International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 01, January-2019

A Review Paper on Segway Forklift

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***Abstract*— A segway forklift is a small electrical vehicle which is designed to build up a cheap forklift for industry warehouses and domestic purpose. The main aim of our project is that goods transportation device which can be driven by anyone. Dynamic principle is that to balance the vehicle two supporting wheels are used to make it stable. This kind of vehicle is interesting since it contains lot of technology relevant to an environmentally friendly and energy efficient transportation industry [2]. So once the design is conceived we do the analysis for the chassis by calculating the mass properties of the parts and the subassemblies to ensure the stability of the fork lift. We do this analysis to get the maximum loading capacity of the segway with the rider and the forklift load on it. After getting the maximum load capacity we do the stress analysis in the important parts and and the subassemblies using finite element analysis (FEM) and on that result we decide the design is safe to use under working condition.**

Index Terms*— Lower frame, upper frame, DC motors, forks, batteries, ball bearing sliders.

I. INTRODUCTION

The **Segway** is a two-wheeled, self-balancing personal transporter by Segway Inc. Invented by Dean Kamen and brought to market in 2001. It is designed to mirror the process of human walking[1]. It is used as convenient way to travel around towns and cities. It is more environment friendly than that of cars. It has a bright future because after 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 [1]. This paper describes the design and construct of Segway without using any sensors. The main purpose was to design and construct a fully functional Segway with forklift so that it can carry load with human weight. It is a small industrial vehicle, having a power operated forked platform attached at the front that can be raised and lowered for insertion under a cargo to lift or move it. It serve the needs of various industries including warehouses and other large storage facilities. The main aim of the forklift is to lift the loaded cargo and move it to the place where the cargo is required. So to make this moving of cargo possible without human effort, Segway forklift is used. There are no of goods that are around 30- 40 kgs which cannot be moved easily by human labour. So to reduce this human effort, we here propose a Segway forklift for it. The product varities in different shapes and different packing of goods for loading and unloading has always been a heavy process during transportation by forklifts were naturally inverted and became the solution to this problem they save time and space [2]. If the goods are arranged in proper ways then the time consumption for the transportation will be reduced and it will be easy to handle. Vehicles which are in use now a day need fuel consumption, in order to make it eco-friendly, we here propose an electric forklift with Segway. The main principle of work is to make it totally cost effective and efficient. Forklifts trucks are common production vehicles which convey raw materials to the production lines, scrap and final products to the storage areas or to the transportation trucks [3]. The advantage of our vehicle is that it has zero emission, zero turning radius and has a safe travelling speed. Simulation will be achieved using numerical methods and finite elements method, supported by modelling and simulation software [4].

II. DESIGN GOALS

- Speed control by two brushless DC motors.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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- Turning will be controlled by two switches.
- Segway is designed to transport person weighing up to 100kgs
- Forklift is designed to transport weight up to 40 kgs.
- It is designed to have speed of 15 km/hr.
- Segway should use as robotic mobility platform [8].

III. OBJECTIVE

- To make compact design than the existing design.
- To make the Segway fail proof.
- To attach the forklift to the body of Segway.
- To carry the load (20-40kgs) which is to be moved from one place to another with less human effort.
- To make it cost friendly.
- To make it more efficient then then existing product.

IV. COMPONENTS

- Frame
- Dc motor
- Power source
- Wheels
- Handle
- Forklift
- Ball bearing slide
- Wire winding motor

1. Frame

It is the main part of the Segway. It is made up of wooden material which is rectangular in shape. On top of the wooden frame we have added an aluminum plate to increase the strength and weight carrying capacity. Motor and wheels are also attached to the frame below. The top part contains handle bar and the motor of the forklift and the battery. It is designed to provide safety of the rider and robust standing platform and to protect the electrical system and components.

2. DC Motor

The motor used are dc motor which are of 18V, 300 rpm it has a power of 250W and it transmit a torque of 92 kg-cm.

