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Mechanical Segway

Ankit S. Khanzode, Ashish G. Masne, Mohd. Shahzad Gulam Ali, Akshay P. Tale, Kamalkishor G Maniyar

***Abstract*— 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. The system is able to operate in transporter mode and robotic mode. The first goal is to maintain stabilization in pitch dynamic. This project focuses on to manufactured Segway without using any type programming & Sensors a state feedback to stabilize system on transporter mode. The system consist of forward and backward movement when the driver operating DPDT switch in transporter mode in order to stabilize body. Small wheel is used so that there is no need of gyroscope for balancing purpose. The aim of this project work is to build up at a very low cost, highly efficient rate and easy to handle and operating also. The tests are performed on mechanical Segway to confirm that Mechanical Segway operating very well and high efficient rate.**

***Index Terms*— Mechanical Segway sensors, solar plate, two wheels and one small supporting wheel (self-balancing)**

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I. INTRODUCTION

In this project, "MECHANICAL SEGWAY" robot has been built as a part of the course applied control and mechanical and electronics fusion. The goal of this project to everyone know about the Segway how is too manufactured or fabrication and how is the working system of the Segway and another one is the how is to ride and balance of the Segway robot. The project aimed at making a two wheeled and one small wheel balancing electric vehicle. A potentiometer and electric motors in the base of the device keep the vehicle right and left. [1] By using switch and circuit board and electric supply go forward and go backward direction easily with the help of perfect balancing. The vehicle has electric motors powered by dry batteries. It balances with the help of small wheel there is no used of Microcontroller, gyroscope and any type of sensors. The rider accelerates or decelerates by using push up switch go forward and backwards in the direction he or she wishes to travel. Steering is providing by simply self-balance and operated two motors with the help of switches. Steering handle is providing speed indicator and also battery power indicator.

1.1 Necessity:

In Mechanical Segway, the aim of this project is to produce at low cost and highly efficient rate. Also, aim of this project is to prepare a Segway purely on mechanical base. In this Segway, there is no use of complex equipment and programming parts so, that it is easy to build up and handle also.

1.2 Objectives:

The objectives of this project are:

- To prepare a Segway at low cost and high efficient.
- To prepare a Segway without using complex and electronics parts such as microcontroller, gyroscope.
- For better performance of Segway we need batteries which are charge by both the ways i.e. solar plate and electric socket.

II. CRITICAL LITERATURE SURVEY:

Two-wheeled, self-balancing systems are studied in many different concepts. They can be considered as robotic platform or as electric vehicle/transporter. Researchers focus on various issues besides the main problem stability. Segway Human Transporter (HT), which is invented by **Dean Kamen,** is known as the first two-wheeled, self-balancing system in the literature. Flexibility, safety and performance are important due to being commercial product.

Also, Segway brings out two wheeled self-balancing robotic platform which is called Robotics Mobility Platform (RMP). Moreover, human scaled robots exist. [2] Some of them are driven by an operator while rests are driven autonomously. As a transporter system, it is driven semi-autonomously by the driver on it. The driver determines the speed and direction of movement of the vehicle by leaning forward and backward. Most of the transporters are combined of standing base and handlebar which make the driver feel comfortable.[3-4] Also, steering mechanism is generally mounted on the handlebar. However, the vehicle in [5] only consists of a standing base. Steering is provided by shifting center of gravity (COG) of driver. The study [6] discusses the system both as a transporter and as a robotic platform which carries goods.

Some studies which are inspired by Segway emphasize creating lightweight and low-cost systems. This is proven in [7, 6, 3, 4, 8, and 9]. Their low-costs make them affordable and lightweight make them portable in anywhere.

Mathematical model of the system is derived in order to design a controller. Many studies apply Lagrange equations while deriving mathematical model [10, 11, 12, 4, 13, 14, 15, and 16]. On the other hand, mathematical model is derived from Newton's law of motion in some studies such as. [17] System's states are determined as linear displacement and linear velocity in longitudinal direction, angle and angular rate related to pitch dynamics. [17] Also, yaw angle and yaw angular rate are considered in some studies.

Mathematical model is the representation of the real system. Therefore, system's parameters such as inertia are important in order to make model more accurate. Inertia of the system is determined by calculating as in [3] or testing as in. [18]

Ankit S. Khanzode, Ashish G. Masne, Mohd. Shahzad Gulam Ali, Akshay P. Tale, Student of final year Mechanical Engineering Department, MGI-COET, Shegaon, Maharashtra, India

Kamalkishor G Maniyar, Associate Professor, Mechanical Engineering Department, MGI-COET, Shegaon, Maharashtra, India

III. COMPONANTS USED IN SEGWAY & ITS SPECIFICATION:

It consists of following mail points:

A) 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. Handle is also made up of same aluminum material to which DPDT switch is fixed.

