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Self Balancing Two Wheeler Hump Detecting Vehicle by Using Gyroscope

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ABSTRACT
The project is about the designing of a two wheeled balancing and hump detecting bike. The two wheeler bike would be able to balance itself and it can be stabilized against any impact in zero velocity as well. Stabilization of a two wheeled vehicle plays vita role in the complex transportation system. Gyroscopes can deliver a major contribution towards stabilization of a two wheeler vehicle. The dynamic stabilization of a two-wheeled vehicle requires that a torque acting on the vehicle naturally be neutralized by a torque produced within the vehicle by a gyroscope. The gyroscope here is used as an actuator. When torque is applied to an axis normal to the spin axis, causing the gyroscope to process, a moment is produced about a third axis orthogonal to both the torque and spin axes.
As the vehicle tilts from vertical,precession,indusing torque is applied to the gyroscope assembly and the opposing gyroscope reaction moment will tend to correct the vehicle. The gyroscope motion is related to the body and actively controlled in order to generate a stabilized moment. We design and fabricated a two wheeler with self balancing mechanism. The model works on principle of inveted pendulum. The self balancing vehicle starts with battery power.
Identification of distress such as potholes and Humps not helps the drivers to avoid accidents or damages for the vehicle but also help to maintain roads. Our project Mainly discuss about the economical solution to identify pothole and hump and give a timely alert for the drivers to Avoid accidents and damages for the vehicles.

I. INTRODUCTION

There are various types of parallel spin axis wheeled two-wheeler vehicles. They are typically used for commuting or for pleasure. Lighter vehicles with smaller engines are usually cheaper than their heavier counterparts and is the primary means of transport in a lot of Asian countries. Nowadays maximum road accidents are of the two wheelers. Needless to say, a lot of investment goes into manufacturing and development Of state-of the-art high technology motor bikes but none can guarantee road safety and it solely depends upon the rider and hence road accidents occur as the person riding the bike loses control over it and the bike falls. Also while learning to ride bicycles children are often afraid to ride as there is a fear of falling.To avoid such tragic scenarios, a mechanical gyroscope can be installed in the vehicles. It works on the principle of inverted pendulum and employs the use of electromechanical components which can be used as a Means of transportation for a single person. The two-wheeled, self-balancing vehicle is a non-linear multivariable and naturally an unstable system. Controlling such a system is a hard task and thus it is the topic of research. It will move forward if the user tilts in forward direction and backward if the user tilts in backward direction. This vehicle can be viewed as ecological, battery operated and very easy to be used as system.

GYROSCOPE

Working principle of a gyroscope is based on gravity. It is explained as the product of angular momentum which is experienced by the torque on a disc to produce a gyroscopic precession in the spinning wheel. This process is termed gyroscopic motion or gyroscopic force and is defined as a rotating object's tendency to maintain its orientation.We know that the rotating object possesses angular momentum, which needs to be conserved. This is done because when there is any change in the axis of rotation, there will be a change in the orientation, which changes the angular momentum. Therefore, it can be told the working principle of the gyroscope is based on the conservation of angular momentum.

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LAWS OF GYROSCOPE:

If the gyroscope is spinning, think about what happens to these two sections of the gyroscope: Newton's first law of motion states that a body in motion continues to move at a constant speed along a straight line unless acted upon by an unbalanced force.

PROPERTIES OF GYROSCOPE:

A gyroscope is a rotating body that exhibits two fundamental properties. These two fundamental properties include gyroscopic inertia and precession.

PARTS OF GYROSCOPE:

1. Spin axes
2. Gimbal
3. Rotor
4. Gyroscope frame

TYPES OF GYROSCOPES:

1. Mechanical Gyroscope
2. Optical Gyroscope
3. Gas bearing Gyroscope

MECHANICAL GYROSCOPE:

The working principle of the mechanical gyroscope is based on the conservation of angular momentum. This is also one of the most commonly known gyroscopes. The mechanical gyroscope is dependent on the ball bearing to spin. These gyroscopes are replaced with modern forms of gyroscopes as they are noisier. They find applications in the navigation of large aircraft and missile guidance.

OPTICAL GYROSCOPE:

These gyroscopes are dependent on the ball bearing or the rotating wheel. They are also not based on the conservation of angular momentum. Optical gyroscopes use two optic fibre coils spun in different orientations. Since there is no movement in the optical gyroscopes, these are considered to be durable and find applications in modern spacecraft and rockets.

