Segway- Transporter

Panchal Anklesha, Reddy Neha, Thakare Apurva, V. P. Mulik

Abstract: ***This project describes the design and fabrication of Segway transporter vehicle. The Segway is based on the principle of inverted pendulum that will keep an angle of Zero degrees with vertical at all times. The Segway is an intelligent vehicle which uses accelerometer to detect the motion of wheels, so that rider can accelerate, brake or steer the vehicle. This Segway is eco-friendly industrial transporter which carries load upto100kg including rider and load in trolly attached at front end. This kind of vehicle is interesting since it contains a lot of technology relevant to an environmentally friendly and energy efficient transportation industry. This thesis describes the development of a similar vehicle from scratch, incorporating every phase from literature survey to planning, design, vehicle construction and verification. The main objective of the project is the cost reduction of existing system with added user interface of real time clock, load in the trolley, direction and battery level indicator. The rider also gets warning with alarm on low battery .The rider controls are supposed to be natural movements leaning forward, backward and right-left; tilting of the handlebar and switch buttons also.***

Keywords: AVR Atmega 328, Accelerometer, RTC, LCD Display, DC Motor, Motor Driver.

I. INTRODUCTION

With lots of environmental problems such as air pollution, global warming and the need for sustainable energy pushes the demands for efficient, green energy powered vehicles. So here comes the concept of Segway - Transporter**.** The Segway is a two wheeled self balancing battery operated vehicle which can be used as a means of transportation for both human and small goods. The Segway is based on the principle of inverted pendulum. The accelerometer detects the acceleration of the vehicle in forward, reverse, left and right directions and it is displayed on LCD display. There are two modes of the operation of vehicle. First with the rotation of handlebar and another with the switch button combinations-both up for forward, both down for backward, right up and left up for each direction resp. The main objective was to build a vehicle capable of transporting the human and goods in industrial campus with eco friendly mode and cost reduction of existing system.

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II. THE DESIGN PRINCIPLES

- The Segway is a uniquely sophisticated machine that uses arduino board working with multiple sensors and redundant physical systems to sense the motion of the rider, and to react to those motions. The "Segway" 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. Person has to tilt the handlebar forward to start moving or press both switch buttons up.
- The accelerometer detects the direction and inputs the values to arduino which sends signals to motor driver circuitry and controls the wheels. The Segway keeps the rider in balance during all phases of a ride: stationary, accelerating and decelerating. This continuous balancing of forces is what makes riding the Segway possible.
- The Segway senses the tilting of handlebar and accelerates forward, balancing the forces, and you are underway [1].
- The Segway industrial transporter is a device that transports one person and goods at relatively low speeds [20kmph]. When a Segway 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 tilts the handlebar forward, the wheels turn in unison in the same direction to provide forward motion.
- In order to stop, the wheels must stop which is achieved by the idle position of accelerometer. For brake apply a deceleration torque to slow the system down without causing the operator to fall forward off the device.
- These operating principles are reversed to allow the system to move backward. In order to turn, the wheels rotate at unequal speeds causing the system to travel in an arc.
- If the system is not translating forward or backward, then the wheels can rotate in opposite directions to turn the machine in place. Under many operating conditions, the system is mechanically stable in the side-to-side (roll) direction. Assuming wheel-ground rolling friction, the system is also stable in the yaw direction [2].

III. THE BEHAVIORAL TASK

- To move forward or backward on the Segway, the rider just turns the handlebar slightly forward or backward. To turn left or right, the rider turns the handlebar right and left.

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- This balancing act is the most amazing thing about the Segway, and it is the key to its operation. To understand how this system works, it helps to consider Kamen's model for the device - the human body.
- If you stand up and lean forward, so that you are out of balance, you probably won't fall on your face. Your brain knows you are out of balance, because fluid in your inner ear shifts, so it triggers you to put your leg forward and stop the fall. If you keep leaning forward, your brain will keep putting your legs forward to keep you upright. Instead of falling, you walk forward, one step at a time.
- The Segway does the same thing, except it has wheels instead of legs, a motor instead of muscles, a microprocessors instead of a brain and an accelerometer instead of an inner-ear balancing system. Like your brain, the Segway knows when you are leaning forward. To maintain balance, it turns the wheels at just the right speed, so you move forward.

