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Development of Balancing System for two wheeled Segway vehicle based on Arduino

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ABSTRACT: Segway vehicles are containing a lot of new technologies which leads the transportation method to another level. It is ecofriendly as its main source of power is electricity and it is also beneficial in order to eliminate parking and traffic related problems asit is very compact. It is cost effective as well as easy to control and has good maneuverability as compared to other compact vehicles. However, current self-balancing control system of Two-wheeled vehicle is facing some problems like great malfunction rate; unbalanced operations; poor accurateness and sensitivity of the controlling system.

Hence for suitable vehical control less gyroscope error and developedperfection of the motors are required because the technological advancement in the transportation is one of the basic necessities. Hence, this research paper focuses on the advancement in self-controlling system of the two-wheeled vehicle.

KEYWORDS: Segway, self-balancing control system, Balancing system, Arduino UNO, Accelerometer, Microcontroller, Gyroscope, DC motors.

I. INTRODUCTION

Due to the problems like environmental degradation and other global problems like Traffic and Parking, Automobileindustries are working on the technologies which can reduce these problems. The daily fuel consumption in world is around 97,200,000 bpd(barrels per day) and in India it is 4,500,000 bpd.

Segway self-balancing vehicle eliminates such problems that's why it is one of the important branches of mobile robot technologies.

This vehicle contains gyroscope & accelerometer sensors connected with two servo motors. Each wheel contains one motor. When IMU detects the change in vertical position of the vehicle due to the human body movementMicrocontroller calculates the advances required to be made in vehicle to balance it, after that these signals are given to the motor controller which drives motors. When vehicle moves forward i.e. vehicle leans ahead the motors will run the vehicle in forward

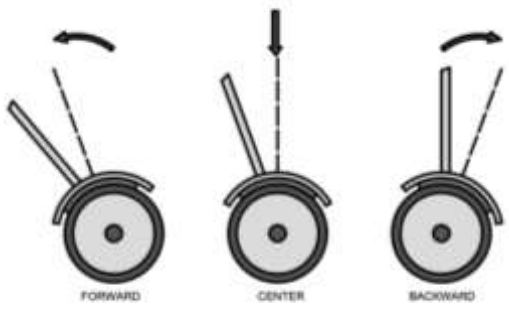

Figure 1

direction at a certain speed so thatfalling of thevehicle can be prevented. Exact same methodis also used for the backward direction. Lateral directional movement of the vehicle is also done by the microcontroller and motors.

There has been a lot of researchesare carried outon this technologies.LQR controller based on pole placement theory, Processidentifier control algorithm(PDI)and by using hybris fuzzy PD controller. But they are not precisely working.

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This article is about increment in effectiveness of controlling system by using Arduino microcontroller.

II. COMPONENETS

A. ArduinoBoard:

The Arduino UNO is an open source microcontroller board based on the Microchip ATmegha328P.The board is equipped with 3memory stick and14 Input/Output digital pins. TheMC operates on 5V Voltage and input voltage rate is 7-12 V. It generates specific type of output during the vehicle movements.

Figure 2

B. IMU:

An IMU measures vehicle's angular rate, force exerted and positionof body using combination of accelerometerandgyroscope. The IMU used isREES52 GY-521 Mpu6050 Module having3 Axis Accelerometer , 3 Axis Gyroscope.

Figure 3

C. Motor :

Electric motor gives power to the wheel helps to turn the vehicle. The motor used is MY1016 350W 24V 2750RPM DC, operates on 24/36V DCSupply Voltage, ≤19.20Afull load Current and ≤2.5Ano load Current. It has 2750 RPM.

Figure 4

D. Battery :

Battery is the power source of the whole system. The battery used is Lead-acid battery named 12V Sealed Lead Acid Battery,12VVoltage,8Ah/20HRCapacity and 2.40 A MaxInitial Current. Lead-acid battery converts chemical energy to electrical energy.

Figure 5

III. CALCULATION

Power requiredfor the motor:
Gross vehicle weight is 120 kg
Considering two speedscenarios; lower and high speed.
Time required to reach top speed is 7 sec.
For both speeds assume,
Low speed= 7 km/h = 1.944 m/s
High speed = 25 km/h = 6.94 m/s

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For force,
(Assuming that and)
F(low speed) = 120* N = 33.26 N
F(high speed) = 120* N = 118.97 N

Total Power,

P(low speed) = 33.26 *1.944 = 64.52 W
P(high speed) = 118.97 *6.94 = 825.65 W

The total power is distributed between two motors hence the power for each motor is 350W.

