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# Self-Balancing Two-Wheeler

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***Abstract :*** *Self-Balancing Two-wheeler (Segway) was once a mysterious invention created by Dean Lawrence Kamen. The Self-Balancing Two-wheeler (Segway) Human Transporter is a personal transport device that uses a built-in computer to remain upright. The aim of this project is to mimic the design of the Self-Balancing Two-wheeler (Segway) and build a low-cost Segway. The first stage of this project is to design the mechanical structure of the transport device. According to different power and functional requirements, different mechanical and electronic components have been chosen for the implementation. The rider shifting weight and a manual turning mechanism on the handlebar are used to control the speed and direction of the Self-Balancing Two-wheeler (Segway). Gyroscope and variable resistor are used to monitor user's physical motion. The Segway is an intelligent vehicle which uses gyroscopic sensors to detect the motion of rider, so that he can accelerate, brake or steer the vehicle. The conventional Segway available in the market are very costly as they are not available locally. Hence the need to design and fabricate a cost-efficient Segway which could be affordable and the same time be reliable to withstand a rider up to 70-80kgs. In this project an attempt has been made to design and fabricate a Segway with minimum resources.*

***Keywords –*** *Accelerometer sensor, Arduino, Gyroscopic sensor, MPU 6050, Motor Driver ,Segway.*

## I. INTRODUCTION

The self-balancing two-wheeler is battery- powered electric vehicle invented by Dean Kamen. It is a vehicle that maintains its own balance and that of its passenger. It is equipped with a stationary T-shaped control shaft fitted into a platform mounted on two parallel wheels. Self-balanced two-wheeler are driven standing up, its handle's according to human body dynamics: lean forward to move forward, stand straight up to stop, and lean backward to reverse. The device has no brakes or accelerator, but has a handgrip for making turns. It is the only vehicle able to turn in place, just like a person, because its wheels have the ability to turn in opposite directions. The first problem with the self-balanced two-wheeler is the price. This technology is not affordable to low-income individuals. The self-balanced two-wheeler is not only a great innovation, but it is also environmentally 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 self-balanced two-wheeler 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.

## II. LITERATURE REVIEW

**2.1 Researches and Development of an Efficient Electric Personal Mover for City Commuters-World Electric Vehicle Journal Vol. 4 - ISSN 2032-6653 - © 2010 WEVA:**

In this paper they develop a two wheel-driven self-balancing vehicle named Tiny, based on inverted pendulum control technique, which can carry one person and travels at a maximum speed of 20km/h. They use two BLDC motors as their prime mover. A gravity sensor and a gyro are mounted to obtain values of tilt and tilt rate, the signals from the two sensors are combined with Kalman Filter to indicate the tilt angle of the vehicle, also there is a PD to control the steering unit. The implementation of the Kalman filter, hardware, software, was discussed and MATLAB simulations were conducted to verify, and the mathematical model of the vehicle was also presented.

**2.2 Designing the Self-Balancing Platform-International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 9, September 2015 131:**

Preliminary discussion on a two wheeled transport system, which also included history of Segway, inverted pendulum was conducted the basic structure of the program algorithm was discussed and hardware requirements such as accelerometer and gyroscope sensors which measure the angle and angular rate of the body. Arduino Mega 2560 microcontroller were mentioned. Here they use Kalman filter for sensor fusion during of gyroscope and inclinometer, A personal transporter with the more efficient use of energy and for commuting over shortest distance was designed and realized.

**2.3 Risodkar 2015:**

In his papers he mentioned a solution regarding the increase in public transportation. One of his vision involves the use of advance technology based on the public transit as the basis of all sustainable solution. In this search for different methods, MPTD's could help promote a model transfer away from the automobile for short distance trips. Electric scooter and Segway's are two users friendly in modes of transportation that facilitate effortless travel and could provide suitable transportation in metro cities. His aim was to make self-balancing two-wheeler was based on the principle of inverts pendulum that will keep SELF BALANCING TWO-WHEELER Viva Institute of Technology, Department of Electrical Engineering. 8 angles of zero degree with vertical all the times. His Segway's also include gyroscopic sensor to detect the motion of rider. His Segway's was eco-friendly mode of transport which caused zero pollutions.

**2.4 Vignesh 2016:**

He states that the self-balancing human transportation system is a small footprint of electrical vehicle which was designed by Dean Kamen to replace the car as a more environmentally friendly transportation method in metropolitan cities. The dynamic of his vehicle is similar to the classical control problem of an invert's pendulum, which means that it was unstable and prone to tip over. He solved this problem by using sensors which sense the pitch angle and its time derivation, controlling the motor to keep the vehicle in balances. He developed a working model of self-balancing transportation device similar to Segway which is portable and economical and uses open sources microcontroller and sensors. His main aim was to achieve space utilization and minimize the fuel consumption especially for commuting over shortest distances.

