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TWO WHEELER SELF BALANCING ROBOT

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ABSTRACT

Two Wheeler Self Balancing Robot one of low-speed transportation devices that, travel on sidewalks, roadways, and other shared-use paths. The objective of this research was to examine the primary operating characteristics of the Two Wheeler Self Balancing Robot(Segway). In this thesis, we designed and constructed mechanically based system for a two wheel balancing robot. In this paper we present Two Wheeler Self Balancing Robot based on gyro sensor, accelerometer along with a microcontroller and use of mechanical and electrical hardware's. The dynamics of the vehicle is similar to the classical control problem of an inverted pendulum, which means that it is unstable and prone to tip over. This is prevented by electronics sensing the pitch angle and its time derivative, controlling the motors to keep the vehicle balancing. This kind of vehicle eco-friendly and energy efficient transportation industry. This thesis describes the development of a similar vehicle from scratch, incorporating every phase from literature study to planning, design, vehicle construction and verification. The main objective was to build a vehicle capable of transporting a person weighing up to 70-85 kg and capable of travelling to some km distance with varying speed. The rider controls are supposed to be natural movements; leaning forwards or backwards in combination with tilting the handlebar sideways should be the only rider input required to ride the vehicle. This thesis also takes into consideration the material used with minimum possible cost. The design of Two Wheeler Self Balancing Robot is such that it covers less space and comfort to the user.

Keywords: Self Balancing Robot, Gyro Sensor, Arduino Nano, Motor driver

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I. INTRODUCTION

Two Wheeler Self Balancing Robot is a two-wheeled, self-balancing, battery-powered electric vehicle (Segway) invented by **Dean Kamen.** Computers and motors in the base of the device keep the Two Wheeler Self Balancing Robot upright when powered on with balancing enabled. A user commands the Two Wheeler Self Balancing Robot to go forward by shifting their weight forward on the platform and backward by shifting their weight backward. Two Wheeler Self Balancing Robot detects, as it balances, the change in its centre of mass, and first establishes and then maintains a corresponding speed, forward or backward. Gyroscopic sensors and fluid-based levelling sensors detect the weight shift. To turn, the user presses the handlebar to the left or the right.

II. REVIEW OF LITERATURE

The Physics behind Two Wheeler Self Balancing Robot: A.

[1]The Two Wheeler Self Balancing Robot is a uniquely sophisticated machine that uses on-board computers working with multiple sensors and redundant physical systems to sense the motions of the rider, and to react to those motions. The "Stand up Scooter" requires the rider to learn how the machine will respond to the throttle and brake, while physically holding on to

the machine to counter the unbalanced forces of acceleration and deceleration. Diagram A (Fig.:1), on the left shows person standing, with gravity and the Two Wheeler Self Balancing Robot reaction force inbalance. In diagram B Person has leaned forward to start moving. The purple arrow is gravity/weight. The magenta arrow is the reaction force of person against the Two Wheeler Self Balancing Robot. The dashed blue line is the vector sum of the two. If Two Wheeler Self Balancing Robot doesn't respond person will fall forward as the Two Wheeler Self Balancing Robot is pushed backward. Diagram C shows the response of the Two Wheeler Self Balancing Robot as it senses the tilt of the Two Wheeler Self Balancing Robot platform as person leans forward. The computers order the motors to power the wheels and accelerate the Two Wheeler Self Balancing Robot. The force of acceleration is the red arrow, and the reaction force of the Two Wheeler Self Balancing Robot to person is the orange arrow. The dashed yellow line is the vector sum of the two. Diagram D shows that the sum of the forces in diagrams B and C are in balance. The vector sums run through each other and the rider, so there are no unbalanced forces or torque. The on-board computers adjust the power to the wheels to keep the forces balanced through the rider. This is what makes the Two Wheeler Self Balancing Robot unique. [1]Fig 2 shows how the Two Wheeler Self Balancing Robot keeps the rider in balance during all phases of a ride: stationary, accelerating, cruising at 6 mph, and decelerating. This continuous balancing of forces is what makes riding the Two Wheeler Self Balancing Robot possible. There are no unbalanced forces to topple the rider off the Two Wheeler Self Balancing Robot, which is why many people with diseases or injuries which result in muscular weakness, such as Muscular Dystrophy or Multiple Sclerosis, can safely ride Two Wheeler Self Balancing Robot. They do not have to compensate for unbalanced forces with their own strength - the Two Wheeler Self Balancing Robot does it for them. [2]The Two Wheeler Self Balancing Robot personal transporter, shown in Figure 2, is a device that transports one person at relatively low speeds. The low-speed (limited to approximately 20 kmph) operation combined with its electric propulsion system makes the Segway a candidate for providing short-distance transportation on city streets, sidewalks, and inside buildings. When a Two Wheeler Self Balancing Robot is in use, the device is driven by two wheels that are placed side-by-side, rather than the standard in-line configuration of a bicycle or a motorcycle. When the operator leans forward, the wheels turn in unison in the same direction to provide forward motion..[3]A Two Wheeler Self Balancing Robot is often used to transport a user across mid-range distances in urban environments. It has more degrees of freedom than car/bike and is faster than pedestrian. However a navigation system designed for it has not been researched. The existing navigation systems are adapted for car drivers or pedestrians. Using such systems on the Two Wheeler Self Balancing Robot can increase the driver's cognitive workload and generate safety risks. [4]Paper concerns the adaptation of a Two Wheeler Self Balancing Robot electric scooter for mobile robot navigation work and its instrumentation in preparation for these experiments, potentially aimed at security applications where its speed and dexterity are of distinct value.[4]Paper has shown how to convert a Two Wheeler Self Balancing Robot scooter into a mobile robot in a simple but effective manner and has detailed its instrumentation towards developing it as a security robot working within the context of a video surveillance system