GASBEARING GYROSCOPE:

In a gas-bearing gyroscope, the friction between the moving parts is reduced by suspending the rotor with the help of pressurized gas. NASA used a gas-bearing gyroscope in the development of the Hubble telescope. Compared to the other gyroscopes, gas-bearing is quieter and more accurate.

APPLICATIONS OF GYROSCOPE

1.Gyroscopes find applications in the compasses of boats, spacecraft, and aeroplanes. The aeroplane's orientation and pitch are determined against the steady spin of the gyroscope.
2.In spacecraft, the desired target's navigation is done with a gyroscope's help. The spinning centre of the gyroscope is used as the orientation point.
3.The stabilization of the large boats and satellites is done with the help of massive gyroscopes.
4.Gyroscopes are used in gyrotheodolites to maintain the direction in tunnel mining.
5.Gyroscopes and accelerometers are used in the design of smartphones providing excellent motion sensing .

SELF BALANCING MECHANISM

Definitions of self-balancing. Adjective. Of someone or something that balances himself or itself. Synonyms: balanced. Being in a state of proper equilibrium.When you try to stop or slow down the bike, or when the bike is riding slower than four kph, the fork angle changes and brings the front wheel forward. This mechanism triggers the self-balancing system. It constantly keeps making minor side adjustments to maintain the bike's balance.The automatic balance vehicle is also called body-sensing the bike. Based on "dynamic stability", the gyroscope and acceleration sensor inside the vehicle are used to detect the change of vehicle attitude, and the servo control system is used to adjust the motor for a balance system.

COMPONENTS :

12V DC MOTOR:

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.DC motors were the first form of motors widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric

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vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

BALL BEARINGS

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.The purpose of a ball bearing is to reduce rotationalfriction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races . Ball bearings use balls to separate two "races," or bearing rings, to reduce surface contact and friction across moving planes.Ball bearings are the most common bearing type and can be found in many every day objects, such skateboards, blenders, bicycles, DVD players and photocopiers. This type of bearing is typically used in applications which have a high speed and a low load.

TYRES

A tyre is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface over which the wheel travels. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint, called a contact patch, that is designed to match the weight of the vehicle with the bearing strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively.

GYROSCOPE

A gyroscope is a device used for measuring or maintaining orientation and angular velocity. It is a spinning wheel or disc in which the axis of rotation (spin axis) is free to assume any orientation by itself. When rotating, the orientation of this axis is unaffected by tilting or rotation of the mounting, according to the conservation of angular momentum. This is major part in the project.

CARBON STEEL

Carbon steel is a steel with carbon content from about 0.05 up to 2.1 percent by weight.No minimum content is specified or required for chromium, cobalt, molybdenum, nickel, niobium, titanium, tungsten, vanadium, zirconium, or any other element to be added to obtain a desired alloying effect. The term carbon steel may also be used in reference to steel which is not stainless steel; in this use carbon steel may include alloy steels. High carbon steel has many different uses such as milling machines, cutting tools (such as chisels) and high strength wires. These applications require a much finer microstructure, which improves the toughness.

HUMP DETECTOR

Speed-breakers(speed humps/speed bumps/sleeping policeman) are traffic calming Devices commonly installed to reduce speed related accidents. Speed-breakers are designed to be Driven over at a predetermined comfortable speed, while causing exceeding discomfort at higher Speeds. In an average vehicular speed significantly improves the safety of people in the Neighbouring areas. Even though there is evidence that speed-breakers reduce speed related Accidents, they have also been known to cause accidents and injuries. When an automobile Approaches a speed-breaker [2] at a speed greater than a threshold velocity, the risk of accident Or injury to the passengers becomes substantial. Motorcycles and scooters are especially Vulnerable because inconspicuous speed-breakers can throw them off balance. Crossing a speed Bump at higher than recommended speed may also damage vehicles. Speed-breakers are Inconspicuous under special conditions, like when there is snow, fog, or rain at night When they are hard to see.

