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# SEGWAY VACUUM CLEANER

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## ABSTRACT

*Specialised Cleaning Equipment used in big hospitals, shopping malls, workstations and other large-scale organisations are expensive. They may cost north of One Lakh Rupees. Here the cost becomes a major issue as well as the cleaning vehicles are large and take up space. Operating them also requires skilled labour. On the other hand, use of traditional mop sweeping takes a lot of time and intense human effort is required for cleaning the floor. Moreover, more cleaning staff is needed to be employed for a given square feet of area and the process is inefficient. Use of vacuum cleaner may be economical over the use of traditional mop, but it is time consuming. Also, if a single person cannot clean the entire floor of an organisation. Our solution i.e. 'Segway Vacuum Cleaner' is 1/10$^{th}$ the cost of the Specialised Cleaning Equipment and easy to use. It may be expensive than a mop, but the extra cost is recovered in amount of time saved as also the cleaning staff required is reduced. Our machine is simple in design as it is in its initial prototype stages and meets the purpose defined. A security personnel who patrols the malls can also use this to go about the floor and clean it while moving about it.*

***Keywords: Vacuum cleaner, floor cleaning, self-balancing Segway, Rocker Switch (DPDT)***

## I.INTRODUCTION

This paper describes the idea, concept and thoughts of providing a consumer-friendly product and providing a better way of transportation and taking concept of vacuum cleaner at a next level. In this project, "SEGWAY VACUUM CLEANER" vehicle is built with the goal keeping in mind of reducing human efforts with low cost in cleaning process. Segways have become an effortless way of transport. Addition of vacuum cleaning mechanism in the Segway is to successfully achieve the goal of floor cleaning process with ease & less human efforts, low cost, high efficiency. In this project work, two wheels and two small supporting wheel (castor wheels) self-balancing Mechanical floor cleaning Segway vehicle is prepared. The system is able to operate in transporter mode. The first goal is to maintain stabilization in pitch dynamic. This project focuses on to manufacturing floor cleaning Segway without using any type programming, complex electronics & sensors. The system consist of forward and backward movement when the driver operates DPDT switch. Small supporting wheels are used so that there is no need of gyroscope for balancing purpose.

## II.EXISTING MACHINES USED

Currently, the methods used are:

i.Robotic vacuum cleaners:

- They are round therefore, they cannot cover corners.
- They have low suction pressure.
- They have low storage of sucked materials.
- They have low battery life.
- They have complex design & excessive cost.
- Trajectory setting is required.

ii.Traditional vacuum cleaners:

- More time is required.
- More human efforts.

## III.PURPOSE

i.To prepare a floor cleaning Segway at low cost and high efficient.

ii.To prepare a floor cleaning Segway without using complex and electronics parts such as microcontroller, gyroscope.

iii.To reduce the human effort and cost & make the environment sanitary.

## IV.LITERATURE SURVEY

| Sr. No. | Paper Name | Author Name | Published Year |
|---|---|---|---|
| 1. | "Segway Design Project" | M. Burkert, T. Groll, T. Lai,T. McCoy, D. Smith | 2004 |
| 2. | Bridging the last mile:A study of the behavioural, institutional, and economic potential of the Segway human transporter | Susan A. Shaheen, Rachel Finson | 2003 |
| 3. | Application of Segway machine for floor cleaning with adjustable wiper. | Ganesh Jadhav, Maruti Yamgar, Abhijit Surwase, Ravikank Deshmukh, Rahul Patil | 2017 |
| 4. | Robovac (Autonomous Robotic Vacuum Cleaner) | Juan Gamarra, Diego Molina, Jetmir Palushi, Raymond Perez, Joseph Seborowski | 2006 |
| 5. | Automatic Floor Cleaner | Manya Jain, Pankaj Singh Rawat, Ast. Prof. Jyoti Morbale | 2017 |