**2.5 Harini 2019:**

In this project they made two wheeled and two small supporting wheel self-balancing as well as manually balancing Mechanical Segway Vehicle which was also known as personal transportation Segway's. It was able to operate in transporter and robotic mode. His first goal was to maintain stabilization in pitch dynamic. Their project focuses on to manufacture Segway's without using any type of programming and sensors. The forward and backward movement controlled by operating DPDT switch in transporter mode. Small wheel was used to eliminate the gyroscope. Which was used for balancing purpose. Their main aim of the project was to build it at very low cost, high efficiency and easy to handle and operate. The overall functionally and performance of the vehicle had been evaluated by number of test drivers and different weights.

## III. COMPONENTS

### List of components used:

- Battery
- Motor drivers
- Arduino
- MPU 6050
- DC geared motor

**Battery**: The lead–acid battery is the oldest type of rechargeable battery. It is able to supply high surge currents and the cells have a relatively large power-to-weight ratio. The price of these kind of battery is relatively low and it is popular among motor vehicles for the high current requirement. The batteries which we used for Self-

Balancing Two-Wheeler are two 12v and 9amph lead-acid batteries and these batteries are rechargeable. Each battery can have a voltage level of 12V, by connecting two battery in serious can achieve the target of 24V.

**Motor Driver**: The Sabertooth Dual 12A Motor Driver is one of the most versatile, efficient and easy to use dual motor drivers on the market. It is suitable for medium powered robots – up to 30lbs in combat or 100lbs for general purpose robotics.

**Arduino:** The Arduino Uno is a microcontroller board based on the AT mega 328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

**MPU-6050:** MPU-6050 combines an on-board Digital Motion Processor with a 3-axis accelerometer and a 3-axis gyroscope on the same silicon die. It can be used to process complex 9-axis Motion Fusion algorithms.

**Motor:** The motors used in our Segway are dc motors with a voltage of 24Volt, 3300rpm and with a power of 250watt.

## IV. METHODOLOGY

**Working:**

To start a Self-balancing two-wheeler, Switches are connected on the battery to supply power to the machine. It consists of two motor places in opposite direction powering each of their wheel individual. They function as one mechanical but electrically they work individually. When the switch is ON the Self-balancing two-wheeler is powered up and all the electronic components then come into function as they are also powered by the battery. The motor drivers act as an interface between the motors and the control circuits helps the machine in moving forward and backwards. The gyroscope on the other helps in turning sideways of the machine. In the end to manage all this functions an Arduino is used to give commands to this other electronic component. So, when switch is ON the ride mounts on the Self-balancing two-wheeler and then he gives command to Self-balancing two-wheeler to move it around. To move it forward and backwards rider as to lean forward and backwards this will be sensed by Arduino and it commands the motor driver accordingly. To turn it around sideways rider just as to bend the handle bar in the direction he wishes to turn. Again, the Arduino will react to this by giving signal to the gyroscope which will turn the motor sideways. In other words, we can say that the Arduino is the brain of the machine the chassis and the handle bar is the body the parts are the organs and the electronic components are the nerves of the body of the machine. To stop the Self-balancing two-wheeler rider just as to come in still position not to bend forward or backwards and stand in straight pose and step down the Self-balancing two-wheeler when it's still and then turns of the switch.

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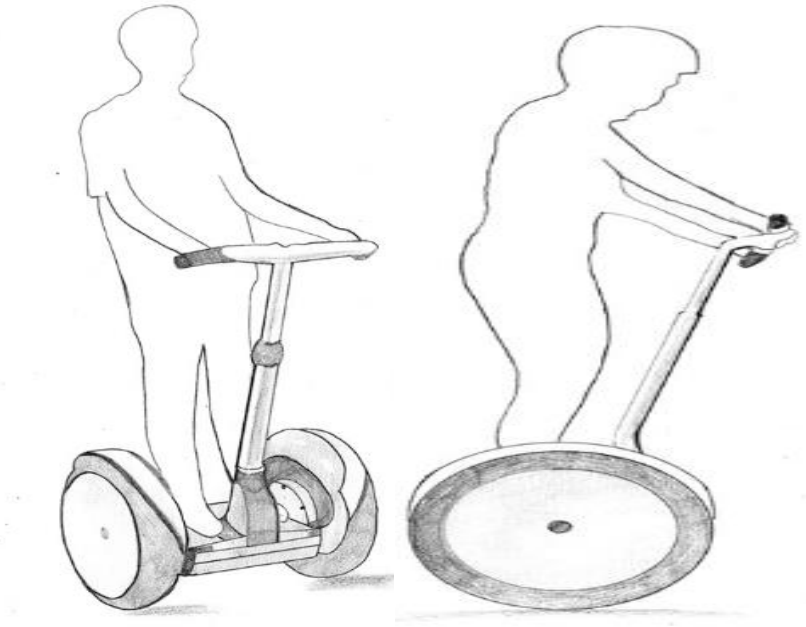

