Design and Fabrication of a Segway

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ABSTRACT

The aim of this project is to fabricate a fail-safe segway at low cost. The segway presently in use is of high cost and a common person cannot afford it, so we have decided to design and fabricate a fail-safe segway which is of low cost. The segway in the market uses both gyroscope and accelerometer sensor for the operation and uses tilt sensors to read the value of tilt of the steer of the segway and uses high end processors and micro controllers for its operation, we have minimized the cost of the segway by using micro controllers and relays and switches for the operation of the segway.Segway has a dis advantage of the lack of stability which caused injuries to many people so we took this problem into serious concern and designed and developed a segway which is fail proof. The segway which we designed and fabricated is of low cost and higher stability and with safer operation and ensure the safety of the user. This segway is easy to use as we have introduced switch system to control the motion of the segway.In this project work, two wheeled and one small supporting wheel self-balancing as well as manually balancing Mechanical Segway vehicle is prepared which is also known as a personal transporter Segway.

INTRODUCTION

Segway is a type of stand-up transportation vehicle. This two-wheeled motorized personal vehicle transporter consisting of a platform for the feet mounted above an axle and an upright post surmounted by handle. Segway uses rechargeable battery that converts the electric energy into mechanical energy. The battery used can be charged easily using a power connection. The first problem with the Segway is the price. This technology is not affordable to low-income individuals. The Segway is not only a great innovation, but it is also environmental friendly since it is fully electrical and does not release any emissions and this would appeal to a lot of people if they knew it existed. The Segway has a bright future, becauseafter most of the problems are taken care of, it will eventually be widely used and accepted as a form of transportation that is better than the bicycle In conclusion, it is only after the Segway passes this phase of interpretative flexibility will it reach closure and stability. It is after this last stage that the diffusion of this technology will take place in a big way.

Principle Components Of Fail Safe Segway

- **Segway chassis and material properties:** Chassis is made up of aluminum section and four aluminum bars is used to make the frame. To make the chassis to balanced, four aluminum bars of equal weight are used. It is engaged firmly with the help of aluminum welding. Aluminum welding is used to connect all the bars. Wheels are attached to the middle of frame in order to withstand the load capacity.

  Details of Segway chassis:

  1) Base Plate Thickness - 10mm
  2) Aluminum Rod Diameter -
  3) Rod Height – 1016mm
  4) Normal Cycle Handle Bar used for balancing purpose.
  5) Width* Length – (304.8 mm *508 mm)

- **Motors:**Motor is fixing with the chassis through screwed bolt and it is the main source of power with is to drive the vehicle. There are two motors, each for one wheel. Each motor is driven by a separate 12v battery.

  Motor Specification:

1) DC gear motor (Wheel chair motor).
2) Voltage range- 12V-24V.
3) Current- 2-5 Amp.
4) Gear ratio- 1:50
5) Power- 150Watt
6) Motor RPM- 100-3200 RPM
7) Weight- 1.75kg

- **Battery:** Battery is a main power source. Two 12V DC batteries are used in Mechanical Segway. Each battery connected with each motor. Battery supplies power to each motor to run the wheels. Battery is rechargeable in both ways electric socket and solar plates.

Battery Specifications:

1) Voltage range- 12V-24V DC (22Ah)
2) Current – 2-5Amp.
3) Battery weights- 5.9kg

- **Mechanical Segway tyres:** In mechanical Segway two tyres is used in both the sides. Scooter wheels are used in Segway reason behind that cost is less, easy to available and friction property is also less. Also higher amount of weight gaining capacity and movements is also very smooth.

Tyre Specifications:

1) Wheel diameter- 177.8mm
2) Material- Combination of rubber and leather.
3) Casing material – combination of fiber and plastic.
4) Thickness of tyre- 100mm

- **Supporting Wheel:** Supporting wheel is used on Mechanical Segway. The purpose of small supporting wheel is to balance properly; there is no need to gyroscope for the balancing purpose. Also easy to assemble and dis-assemble.

Supporting small wheel Specification:

1) Wheel diameter- 63.5mm
2) Material - Plastic hard rubber
3) Metal casing is used to supporting the wheels and one fixing socket is provided.

DESIGN CALCULATIONS

- Power Calculation.

Avg Load Acting: 100 kg
Avg Velocity: 12 km/hr
Power = load * velocity = 100 * 9.81 * 12 *1000 / 3600
= 3.27 KW

- Design of V-Belt & Pulley :

Power = 3000 W
N_1 = 2400 rpm (Driver)
N_2 = 800rpm (Driven)
C = 200 mm

- Design Power = P_R * KL = 3000 *1.10 = 3300 watt.

