3rd pin of the 2nd DPDT switch. And the 4th pin of the 1st DPDT switch is connected to the 4th pin of the 2nd DPDT switch.

The motor positive and negative terminals are connected to the DPDT switches. A speed governor is provided in the system to adjust the speed of the hoverboard.it will control the direction of the motor by using the Pulse width Modulation technique(PWM),by modulating the width of DC voltage with a duty cycle fully adjustable from 10% - 100 %. In the power terminals of the motor speed control switch, a battery source is provided. And a display is given to the system to know the battery level. The display is placed just parallel to the battery source.

V. COMPONENTS SPECIFICATIONS

SLNO	COMPONENTS	DESCRIPTION
1	BLDC MOTOR	24V, 6.25A, 150W, 2750rpm
2	BATTERY	12V, 9Ah, Sealed lead acid battery
3	DPDT SWITCH	15 – 30V, 15A, ON-OFF-ON
4	SPEED GOVERNOR	6-90V, 20A, 200W
5	TYRE	Diameter -150mm Thickness-50mm Bearing-8mm
6	DISPLAY	3.5-30V, <15 mA, refresh speed – 200mS/time
7	HANDLE AND CONTROL SHAFT	Shaft height-1016mm
8	FRAME	Thickness- 10mm Width*length-304mm*508mm
9	SUPPORTING WHEEL	Diameter- 63.5mm
10	BATTERY CHARGER	Input voltage-(110-240V) Rec:battery capacity-12V/7-10Ah

Table 1: Component specifications

VI. CALCULATION

Weight to be carried = 100kg
Diameter of the tyre = 0.1651m
Radius of the tyre = 0.08255m
Required speed = 12kmph
(normal speed of a hub rotor hoverboard is 6 to 7 miles/hour)
[7 miles = 11.2654 km]

(max: speed of hover board is 10 miles/hour)
[10 miles = 16.0934 km]

- Total reaction on each tyre
  normal reaction of each tyre = W/2
  W = Weight = 100/2
  = 50 kg
  = 50 x 9.81
  = 490.5 N
- Static friction
  Considering it as u,
  u = 0.025
  Dynamic friction v = 0.002
  then,
  Static frictional force, F(u) = 0.025 x 490.5
  = 12.2025 N
  Dynamic frictional force, F(v) = 0.002 x 490.5
  = 0.981 N
- Torque required in static friction,

  T = Fxr F = force, r = radius of wheel
  T = 12.2025 x0.08255
  = 1.0122 Nm

  Torque required in dynamic friction,
  T = F x r
  T = 0.981 x 0.08255
  = 0.0081 Nm
- Internal force required for the motion,
  F = ma
  m = 100 Kg
  a = dv/dt = [(16000/3600) /10]
  = 0.444 m/s
  F = 100 x 0.444
  = 44.4 N
- Torque required for moving the vehicle,
  T = F x r
  = 44.4 x 0.08255
  = 3.665 Nm
- Total power required to move the vehicle,
  P = T x w
  T = Torque
  w = Angular velocity
  =2 rps
  60 x rpm = rps , 16 kmph = 514.1286

  from reference 1 rpm = 6 (angular velocity)
  So,
  w = 514.1286 x 6

  = 3084.7716
  Power required to move vehicle,
  P = T x w
  w in rad/sec

  Rad/sec to degree =
  $$\frac{given\ angle\ x\ 2\pi}{360}$$

  So,
  $$\omega = \frac{3084.7716x2\pi}{360}$$

  = 53.839 rad / sec
  P = 3.665 x 53.839
  = 197.3199
  = 198

VII. HOVERBOARD DESIGN AND WORKING

Fig 3: design of hoverboard

The three-wheeled hoverboard is designed based on the fundamentals of machine design. After carrying out the required machining operations, the motors, bearings, drive wheels, swivel wheel, and springs are mounted onto the footplate. Then after mounting the components under the footplate, the handle is fixed on top of the footplate. Two DPDT switches are placed in the handle to control the direction of the hoverboard, and a speed governor is placed in the handle to adjust the speed of the motor. A display is added to the handle to check the battery level. After making the circuit wiring and connecting the electronics, the assembly of the segway is shown in the figure. Two rechargeable lead-acid batteries of 12V each and a capacity of 9AH each are connected in series to power the two 24V BLDC motors.

All the switches and the controls of the motors which kept at the handle to operate are connected with wires. The wheel motors have two different switches for each wheel so that for turning of each motor is controlled. When both the switches are pressed forward the segway will move forward. If the rider wants to turn left the right wheel motor switch will be used to turn towards the left. If the rider wants to turn right the left wheel motor switch will be used to turn towards the right. The speed governor will help to control the speed of the hoverboard.

VIII. RESULT

In this project we have to estimate the battery capacity, we can explain how much charge is left in the battery. On the other hand, we can say that we have to know the battery behavior that it is fully charged, in the middle means 50% state of charge or completely discharge.