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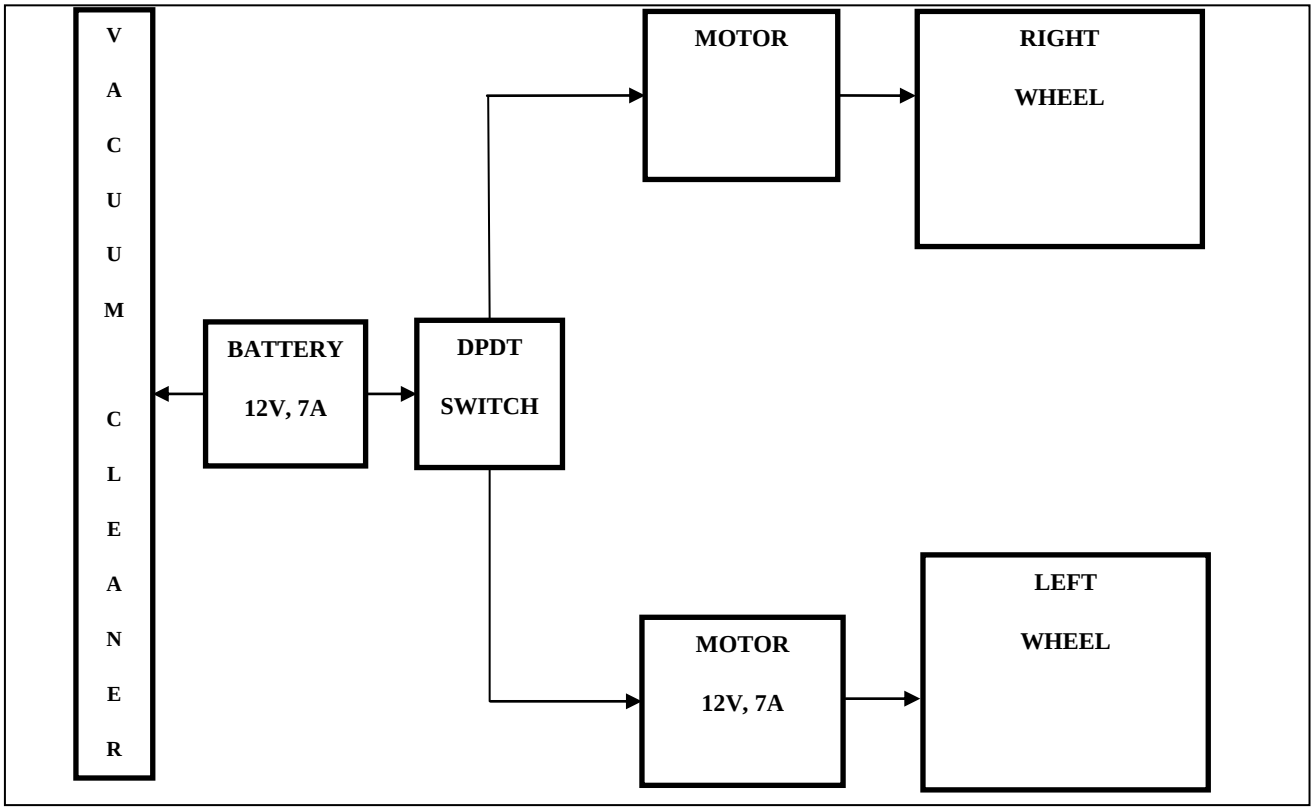
## V.BLOCK DIAGRAM




## VI.COMPONENTS

Battery (3 nos.)


Wiper Motor: 12V, 7 amp (2 nos.)

Frame (MS)