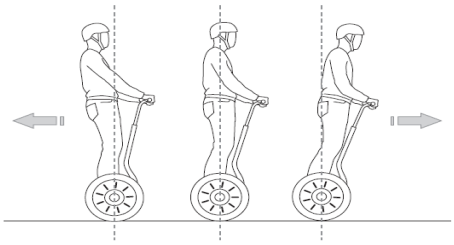

Fig.1 Behavioral task of the Segway-Transporter

IV. THE PRESENT SYSTEM

The present system consist of

1. Brushless Dc Motors

Brushless Dc Motors Two 250W brushless dc hub motors are used. They have been selected over normal Dc motors as they have a better power/weight ratio , greater efficiencyand hence are more compact ,robust and reliable . The absence of a commutator and carbon brushes (which are subjected to mechanical wear and tear due tofriction) enables this type of motor to have a longer life. The armature is the stationary part and has three coils , while the rotor is a permanent magnet. Eachmotor has three hall sensors used to detect the position of the rotor. The stator speed Ns and the rotor speed Nr are both the same at steady state as this is asynchronous motor . The rotor speed Nr is measured by taking feedback from the hall sensors while the stator speed Ns is the frequency at which you alternately switch the coils. By taking feedback Nr and Ns are kept the same. Hence the speed of the rotor is directly proportional to the frequency of switching and the output torque is inversely proportional to the frequency of switching.

2. Wheels

Two small wheels are used. The outer diameter of the motor almost matches the rim size and hence mounting the motor in these wheels is considerably easier. By using a mechanical structure of mild steel the motors are mounted above the wheels.

3. Mechanical structure

The entire structure is made of mild steel. After both the motors are individually connected to the wheels three rectangular sections are connected between them .They are welded at both the ends. A rectangular platform is fitted on these sections. A vertical rod is screwed on this platform with a rectangular rod welded at the top end. The rider stands on the platform and takes support from the vertical rod.

4. Accelerometer

ADXL335 is complete 3axis accelerometer with signal conditioned voltage outputs which measures acceleration magnitude and direction with a minimum full scale range of +/- 3g. It measures all non contact forces and hence its reading is also affected by pseudo forces due to acceleration. The analog output is connected to the ADC input of the microcontroller.

5. Microcontroller

AVR Atmel Atmega328 microcontroller is used. It is a 8-bit microcontroller and it can run at a maximum clock frequency of 16 MHz. It has various timers analog to digital converts and supports various protocols of data transfer. In this board there are three basic parts – the first part has the power supply circuit where from any input voltagebetween 7 to 36 V is converted to 5V and given to the microcontroller. For this a switching regulator is used to convert the input to around 5.5V and then a low dropout regulator is used to convert 5.5V to regulated 5V. This method is used as it is more efficient and reliable. Only using a linear regulator is not efficient as all the excess voltage is just dropped across the regulator and it gets heated up and may blow off when used for a long time. While a switching regulator switches the input and converts it to the desired voltage , it is about 85-90% efficient. An external crystal of 16 MHz is connected between the XTAL1 and XTAL2 pins and load capacitances of 22pf are connected from each pin to ground.

6. Motor Drivers

They need an analog signal for speed control and a digital signal for direction control. These both are generated from the microcontroller. Four relays are used, two for each motor driving purpose. The combinations of 4 relay's ON-OFF conditions decide the driving condition of motor. The speed is kept fixed 20kmph.

V. BLOCK DIAGRAM

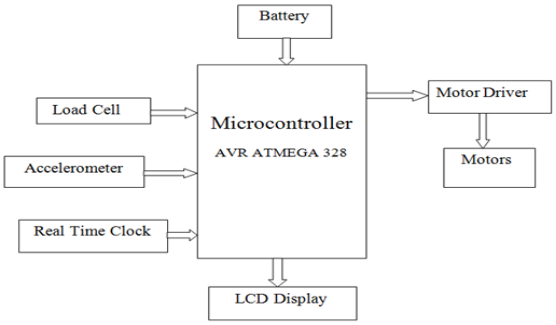

Fig.1Block Diagram of Segway-Transporter

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Fig. 2 Segway-Transporter

VI. CONCLUSION AND DISCUSSION

The system will provide an eco-friendly self balancing vehicle for the transportation of a single person and can eliminate the use of fuel.The conclusion is thus found out to be, the vehicle which we have developed is very much energy efficient and last but not the least its cost is very less than an conventional standup transporter Segway.

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