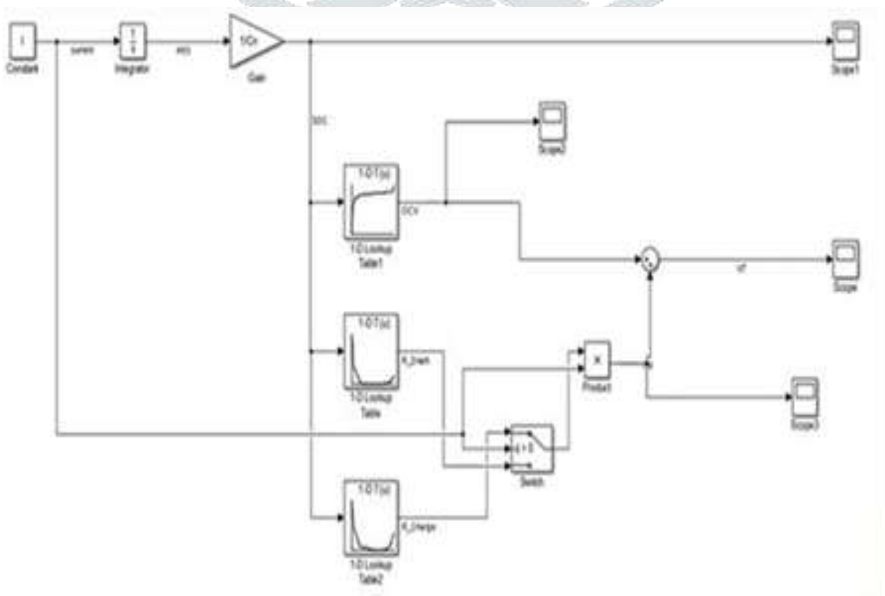

Fig 4: simulation model

The battery test system based on MATLAB's programming with a consistent power source was created and used to know the battery limit and the battery charging and discharging time for its various charges. In a dynamic load, the battery discharge current is held steady and the battery voltage is lowered by the heap.

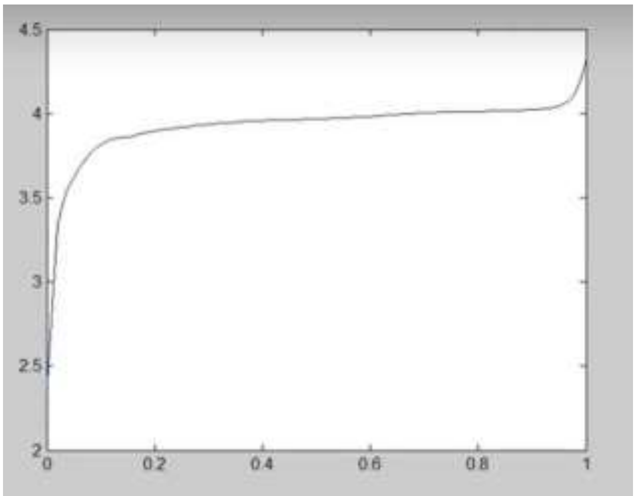

Fig 5:Output of SOC which is OCV

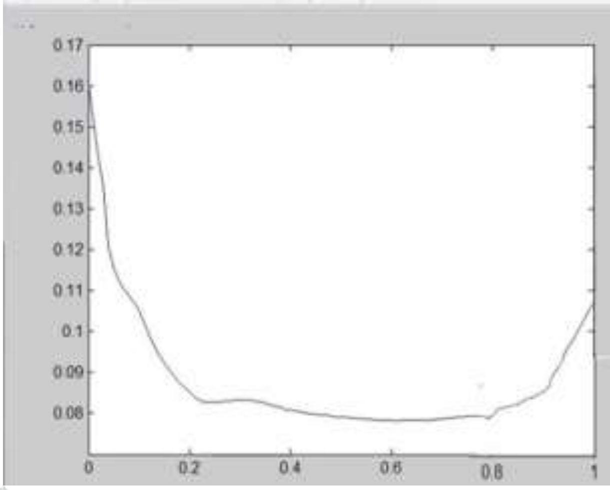

Fig 6: Output of Charge Resistance of Battery

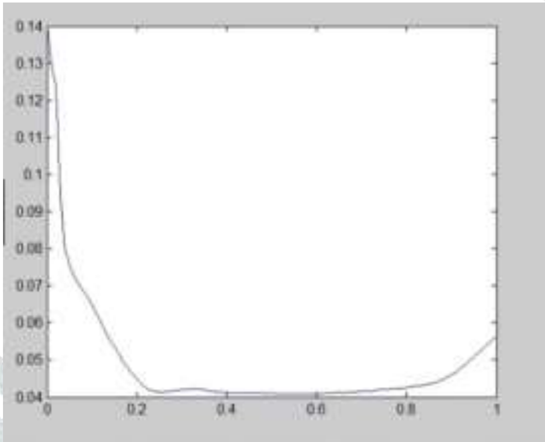

Fig 7. Output of Discharging Resistance of battery

IX. CONCLUSION

Personal electric vehicles are technically possible now. The price of a personal electric vehicle that is available on the market is very higher for its range, it uses cutting-edge technologies which has increased the price. In this project, fabrication methods are changed. For balancing purposes a gyroscope sensor is used in the hoverboards available on the market, but in this project, a support wheel is used to balance the vehicle. The charging time is higher in this project because a strong battery is preferable to lower the cost. Thus, the feasibility of a personal electric vehicle depends on reducing the cost and making it available for every person and in every place.

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