Self Balancing Solo Wheel Hovertrax 4/24/2018

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Abstract- *The main aim of the project is to balance a Solo Wheel Hovertrax using hub wheel motor. This is an advanced technology of the skateboard. Usually there is two or four wheel skateboard which is very easy to balance and for that general motors' can be used. The proposed system is enhanced to use in industrial applications for easy working. This project presents a self-balancing solo wheel hovertrax that runs on battery power. The equipment senses human body movements and accordingly accelerates or decelerates, depending on the orientation of the human body. The one wheel motorized skateboard would follow the motion, that of a straight tine path. However, depending on the direction given by the rider, the skateboard would stop its translatory motion and follow the direction of the rider. Since it runs on battery power and doesn't cause any pollution it is sustainable to environment*

Keywords- Hub wheel motor, Gyroscope, Self balancing, Arduino

I. INTRODUCTION

Solo Wheel Hovertrax are a new and promising alternative form of urban transportation. They provide all the advantages of a regular bicycle: fun exercise, free parking, zero emissions, and freedom from gridlock. Imagine skateboarding up a hill as comfortably as riding down; what the experience is all about. In most situations in the city, riding a hovertrax will be faster and cheaper than either car or public transit.

Fundamentally, the hovertrax is just a regular skateboard with an electric motor to provide additional assistance. You can skate normally and just use the motor to help out on hills and headwinds, or use the motor all the time just to make riding easier. Hovertrax is born from the idea of simplifying the methods of transportation inside university campus and facilitate easy working to the labors. Throughout the years, many students have used simple methods of transportation along far distance buildings inside campus.

II. LITERATURE REVIEW

M.HUBBARD [1] Human control of the skateboard is investigated by modeling the rider as a single, rigid body pinned to the board along the roll axis. Human input is taken to be a torque applied at the ankles. The equations of the non holonomic rider-board system are presented and a simple tracking task is established. Its dynamics are augmented by those of the skateboard and rider to describe the complete system in the tracking mode. Several control schemes are discussed. Under certain conditions, simple proportional feedback control of rider tilt angle can stabilize roll motion of the vehicle, but in the most general case full state feedback is required. In the complete state feedback case, a performance index for the tracking task is defined and the minimizing feedback gains determined. Time simulations of the tracking task using the optimal feedback gains are shown. Experimental results are presented which tend to validate the theory.

ALEXANDER S. KULESHOV [2] :In this paper the further investigation and development for the simplified mathematical model of a skateboard with a rider are obtained. This model was first proposed by Mont Hubbard (Hubbard 1979, Hubbard 1980). It is supposed that there is no rider's control of the skateboard motion. To derive equations of motion of the skateboard the Gibbs-Appell method is used. The problem of integrability of the obtained equations is studied and their stability analysis is fulfilled. The effect of varying vehicle parameters on dynamics and stability of its motion is examined.

III. TECHNICAL CONTENT

3.1 HUB WHEEL MOTOR

The wheel hub motor (also called wheel motor, wheel hub drive, hub motor or in-wheel motor) is an electric motor that is incorporated into the hub of a wheel and drives it directly. The basic idea is just the same. In an ordinary motor, you have a hollow, outer, ring-shaped permanent magnet that stays static (sometimes called the stator) and an inner metallic core that rotates inside it (called the rotor). The spinning rotor has an axle running through the middle that you use to drive a machine. But what if you hold the axle firmly so it can't rotate and switch on the motor? Then the rotor and the stator have no choice but to swap roles: the normally static rotor stays still while the stator spins around it. Try it with an electric toothbrush. Instead of holding the plastic case of your toothbrush (which, broadly speaking connects to the static part of an electric motor), try holding only the bristles and then turn on the power. It's quite tricky to do, because the brush moves so fast, but if you do it right you'll find the handle slowly rocks back and forth. This is essentially what happens in a hub motor.

Figure no 3.1: hub wheel motor

3.2 IMU SENSOR

The IMU sensor contains a Micro Electro Mechanical System (MEMS) accelerometer and a MEMS gyro in a single chip. It is very accurate. It contains 16-bits analog to digital conversion hardware for each channel, therefore, it captures the x, y, and z channel at the same time. The sensor used the I2C-bus to interface with the microcontroller.

The sensor sleep mode was disabled, and then the registers for the accelerometer and gyro were read. The sensor also contained a 1024 byte FIFO buffer. The sensor values are stored in the FIFO buffer and the buffer was read by the microcontroller.

The FIFO buffer was used together with the interrupt signal. If the IMU places data in the FIFO buffer, it signals the microcontroller with the interrupt signal to apprise the microcontroller about the data in the FIFO buffer waiting to be read.

The IMU had two sensors, an accelerometer and a gyroscope. The tri-axial accelerometer gave the components of acceleration (g) along its three axes. It was sensitive to noisy data. The gyroscope provided the angular velocity along its three axes. It was less sensitive than the accelerometer but its Output drifts from the reference value along with time. This was the reason sensor fusion becomes necessary as the values obtained from either of the sensor is not completely reliable.

3.2.1 GYROSCOPE

A gyroscope maintains orientation and angular velocity. It is a spinning wheel or disc in which the axis of rotation is free to assume any orientation by it self. When rotating, the orientation of this axis is unaffected by tilting or rotation of the mounting, according to the conservation of angular momentum.