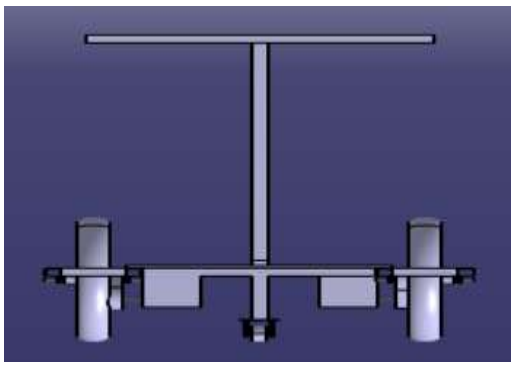
Chain Sprocket

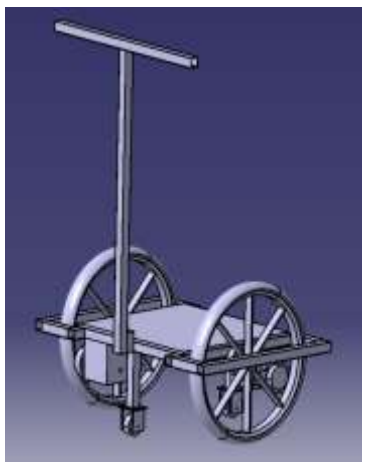
Chains

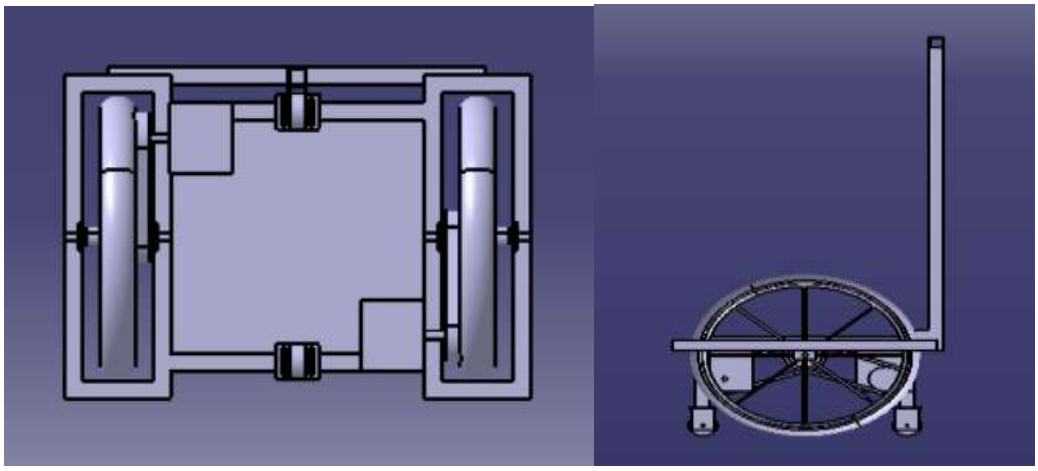
Wheel

Vacuum Cleaner

**VII.ASSEMBLY DRAWING (Without Vacuum and Batteries)**







## VIII.SYSTEM WORKING

i. Supply is directly given to the motor from the Battery.
ii. Motor used here is a Wiper Motor, also known as Gearhead Motor (Gear Motor).
iii. Motor rotates the Sprocket which in turn rotates the wheel.
iv. From the battery through wire the power supply is given to the DPDT switches for controlling the direction of movement and dust collecting arrangement or vacuum suction arrangement.
v. Both DPDT switches are pressed in upward directions to execute forward movement.
vi. Both DPDT switches when pressed in downward directions, reverse movement is executed.
vii. To execute a Left-Turn, left switch is placed upwards and right switch is pressed downwards. Thus, supply to the Right-Wheel is in forward direction & Left-Wheel power is in reverse direction.
viii. To execute a Right-Turn, right switch is placed upwards and left switch is pressed downwards. Thus, supply to the Left-Wheel is in forward direction & Right-Wheel power is in reverse direction.
ix. Drive used here is normal Bicycle drive, wherein sprocket is free & the drive is in forward direction only. Here, we have welded the sprocket to the wheel so that the drive is in forward as well as backward direction.
x. The vacuum cleaner is powered from DC supply directly from Battery pack.
xi. After suction, we have rotating sweepers which wets the surface below with water droplets & disinfectant. Thus, sucking the dirt from the floor is followed by sweeping the floor.
xii. Magnetic strip is provided to attract metal particles.
xiii. Sweeping blade is provided which gives a mop effect at the end.
xiv. We are using small caster wheels to replace the Gyroscope used for self-balancing purpose.
xv. Vacuum Cleaner is attached at the front of the Segway.
xvi. It is suitable for dry as well as wet applications.

## IX.CALCULATIONS

**Total Weight Calculations:**

Mass of Segway = 25 kg

Mass of Operator = 65 kg

Total mass of System = Mass of Segway + Mass of Operator

= 25 + 65

= 90 kg

Total Weight = mg

= 90 x 9.81

**Total Weight = 882.9 N**

**Torque Calculations:**

Radius of Wheel = 177 mm

Torque = Frictional Force x Radius

$= (\frac{\mu W}{2})$ x R

= ((0.4 x 882.9)/2) x 0.177

**Torque = 31.25 Nm (for one motor)**

**Power Calculations:**

Power $= \frac{2\pi NT}{60}$ W

$= \frac{2\pi X25X31.25}{60}$

**Power = 81.81 W**

**Battery:**

Power for two motors = 163.62 W

Power = V x I

163.62 = 12 x I

$I_{total}$ = 13.65 amp (total)

= 14 amp

$I = \frac{Itotal}{2}$

$= \frac{14}{2}$

Hence two batteries of **12V 7 amp** are used.

**Calculations of Frame:**

Area of Frame = 74594.72 $mm^2$

Force = 882.9 N (total weight)

$$\text{Stress} = \frac{Force}{Area}$$

$$= \frac{882.9}{74594.72}$$

**Stress = 0.0118359 MPa**

$$\text{Yield stress} = \frac{\max load}{area}$$

$$= \frac{120 \times 9.81}{74594.72}$$

**Yield stress = 0.0157812 MPa**

$$\text{Factor of safety} = \frac{Ultimate\ Load}{allowable\ load}$$

$$= \frac{120}{90}$$

**Factor of safety = 1.33**

Design Factor of Safety is **1.5**

As Factor of Safety of our Segway is **less than** design factor of safety. Hence Design Is Safe.

## X.FUTURE WORK

i.The following are the possible ideas for future work:

ii.Smart Batteries which are rechargeable, compact, can last longer can be adopted. Also they could charge up quickly.

iii.Manufacturing drawings can be made for future prototype testing and in-depth analysis.

iv.The steel frame used can be replaced with another frame made up of composite material which is both lighter and stronger than steel.

v.This concept can be developed further to work on both AC & DC power.

## XI.CONCLUSION

i. Thus, we have successfully combined Segway with Vacuum Cleaner.
ii. Our design is an alternative which lies in between use of vacuum cleaner and expensive cleaning vehicles.
iii. We have studied Segway Transporter Mechanism & Vacuum Cleaning Mechanism.
iv. The main objective of our project is successfully achieved with correct result.
v. The Segway vacuum cleaner has been evaluated in different locations and scenarios.

## XII.ACKNOWLEDGMENT

The project would not have been the light of the day without the whole heartedly support of our guide Prof. A.R. JAIN, he always boosted our morals. Nonetheless, over the weeks, he has rendered us significant encouragement in various aspects and guided us. We thank him for their valuable guidance and his direct and indirect assistance in the successful and timely completion of "SEGWAY VACUUM CLEANER"

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