CONSTRUCTION:

The gyroscope disc is manufactured using CNC lathe and drilling operations. The steel frame used is bolted On the bottom steel base. Round edge wheels are fitted to the steel base at the bottom, the holes in the frame are Drilled in order to fit the gimble of the gyroscope assembly, the DC motor supported on a U bracket is placed on The gimble. The only pre-requisite for this setup to work is that the mass distribution, the mass should be Dominant on the upper side (setup should be top heavy) of the gimble. The center of gravity is thus just above The gimble axis, stainless steel disc used

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as gyroscope are fitted to the shaft of the motor. The DC motor is Bolted to the U-bracket due to which it remains intact with it and the shaft of the DC motor is fixed to a steel Hub which has got holes drilled on its top flat surface to be used to finally fix the gyroscope disc by bolting it With the hub. The material used in making the gyroscope disc, hub, steel frame, and U-bracket is Mild Steel. To Finally assemble the entire model, various sizes of nuts and bolts were used. One important design consideration That we made in this model is that the gyroscope disc should be freely suspended in the U-bracket connected to The steel frame. So for that, we used ball bearings and studs to make the angular movements and adjustments Free and swift. The circlips are placed on the inner ends of the studs to avoid the studs to move out of the ballBearings, thus avoiding breakdown of the model during the running condition. The model has been made in such A way that the front wheel can move to take turns in order to change the direction of movement.

WORKING

The model is powered by a power supply unit of 12V output. Once the motor starts rotating, the Mild steel Disc fitted on the motor shaft starts to rotate and gradually gains speed. This rotation of the disc leads to the Production of the gyroscopic effect thus, when the wheels lose their balance due to the active gyroscopic couple, A counter acting reactive gyroscopic couple is produced in the opposite direction due to gyroscopic effect, thus Stabilizing the prototype model. This gyroscopic effect occurs on both left as well as right hand side. Thus, due To rotation of the gyroscope, a counter-acting reactive gyroscopic couple leads to thestabilization of the Prototype. The motor and gimble axle assembly is designed in such a way that it is top heavy. This means that The center of gravity lies above the gimble axle. So the motor and gyroscope assembly tries to attain the position Such that the center of gravity of the core will move downwards. But at the same time the motor and gimble Assembly is arranged within the frame having bearing reaction at ends. So, the only possible way for motor to Attain the stability is to either lean forward or backward. So, when the motor is started the body is about to fall On either side and also the motor assembly is leaning this causes the precession of spin axis. Due to this Precession, according to right hand rule the reactive gyroscopic couple acts on the frame which nullifies the Effect of the disturbing couple and thus stabilizes the vehicle. After few rotations and oscillations of motor, the Motor and frame attains the stationary position and gyroscope is subjected to pure rolling motion about the spin Axis .The sensor detects the speed bumps and sends the data to microcontroller unit which Analyze with the help of predefined parameters like color and height of the bumps sends an alert Signal to the output world. An acoustic output will be taken out as an audio warning alert and Visuals are displayed through an LCD indicator

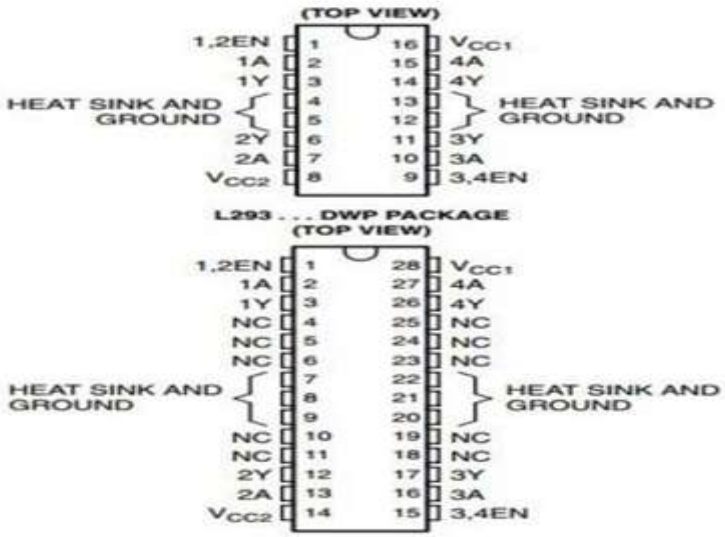

FIG 1:L293D PIN DIAGRAM

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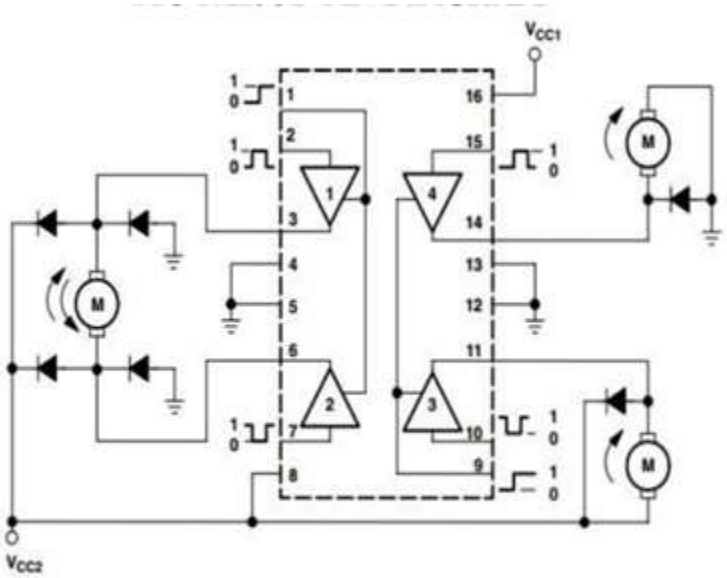