1) Atomic Weight (g/mol) - 26.98
2) Thermal Conductivity(0-100^{0}C) (cal/cms.^{0} C) - 0.57
3) Electrical Resistivity at 20^{0}C (Ω.cms) - 2.69
4) Density (g/cm^3) - 2.6898
5) Modulus of Elasticity (GPa) - 68.3

- ***Details of Segway chassis:***

1) Base Plate Thickness - 10mm
2) Aluminum Rod Diameter - Ø25mm
3) Rod Height – 1016mm
4) Normal Cycle Handle Bar used for balancing purpose.
5) Width* Length – (304.8 mm *508 mm)

Fig. 1: Mechanical Segway Chassis

B) 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) Noise- 60dBA
8) Weight- 1.75kg
9) Brake- DC 24V, 0.45A & 30kgf-cm

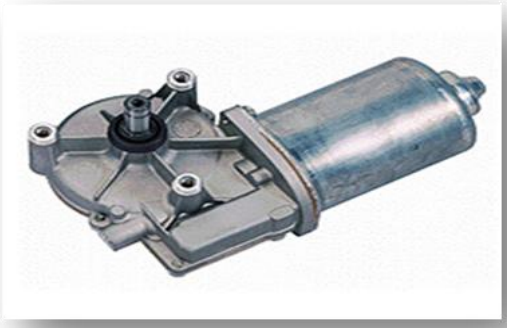

Fig.2: Dc Gear Motor

C) 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
4) Grid alloy lead- Calcium tin Alloy
5) Container cover- ABS resin
6) Electrolyte- diluted sulfuric acid
7) Size- 181*76*167mm
8) Battery type- AGM (Absorbent Glass Mat)

Fig.3: AGM type Battery

D) DPDT (Double Pole Double Throw) Switch:

Double Pole Double Throw (DPDT) switch. It is used to guide the direction of rotation of motor shaft. By operating the switch the direction of vehicle can be controlled. Connecting wires are used to connect switch with motor.

- ***DPDT Switch Specifications:***

1) Circuit- DPDT
2) Switch Function- On-off-on
3) Actuator type- concave (curved)
4) Panel cutout dimensions- 30*22.20mm
5) Operating temperature- -20^{0}C ~55^{0}C
6) Current rating- 15A (AC)
7) Voltage rating- 125V (AC)

Fig.4: DPDT Switch

E) 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

Fig. 5: Segway wheels

F) Motion control potentiometer:

Rotatory type potentiometer is used in Mechanical Segway. Purpose of potentiometer is to turn the Segway right and left by using rotary potentiometer.

- ***Rotary potentiometer specifications:***

1) Size- 22.225 to 76.20mm
2) Range of motion- 320^0 to 358^0
3) Drive interface- Round solid shaft
4) Standard operating temperature- -55^0 to 125^0C.
5) Extreme environment- Extended temperature.

Fig.6: Rotary Potentiometer

G) Digital Speedometer:

Digital speedometer is used on Mechanical Segway. Purpose of speedometer is to check the speed in RPM, also check the time in hours and indicated battery power.

- ***Speedometer Specification:***

1) Item width*length*height- 4.1cm *7.9cm*2.16cm.
2) Weight-280g.

Fig.7: Digital Speedometer

H) 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.

Fig.8: Supporting Small wheel

I] Solar plate:

Mechanical Segway one advance function is used for the battery charging i.e. solar plate. The purpose solar plate to charge the battery with help of electric socket and solar plate.\

- ***Solar plate Specifications:***

1) Maximum Power- 2Watt
2) Optimum power voltage- 16.8V
3) Optimum operating current- 024Amp
4) Dimensions- 220-150-20mm
5) Weight- 0.5Kg

Fig. 9: Solar plate

IV. ASSEMBLY:

- Rotary potentiometer is fitted in bottom portion of handle bar.
- One small wheel is also fitted on back portion of Segway.
- A DPDT switch is fixing to handle bar.
- Segway wheels are attached on the motor shaft.
- Handled bar is fitting in the front side of chassis.
- Speedometer & battery indicator is attached on the handle bar.
- Two motors are placed in the opposite side of chassis.
- Battery & Circuit board is placed middle side of chassis.
- Solar plate fitted in front of Segway handle bar

Fig.10: Mechanical Segway

V. RESULT AND DISCUSSION:

Mechanical Segway presents the results of the project. First comes a short discussion on the implementation of the balancing without using any type of programming and sensors.

This is followed by some initial driving results and why the vehicle did not behave in satisfactory manner and what was done to improve performance without using programming and sensors.

- ***Initial driving results:***

When testing the vehicle for the first time the controller gains were significantly lower as a precaution. This test was mainly performed to see that the system functioned as intended, spinning the wheels in the right and left direction etc. after this was confirmed the first riding test was conducted, and already with this controller the vehicle was drivable. The control strategy with the remaining error serving as a source for speed turned out to be a success and speed control by using DPDT switch forward and backward worked well.

VI. CONCLUSION:

Basically this investigation is successful achieved the objective with the acceptable outcome. The main goal of this project was a build a functional two wheels and one supporting wheels transporter and this goal has been fulfilled. The overall functionality and performance of the vehicle has been evaluated thoroughly by a number of test drives. The vehicle has been tested by a number of different weights. This project is implementing with an idea to find an effective solution to transportation problem.

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Mr. Ankit S. Khanzode, Studying in Mechanical Engineering, MGI-COET, Shegaon, Dist- Buldana, affiliated to SGBAU, Amravati.

Mr. Ashish G. Masne, Studying in Mechanical Engineering, MGI-COET, Shegaon, Dist- Buldana, affiliated to SGBAU, Amravati.

Mr. Mohd. Shahzad Gulam Ali, Studying in Mechanical Engineering, MGI-COET, Shegaon, Dist- Buldana, affiliated to SGBAU, Amravati.

Mr. Akshay P. Tale, Studying in Mechanical Engineering, MGI-COET, Shegaon, Dist- Buldana, affiliated to SGBAU, Amravati.

Prof. Kamalkishor G. Maniyar, working as Associate Professor and Head, Mechanical Engineering Department, MGI-COET, Shegaon, Dist-Buldana, Affiliated to SGBAU, Amravati. Graduation in Mechanical Engineering from SGBAU, Amravati and post- Graduation from Government College of Engineering, Aurangabad. Total experience is nine years and specialization in Manufacturing and Advance Manufacturing Engineering.