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Design and Fabrication of Fail Safe 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.*

Keywords: Accelerometer, Gyroscope, Stability, Fail-safe

I. 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.

II. Objective

The main objective is to design and fabricate a segway which is fail proof and at low cost.

III. Principle Components Of Fail Safe Segway

The main components of Fail Safe Segway

Frame or chassis

The segway we have fabricated has a square shaped chassis. This chassis is made from mild steel pipes. The pipes used are medium gauge one inch hallow square pipe. This pipes are welded together to form the chassis of the segway. This are joined in such a way it form a 500X500 mm square shaped member. At the center of the frame another square pipe is added to increase the strength and weight carrying capacity of the frame.On top of the frame mild steel sheet is added to provide the platform for standing on the frame

Driving mechanism

The drive train is the heart of the automobile. In our segway the drive train includes two DC motor and four rechargeable batteries which are charged to drive the motor. The type of drive in a segway is two wheel drive. In which both the wheels are driving wheels. The powers from the motors are transferred to the wheels independently or separately. The motors shaft is welded to the wheel shaft for the transfer of motion between the wheels and the motor. The final parts of the drive train are the wheels and tires, which transfer the power generated by the motor to the ground.

Motors: The motors used in our segway are dc motors with a voltage of 12v, 60 rpm and with a power of 90watt.

Battery: The battery which we used for our segway is a 12v and 7.5amph lead acid batteries and these batteries are rechargeable. The batteries are connected in parallel and are connected to the control unit from which the power is transferred to the motors. The total charging time will be some 2-3 hours

Control unit: The control unit of a segway is the brain of the segway. It plays a very important role behind every operation of the segway. The signals which ever are given to the segway are transmitted through the control unit to the motors. For the segway to run the control unit is needed. The operation of the control unit will be in accordance with the switches, when the switches are pressed the signals are transferred from the control unit to the motors. When the switches are pressed the signals will be passing through the microcontroller where the required instructions are obtained from the program and this signals are then transferred to the relays. The relay passes the signals to the motors.For the different operations on the segway different relays work.

IV. Assembly Of Segway

i. Two motors are placed in the opposite side of the chassis and they are attached to the frame by c-clamps.
ii. Motor shaft is fitted in coincidence with the wheel shaft.
iii. Later the two shafts are joined together by the process of welding.
iv. Wheels are assembled to the frame or chassis by using ball bearings and c- clamp
v. The handle bar is attached to the segway on the top of the chassis at the front side of the segway.

V. Results And Discussions

- A new segway was successfully fabricated. This segway is developed with low cost and low operating costs. The segway which is developed is fail safe and is very easy to operate.
- The batteries use only 2 to 3 units of power for charging and it lasts for 7 hours
- The maintenance cost, operating costs are very less compared to conventional vehicles and conventional Segways.
- As the vehicle is developed in category of stand-up transportation it is very light in weight as compared to other vehicles
- As the vehicle is an electric vehicle its prime mover that is an electric motor is 90% to 95% efficient so we get 95% of the power of the batteries in the road wheels**.**

VI. Chassis Stress Calculations

Stress: It is the intensity of internal resistance offered by a body/material against deformation.
Stress= Resisting force per unit area (or) load/area

- The weight acting on the segway = weight of the segway + weight of the user.
- Weight of the segway =30kg
- Max Weight of the user = 80kg
- Total weight acting on the segway = 30+80 = 110kg
- Load acting on the segway= 110X9.81 = 1079.1 N
- Area of the segway chassis = 500X500mm = 250000mm2
- Stress acting on the frame or chassis of the segway = 1079.1/250000

$$=4.3164X10^{-3}MN$$

The stress acting on the frame of the segway is very less than the allowable stress of the mild steel. So, the design is safe.

Yield stress: The yield stress or yield strength of the material, beyond which the material is said to start yielding.

- The maximum weight acting on the chassis of the segway = 200kg
- The area of the frame =500X500=250000 mm2
- Yield stress= yielding load/area
- Load acting= massX9.81= 200X9.81 = 1962 N= 1962/250000 = $7.848X10^{-3}$MN
- The yield stress developed due to the max load is far far less than the yield stress of the mild steel. Hence the design is safe.

Factor of safety = The ratio of ultimate load to allowable load is known as factor of safety

- Factor of safety= Ultimate load/Allowable load
- The ultimate load acting on the segway chassis = 200X9.81 = 1962N

- The allowable load acting on the segway chassis = 110X9.81 = 1079.1 N
- Factor of safety = 1962/1079.1= 1.8182
- Design factor of safety = 2
- The factor of safety for our segway is less than the designed factor of safety. Hence the segway design is safe.

Ball bearings strength:

The load carried by a non-rotating bearing is called a static load. The basic static load rating is defined as the static radial load (in case of radial ball or roller bearings) which corresponds to a total permanent deformation of the ball (or roller) and race, at the most heavily stressed contact, equal to 0.0001 times the ball (or roller) diameter.

For radial ball bearings, the basic static radial load rating (C0) is given by

$C_0 = f_0.i.Z.D2 \cos \alpha$

Where

I is the number of rows of balls in the bearing = 1

Z is the number of ball per row = 10

D is the diameter of balls in mm = 3

α = Nominal angle of contact i.e. the nominal angle between the line of action of the ball load and a plane perpendicular to the axis of bearing = 00

f_0 (A factor depending upon the type of bearing) = 12.3

$C_0 = 12.3 \text{ X } 1 \text{ X } 10 \text{ X } 32\text{X} \cos (0) = 1107$ N

The load which the ball bearings can withstand is less than the load which is acting on the bearings. Hence the bearings used are perfectly suited for our segway.

VII. Conclusion

This design and fabrication project on fail-safe segway personal transporter is aimed at providing a zero pollution environment within the campus and cut short on the costs of the actual segway this also provides solution for making the segway fail proof from falling. The conclusion is thus found out to be, the vehicle which we have developed is light in weight & very much energy efficient and fail proof from falling and last but not the least its costs is very less than an conventional stand up transporter namely segway.

VIII. Fabricated Model Of Fail Safe Segway

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