A gyroscope is a wheel mounted in two or three gimbals, which are pivoted supports that allow the rotation of the wheel about a single axis. A set of three gimbals, one mounted on the other with orthogonal pivot axes, may be used to allow a wheel mounted on the innermost gimbal to have an orientation remaining independent of the orientation, in space, of its support. In the case of a gyroscope with two gimbals, the **outer gimbal**, which is the gyroscope frame, is mounted so as to pivot about an axis in its own plane determined by the support. This outer gimbal possesses one degree of rotational freedom and its axis possesses none. The **inner gimbal** is mounted in the gyroscope frame (outer gimbal) so as to pivot about an axis in its own plane that is always perpendicular to the pivotal axis of the gyroscope frame (outer gimbal). This inner gimbal has two degrees of rotational freedom.

The axle of the spinning wheel defines the spin axis. The rotor is constrained to spin about an axis, which is always perpendicular to the axis of the inner gimbal. So the rotor possesses three degrees of rotational freedom and its axis possesses two. The wheel responds to a force applied to the input axis by a reaction force to the output axis.

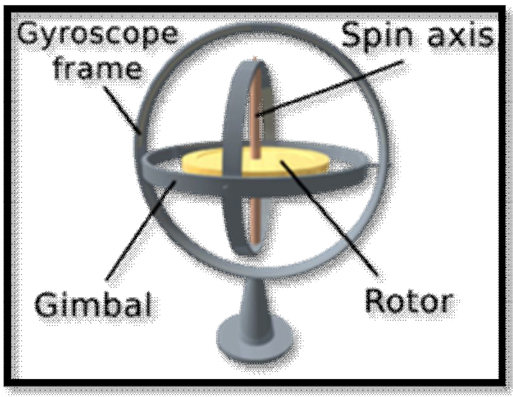

Figure 3.2.1: Gyroscope

3.2.2 SENSOR FUSION

The sensor has a 'Digital Motion Processor' (DMP), also called a "Digital Motion Processing Unit". This DMP can be programmed with firm ware and is able to do complex calculations with the sensor values. The DMP can do fast calculations directly on the chip. This reduced the load for the microcontroller (like the Arduino). The values obtained from accelerometer and gyroscope was processed by DMP. It gave the yaw, pitch and roll of the vehicle. Here only value of the pitch is necessary as it gives the tilt value in the axis under consideration.

3.3 ARDUINO

Arduino is open source computer hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project. Here we are using Arduino atmega328p.

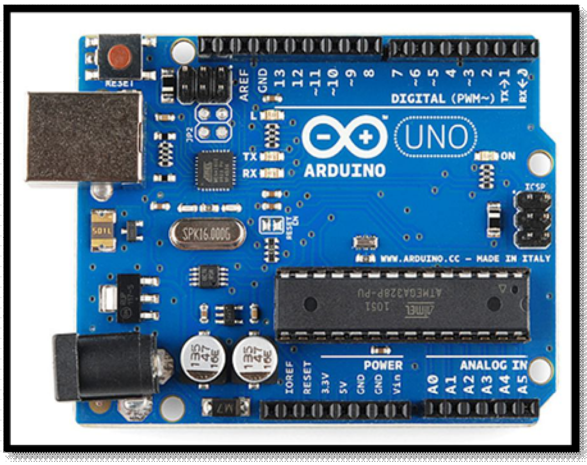

Figure 3.3: Arduino

3.4 BATTERY

Lithium-ion batteries are common in home electronics. They are one of the most popular types of rechargeable batteries for portable electronics, with a high energy density, tiny and low self-discharge. LIBs are also growing in popularity for military, electric vehicle and aerospace applications.

The three primary functional components of a lithium-ion battery are the positive and negative electrodes and electrolyte. Generally, the negative electrode of a conventional lithium-ion cell is made from carbon. The positive electrode is a metal oxide, and the electrolyte is a lithium salt in an organic solvent. The electrochemical roles of the electrodes reverse between anode and cathode, depending on the direction of current flow through the cell. The most commercially popular negative electrode is graphite. The positive electrode is generally one of three materials: a layered oxide(such as lithium cobalt oxide), a polyanion (such as lithium iron phosphate) or a spinel (such as lithium manganese oxide). Depending on materials choices, the voltage, energy density, life, and safety of a lithium-ion battery can change dramatically.

Figure 3.4: Battery

IV. CONCLUSION

The project "SELF BALANCING SOLO WHEEL HOVERTRAX" is successfully tested and implemented. It can be used in various applications like personal transportation and commuting,urban areas etc. It is found that Solo Wheel Hovertrax is slightly difficult to use as compared to two wheel counterparts but it is more fun to ride and it gives more mobility experience. Also the weight of Solo Wheel Hovertrax is found to be far less if same motors are used. Hence it is more compact & portable as compared to Two Wheel Hoverboard. If speed is taken into consideration the Solo Wheel Hovertrax beats Two Wheeled Hoverboard easily because Solo Wheel Hovertrax uses just one hub wheel motor so it has less weight comparatively Two Wheel Hoverboard uses two hub wheel motors so more weight that leads to reduced speed.

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