III. DIAGRAMS

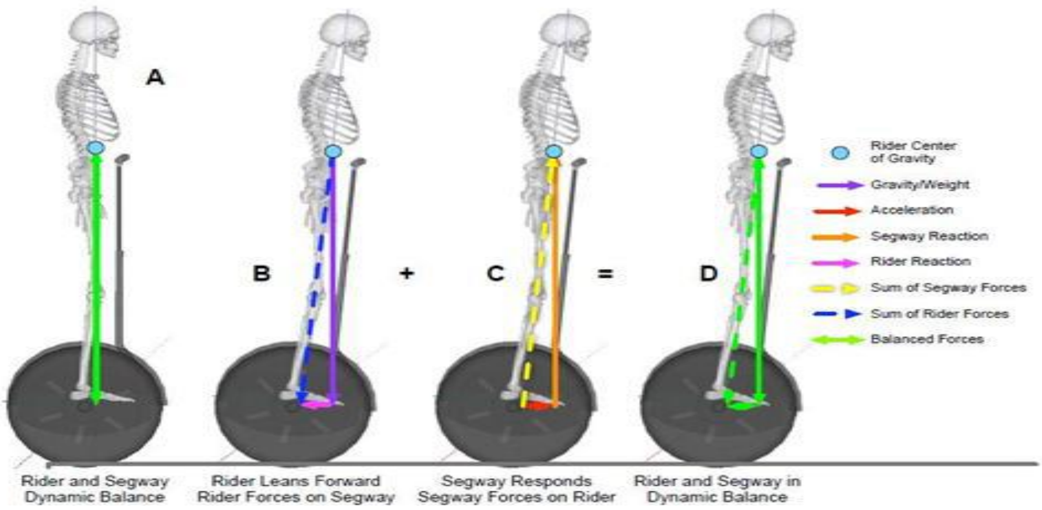

Fig. 1: Two Wheeler Self Balancing Robot rider

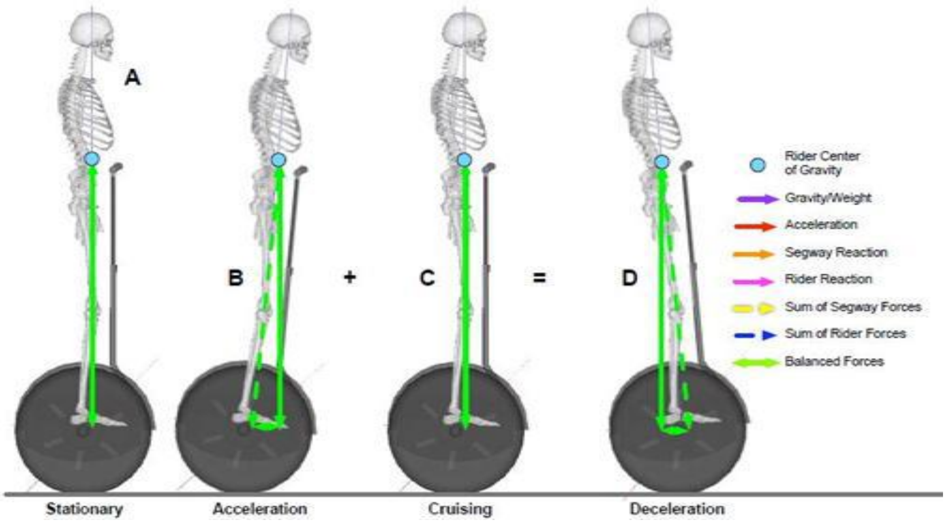

Fig. 2: Two Wheeler Self Balancing Robot Balances the Forces on the Rider in all Phases of Riding