3. Power source

We are going to use two batteries of 12V and 7.5amph each one for the wheel drive which are driven by two dc motors and the other one is used forklift motor. They are acid lead batteries. The batteries we have connected in parallel and are connected to the control unit from which the power is transferred to the motors. The charging time required for the batteries is 2-3 hours.

4. Wheels

Wheels are the circular components which are attached to dc motors.

Wheel specification

- Outer diameter of wheel 300 mm
- Inner diameter of wheel 20 mm
- Outer dia. Of support wheel 60 mm
- Inner dia. Of support wheel 10 mm

5. Handle

The handle is attached to the frame and it serves as a support to the driver. It is that part were the control switches are attached.

6. Forklift

The forklift is one of the main part of the Segway forklifter. The main purpose of the forklift is to pick up the goods and can easily move it from one place to another. It is deisgn by using the principle of 3 point contact. Material used for fork lift is mild steel. It is made by two strips which have sharp and tapered edges.

7. Ball bearing slide

For the up and down movement of the forklifter we are using sliders which consist of ball bearing. The ball bearing are controlled by a ball retainer. This hold the ball bearing in place and allows the members of the slide to move relative to each other. With the precise design and manufacture the members and the retainers move at the ratio of 2:1. It consist of inner and outer part of which inner is attached to the backside of the forklift and the outer part is attaches to the frame.

8. Wire winding motor

To lift the forklift mechanism we are using wire winding motor which consist of motor and wire which winds and dewinds on the shaft of the motor as per the need.

Specifications:

- Travel speed: upto 60 m/min
- Winding length: 2000 m max
- OD of the drum: up to 3.3 m

V. FUTURE SCOPE

- Using of sensors based baking system.
- Installation of more sensors to get more efficient work.

International Journal of Engineering Research & Technology (IJERT)
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- Using of composite material for the build-up.
- Making it fully automated.

VI. SEGWAY BALANCING TECHNIQUE

The balancing action of the Segway is described in the figure given below.

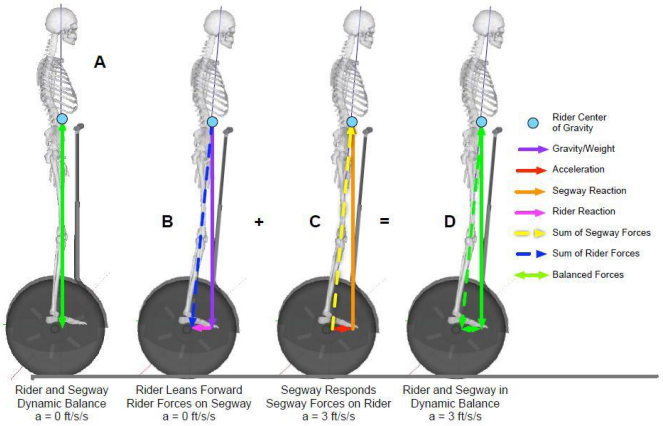

Fig- 6(a): the forces acting on a Segway.

In the figure A the rider is standing with gravity and the segway reaction force is in balance. So in the next part that is B the rider has leaned in forward direction for the movement of the segway. There are different colored arrows present which have different meaning given in the picture. By leaned movement of the rider the segway senses the motion and starts moving forward direction as we can see in the figure C. so of all the addition of the A B and C the segway balancing technique is studied. So by using this same phenomena we can built our segway. Figure D shows the sum of all the forces acting on the segway and it gives the vector sum of the forces to run the segway.

In figure 6(b) it shows balancing if segway during acceleration and deceleration.