FIG 2: BLOCK DIAGRAM OF L293D

Basic formulas used in calculation :
Moment of inertia , $I = mr^2/2$
Angular Momentum = $I\omega = mr^2\pi N/60$
Torque, $\tau = Frsin\theta$
Force, $F = mg$
Tilt distance = $hsin\theta$
M = Mass of the disc= 1.2kg
R = Radius of the disc
N = RPM I

Table I
Changes of moment of inertia and angular momentum with respect to radius

Serial No	**Radius (m)**	**Moment of inertia (kgm^2)**	**Angular momentum (kgm^2/s)**
1	0.01	0.0001	0.159
2	0.02	0.0004	0.638
3	0.03	0.001	10436
4	0.04	0.0019	2.553
5	0.05	0.003	3.989
6	0.06	0.004	5 745
7	0.0725	0.0063	8.388
8	0.8	0.007	10.213

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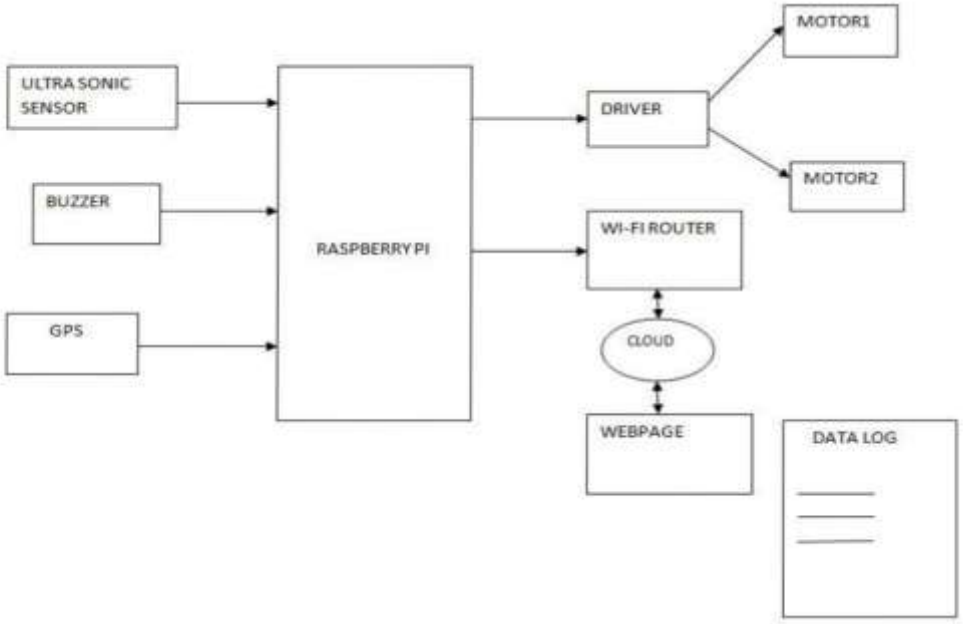
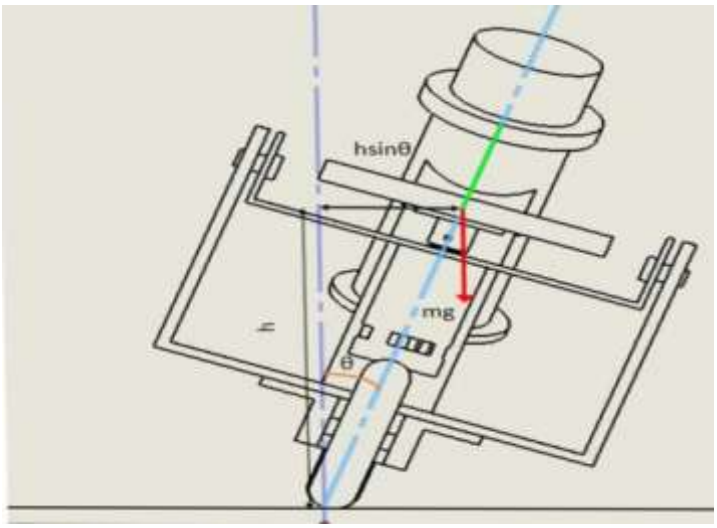