- Designation of belt w.r.to design power & other parameters:
  - Designation : A
  - Width : 13 mm
  - T : 8 mm
  - D : 75 mm
  - K_b : $17.6*10^3$
  - K_c : 2.52

- Peripheral Velocity :

$V_P = \pi * D_1 * N_1/60$
$= 565.48$ m/min = 9.42 m/s
$V_P = \pi * D_2 * N_2/60$
$D_2 = 224.88$ mm

- Belt Tension = $F_1-F_2 = P_d / V_p =$ 17.51 N

$F_1-F_2 = e^{\mu \Theta / \sin(\alpha/2)}$
$\mu = 0.3$
$\Theta = 2.39$

Assuming Cone Angle = α = 34 deg
$F_1/F_2 = 11.61$
$F_1 = 43.33$ N
$F_2 = 3.73$ N

- Power rating of the belt :

$F_w - F_c = e^{\mu \Theta / \sin(\alpha/2)} - 1 / e^{\mu \Theta / \sin(\alpha/2)}$

$F_w = w^2 = 169$
$F_c = Kc * (V_P / 5)^2 = 9.749$
Power Rating = 1371.01 watt

- No of Belts = n = P_d / power per belt = 3300 / 1371.01 = 2

- Length Of Belt = $\pi/2$ ($D_1 + D_2$) + 2C + ($D_2 - D_1$)^2 / 4C
  = 900 mm

- Design Of Pulley :
  L_P = 11 mm
  B = 3.33 mm
  H= 8.7 mm
  C = 19.04
  F = 11.5

- Width of Pulley = (n-1) e + 2F
  = 156.28 mm

- Torque
  T_d= 60 * P_R * K_L / 2πN2
  K_L = 1.75
  T_d = 3.133 * 10^3 Nm
- Type of construction = Diameter is below 150 mm

- Rim thickness (t)
  t = 0.25 $\sqrt{D}$ + 1.5
  t = 3.66 mm.

DESIGN AND DRAWING

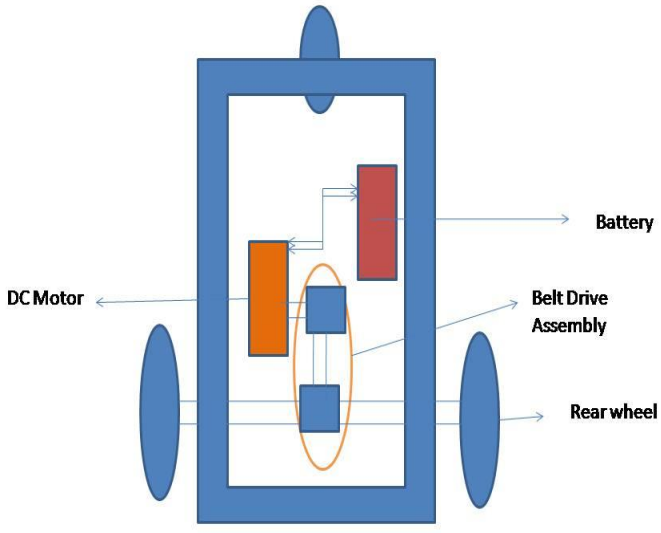

Fig: Top View Design

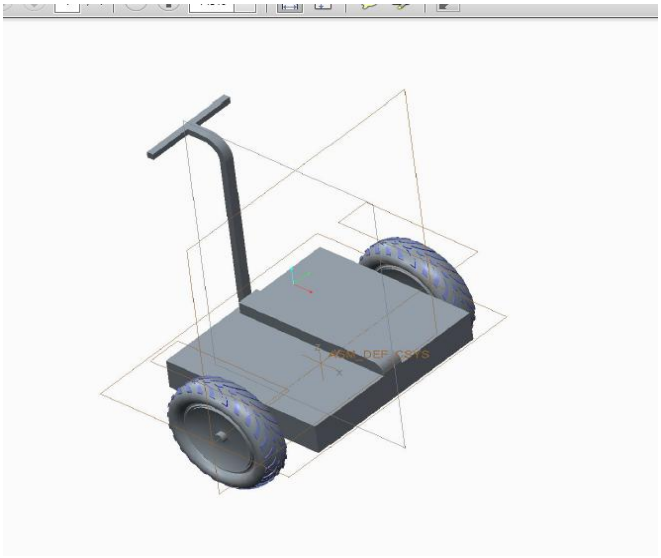

Fig. Proposed CAD model of project

Components of project:

1. Belt & Pulley Mechanism
2. Front and rear axle
3. Chassis
4. DC motor
5. Battery
6. Controller
7. Steering
8. Wheels
9. Accelerator
10. Braking system
11. Electrical connection

ADVANTAGES , LIMITATIONS AND APPLICATION

A). Advantages

1) Become more productive: more work can be done by using the product versus walking
2) Become more recognizable: Riders stand an additional eight inches off the ground, allowing you to be better seen and giving the rider better sight lines, over cars in a parking lot or boxes in a warehouse.
3) Low operating costs: no need for gas and inexpensive battery charging (A complete cycle charge will take eight to ten hours)

4) Reduce fatigue caused by walking
5) A clean, green, eco-friendly machine! (zero emission)

B). Limitations

1) Slow, having a max speed of 12.5 mph
2) Does not exactly say how far the Segway will go with riders of different masses
3) Heavy, weighing around 100lbs
4) Unlike bicycles, a drained Segway cannot be pedaled home or a charger
5) Expensive, which costs around $3000-$5000

C). Application

1) In school.
2) In colleges.
3) In company campus.
4) In hospitals.
5) Security purposes.

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