IV. WORKING

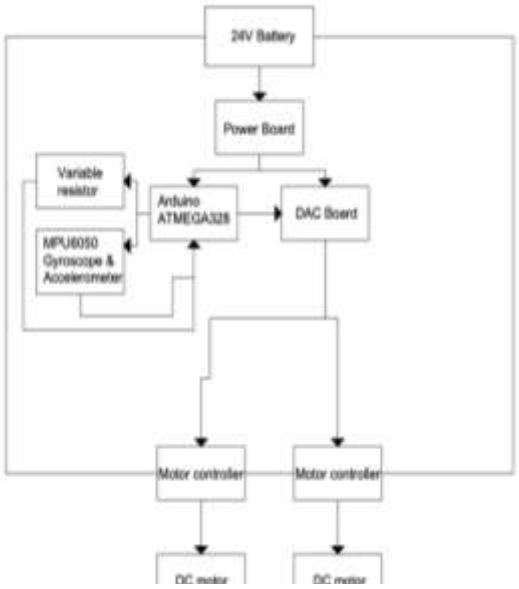

Figure 6

IMU which contains Gyroscope and accelerometer programmed to measure the staringposition of the vehicle in order to start the vehicle.Vehicle is in the balance state at its rest condition that's why it will not generate the signals causing the motor rotation. When vehicle is at straight position and after that inclines in forward direction, motorwill start rotating causing vehicle to move forward; same procedure for the reverse direction. However during therunning condition of the vehicle when it moves backwardfrom the forward direction, MC will not give signal to start the motor to rotate in reverse direction, butmotor will rotate in theforward direction at high speed rate for the fraction of second to maintain the balance and after that it allows the motor to rotate in backward direction.

The working of this system is shown by the prototype. For programming the microcontroller.

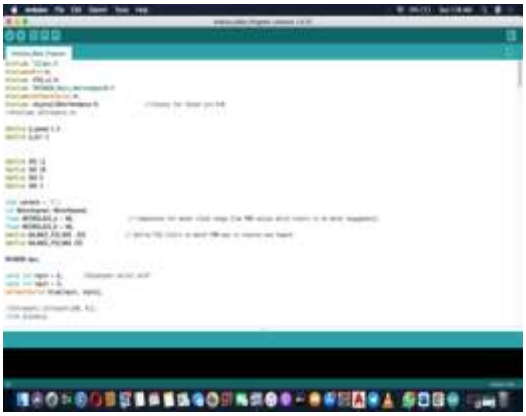
Figure 7

This part of programming shown in fig. the initial values input to defined and the motor speed range.

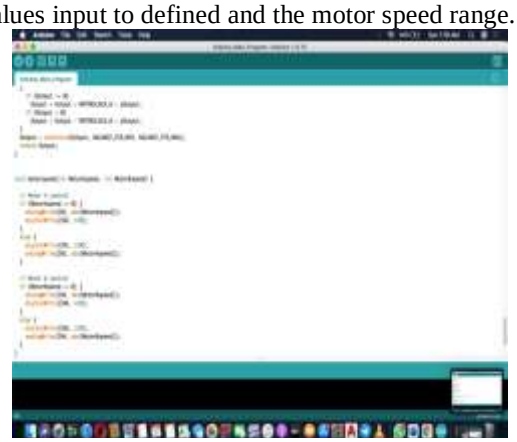
Figure 8

V. RESULT AND TESING

Motor controlling is gained successfullyby amalgamating the software system and the appropriate hardware system. The motor and MC in the base sustains the balancing of vehicle during the operation. Even when the external force is given, the vehiclecomes in an balanced state. The actual working is shown in https://youtube.com/shorts/qhVlbwd3JTM?feature=share) this video.
Thephoto of the prototype is as shown below.

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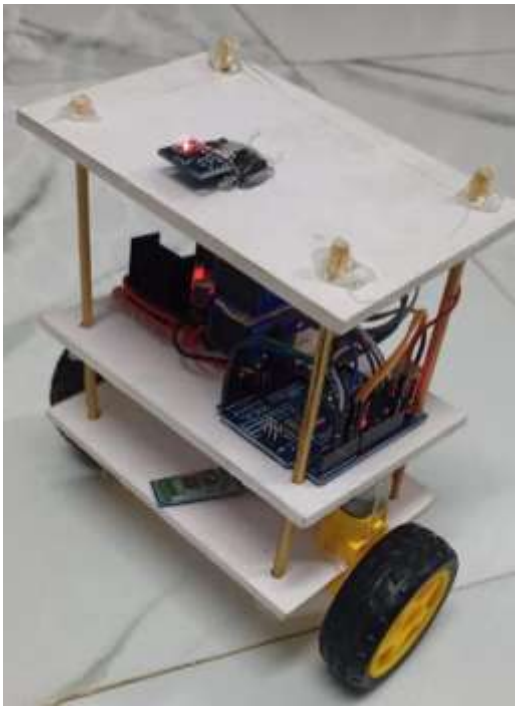

Figure 9

VI. CONCLUSION

The aim of this research was to develop the more reliablebalancing system Segway scooter.The functionality and performance of the vehicle has been calculated thoroughly by a number of tests. This project has been implemented with an idea to find an applicablesolution to transportation problem.

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