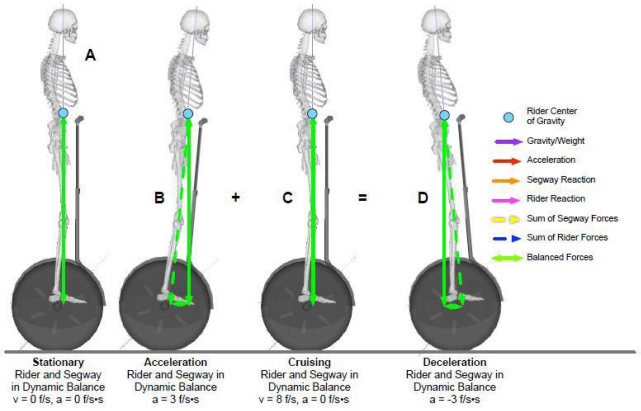

Fig. 6(b): segway balances the force on the rider in all phases of riding

While acceleration when the riders leans more in forward direction the speed of the segway increases. Same goes with the deceleration when the rider will lean in the backward direction the speed decreases. For turning the same mechanism is used if the rider wants to turn toward right thr rider will lean towards right side and the sensors will sense and turn towards right. So while turning if the riders wants to slow down the while leaning to right it will also lean towards backward to reduce the speed.

VII. WORKING PRINCIPLE OF FOEKLIFT MECHANISM

Safety is the most important consideration in the design of the forklift, while the fork lifts is during loading and moving stability system consists of 3 point of contacts, 2 front wheel drives and supporting the real wheel contact axel arranged on safety mounted.[2]

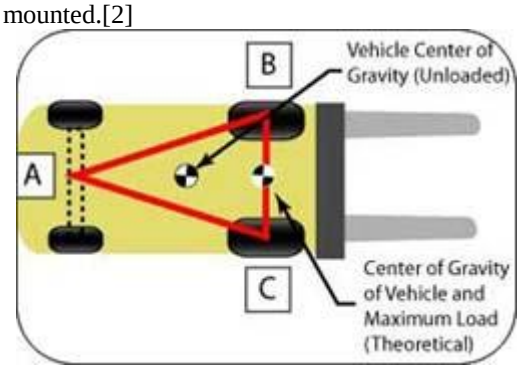

Figure 8: stability triangle formed by connecting the three support points of a powered industrial trucks suspension system So by using this concept the design of the fork lift is done.

VIII. CONSTRUCTION

The basic aim of our construction is that to make such design which is cost effective and attractive. So our segway consists of two rectangular boxes which at the middle has two slots in which 12V dc motors are kept and fixed in such a way that there shafts are out of the boxes on which the wheels will be attached. On the upper part of the box the handle of the segway is attached at the center. On the handle there is forklifting mechanism attached. Which consist of ball bearing slides which are attached to the handle and on these ball bearing slides the forks are attached due to this the up and down movement of the forklifts can occur. These forks are attached with a wire cable which passes over through a pulley which is in between the handle and attached to a wire winding motor which lifts the forks and the weight on it. The wire winding motor and the wheel motors have 2 different batteries of 14V each. Then the controls of the wheels and the forklifts are given on the handle so that the rider could easily operate vehicle.

IX. WORKING

All the switches and the controls of the motors are kept at the handle to operate they all are connected with wires. The wheel motors have two different switches for each wheel so that for turning its each to operate.when both the switches are pressed in forward direction the segway will move forward. If the rider wants to turn left the right wheel motor switch will be used to turn towards left. For the forklifting mechanism the switches are present to take the load up and down after setting the load to a certain height then by using the wheel switches the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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segway can be moved with the load. For forklift wire winding motor is used which winds and dewinds the wire to move the load up and down.

X. EXPERIMENTAL ANALYSIS

The dynamics of the segway RMP are non-minimum phase in the position and velocity. That is the wheels must first move backward before the RMP can accelerate forward [8]. It is done by the dynamics of the inverted pendulum. The machine leans forward initially and when it reaches the constant speed it becomes straight. In this type of applications the tilting of the platform can increase the efficiency.