Hump detecting flow chart

Sketch showing the parameters when the vehicle is leaning

Table 2



Changes of Tilt Distance and Torque with respect to Precession Angle

Serial No	Precession Angle (θ)	Tilt Distance (m)	Torque (Nm)
1	5	0.0871	1.0249
2	10	0.173	2.042
3	20	0.342	4.022
4	30	0.5	5.88
5	40	0.642	7.559
6	45	0.707	8.315
7	46	0.719	8.459

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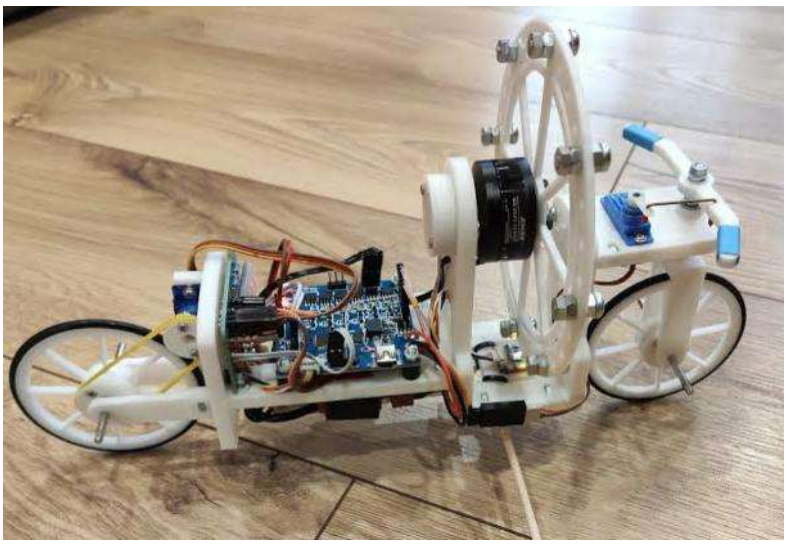

Fig : 3 self balancing two wheeler hump detecting vehicle by using gyroscope

ADVANTAGES:

- Zero emissions.
- Echo friendly with environment.
- Safe top speed range for an individual riding on it.
- Produce less noise.
- Low maintenance required.
- No fuel is required.
- Whole vehicle consists of very low weight.
- It is safe and also provides safety during accidental condition by balancing vehicle.

DISADVANTAGES:

- It requires ground reaction forces.
- It can not withstand large angle disturbance.
- High cost.

II. APPLICATIONS

The above gyroscopic stabilization concept can be used in motor bikes for advanced stability and safety and Also in bicycles and other such vehicles for safer transportation. The gyroscope assembly can be placed at Specific locations in the vehicle to get the stabilizing effect. In addition to being used in compasses, aircrafts, Computer pointing devices, missiles etc., gyroscopes have been introduced into consumer electronics. Since the Gyroscope allows the calculation of orientation and rotation, designers have incorporated them into modern Technology. The integration of the gyroscope has allowed for more accurate recognition of movement within a 3D space than the previous lone accelerometer within a number of smartphones. Gyroscopes in consumer Electronics are frequently combined with accelerometers (acceleration sensors) for more robust direction- and Motion-sensing. Examples of such applications include smartphones, game console peripherals, and virtual Reality sets. Cruise ships use gyroscopes to level motion-sensitive devices such as self-levelling pool tables. An Electric powered flywheel gyroscope inserted in a bicycle wheel is being sold as a training wheel alternative.

- Institutions like college campuses and hospitals are sprawled over a large areas with considerable distance between buildings .
- Increased productivity at work places like railway stations, airports, research facilities and ware houses etc.
- Patrolling by security and personal staff.
- Transportation etc.

III. CONCLUSION

The final model of the self-balancing vehicle design is shown below. This design has been tested at different RPMs of the disc and also with different weights to see that the vehicle is balancing. This paper presents design And fabrication of the two-wheeler self-balancing vehicle which is capable of balancing itself under application Of external forces and loads. The vehicle balances itself under various conditions like forced tilt of the vehicle. Thus the proposed system can be much helpful for two-wheeled vehicles reducing accidents or unwanted falls and increasing safety to the rider. This system reduces the work of humans as well as provides eco-friendly

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