IV. ELECTRONIC CONNECTIONS

Two Wheeler Self Balancing Robot is going to be controlled by a main microcontroller which is going to be Arduino Nano with an IMU MPU 6050 which has 6-axis Gyroscope and accelerometer inbuilt in it, a motor driver and a rotary potentiometer. Two 12V DC wipermotor with a capacity of 130W each are going to be controlled a motor driver. This motor driver will manage the current of about 12 to 15 Amps. Outputs from motor driver will go into 5V of Arduino Nano and other at pin number 13. Other output will be connected to a dead man switch which when pressed will break the circuit and both the motors will be switched off. Now for the IMU MPU6050 its GND (ground) will be connected to GND of Arduino Nano and VCC of IMU(Inertia measurement unit) to the 5V of Arduino Nano then SCL(serial clock) of IMU chip to analog input of A5 pin of Arduino Nano while SDA(serial data) pin of IMU chip to the A4 analog pin of Arduino Nano and lastly the INT (Interrupt) pin of IMU chip to the digital pin number 2 of Arduino Nano. One sealed lead acid batteries of 7ampere hour shall be connected in series and they will provide sufficient power to the machine. Rotary potentiometer will be connected to the main steering column and it will calculate the angular displacement of the steering and accordingly will send analogue signal to the controller. Thus the tilting of steering will cause motion in that particular direction.

V. WORKING

As we power on the Two Wheeler Self Balancing Robot the gyro and accelerometer sensors will evaluate some random angle and values which we have to ignore and focus on the stable position of the Two Wheeler Self Balancing Robot without any load on it. As we get a stable position we will lock the position by pressing a button and thus that will be our reference co-ordinate. As the rider tries to move forward/backward there will be pitching in Two Wheeler Self Balancing Robot which will be sensed by accelerometer and gyro sensors. As the tilting of steering is done at particular angle and weight is displaced to the direction at which the users wants to move, sensors will sense this & they will transmit signal to microcontroller and from controller to the motor. Thus the balancing as well as motion in that particular direction will be achieved. When the vehicle leans forward, the motors spin both the wheels forward to keep from tilting over. When the vehicle leans backward, the motors spin both wheels backward. When the rider operates the steering control to turn left or right, the motors spin one wheel faster than the other, or spin the wheels in opposite directions, so that the vehicle rotates.

Fig. 3: Arduino Nano

VI. CONCLUSION

Experiments were performed to study the dynamic behaviour of the Two Wheeler Self Balancing Robot. Under small disturbances, the Segway-Human system has a very predictable behaviour. In such cases, pitch angle and speed responses showed almost linearly under-damped responses studied and a map between the turning command and a resulting yaw rate was obtained from the experimental results. The experimental results were used to set the simulation parameters for three different cases. First, the parameters of a two-wheeled inverted pendulum were adjusted to simulate the impulse response of an unloaded Two Wheeler Self Balancing Robot. Then, a rigid-body model of a human was added to the model and its parameters adjusted until the simulation response matched the experimental impulse response of a loaded Two Wheeler Self Balancing Robot to a manually applied force on the rider. Finally, the model parameters were set to match the response of the Two Wheeler Self Balancing Robot and human rider to a known force. The dynamic model was used to simulate different environmental conditions. Simulations of sudden turning motions showed the importance of the human rider for the stability in the roll direction. When travelling on inclined surfaces, the pitch angle stability and speed are affected. It was found that the ability to climb up or go down a hill is highly affected by the pitch angle. Higher pitch angles helped the vehicle climb up, and negative pitch angles helped to avoid instability when going down a slope. Slick surfaces also affected how well the vehicle could balance. Low friction surfaces limit the capability of the motors to accelerate the vehicle. When a high pitch angle is present and the traction provided by the ground is low, the vehicle is more likely to lose balance. Simulations of inclined surfaces and slipping in both wheels also showed that contact between the rider and the vehicle can be lost under many combinations of pitch angular accelerations and linear accelerations.

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