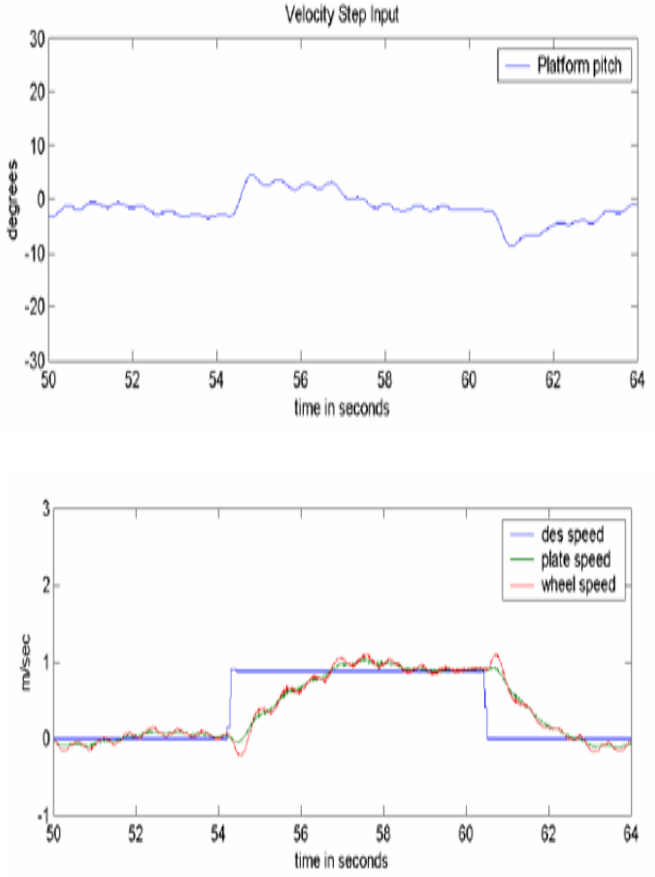

Figure10: dynamics of the segway RMP during acceleration and deceleration.[8]

Stress analysis for chassis:

It is the intensity of internal resistance offered by a body/material against deformation.

- The weight acting on the segway = weight of the segway forklift + weight of the rider
- Weight of the segway forklift = 40kgs
- Weight of the user = 90kgs
- Weight acting on the segway = 40+90 = 130 kgs
- Load acting on the segway = 130*9.81= 1275.3 N
- Area of segway chassis = 500*500 = 25000 mm^2
- Stress acting = 1275.3/25000 = 0.051 N/mm^2

The stress acting on the frame is less than the allowable stress of the material wood. So the design is safe.

XI. CONCLUSION

So the project carried out by us made an impressing task in the field of production and manufacturing industries and also to the common people .The design of our project is such made that it requires less area for working and for parking. As it is a electric vehicle it is clean green and ecofriendly. It does not require any kind of fuel. It is made with safety consideration of the rider that even kids can drive them easily. It uses less time to transport goods of 30 – 40 kgs then by the human effort. The safe is fail safe segway designed. The potential of our project is good and the return on the investment is also very good [2]. This design has been thoroughly tested, and all aspects have been taken into consideration. The proposed design may be used for fabrication of a full-scale personal transporter for personal use and is sure to cost much less compared to the original Segway, which costs a fortune in comparison.

ACKNOWLEDGMENT

It is our privilege to express our sincerest regards to our project guide **Prof. Priyanka Verma** who gave us the golden opportunity to do this wonderful project on the topic **"*Design and fabrication of Segway forklifter*"**, Prof. Priyanka Verma for her valuable inputs, guidance, encouragement, whole-hearted cooperation and constructive criticism throughout the duration of our project. It is indeed a matter of great pleasure and proud privilege to be able to present this project on **"**It is indeed a matter of great pleasure and proud privilege to be able to present this project on **"*Design and fabrication of Segway forklifter*".**

We are also grateful for the co-operation, valuable suggestion rendered by "**Prof. Arunkumar Lokhande**" ,as a head of department and all other teaching staff of the department.

Finally we are greatly indebted to management of our college and express appreciation and thanks of our Principal "**Dr. S. K. Narayankhedkar**", for coordinating keen interest and providing necessary facilities in completing the project.

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