Figure 1: Self-Balancing Two-Wheeler

**Chassis design:**

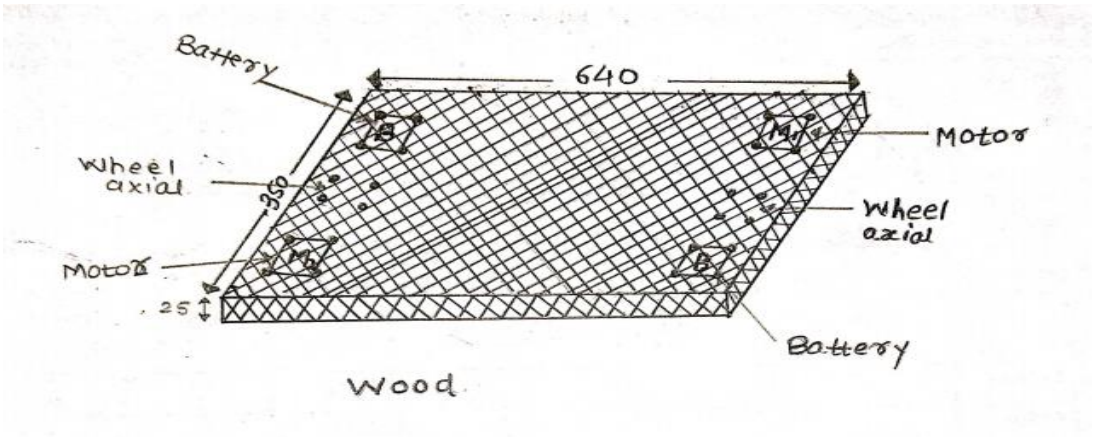


Figure 2: Wood

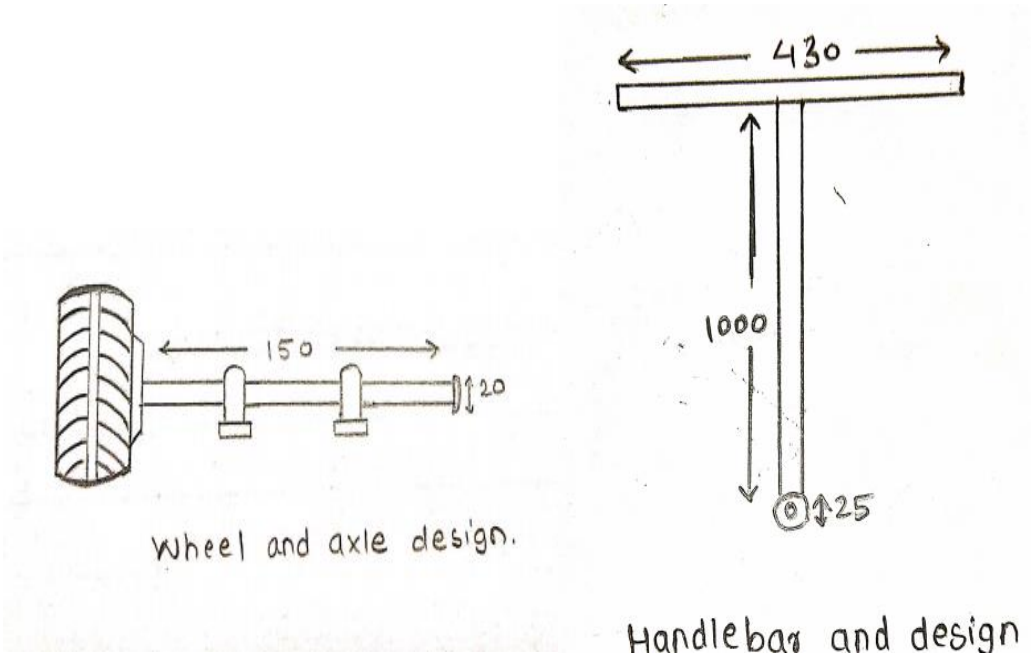


Figure 3: Wheel And Handlebar

## V. CONCLUSION

In this paper, the design and fabrication of a self-balancing two-wheeler personal transporter namely 'Segway' is discussed. This paper presents a Self-balancing two-wheeler whose behaviour is based on the stabilization of an inverted pendulum. This vehicle has been manufactured using low-cost commercial components. An experimentation system has been obtained and allows to test various controllers. This was implemented with an idea to find an effective solution to transportation problem. The main objective was to achieve cost reduction. The design of our project is such made that it requires less area for working and for parking. As it is an electric vehicle it is clean green and eco-friendly. It does not require any kind of fuel. It is made with safety consideration of the rider that even kids can drive them easily.

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