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A Review on Various Self-Balanacing Methods

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Abstract—Motorcycle dynamics is the physics of the motion of bicycles and motorcycles and their components, due to the forces acting on them. Dynamics is a branch of classical mechanics, which in turn is a branch of physics. Bike motions of interest include balancing, steering, braking, accelerating, suspension activation, and vibration. The study of these motions began in the late 19th century and continues today. This paper will be focused on the various methods and technologies. This Paper, will Focused on various methods and technologies to Self Balance Bicycle with various disturbances applied on it. Our findings from this review will be related to any application involving the control of a two wheeled aligned vehicle. The mission of this project was to build a two-wheel bicycle prototype capable of balancing on its own by controlling its handle. Machine learning phase and embedded system we are proposing the system. This proposed system aimed to make a bicycle bot, powered by an electric motor, which could balance by itself and move along a particular path.

Keywords—Selfbalancing; Gyroscopic Effect; Gyro Sensor; Two Wheeled Bot;

I. INTRODUCTION

Motorcycle dynamics is the science of the motion of bicycles and motorcycles and their components, due to the forces acting on them. Dynamics is a branch of classical mechanics, which in turn is a branch of physics. Bike motions of interest include balancing, steering, braking, accelerating, suspension activation, and vibration. The study of these motions began in the late 19th century and continues today.

Bicycles and motorcycles are both single-track vehicles and so their motions have many fundamental attributes in common and are fundamentally different from and more difficult to study than other wheeled vehicles such as dicycles, tricycles, and Quadra cyclers. As with unicycles, bikes lack lateral stability when stationary, and under most circumstances can only remain upright when moving forward.

Bicycle Physical Dynamics have been studied by Scientists, Engineers and Mathematicians. Self-Stability Balancing existence on controlling a moving Bicycle has not been extensively researched or achieved satisfactorily. For Transportation and recreation Bicycles have been a popular form over a century. This Paper, will Focused on various methods and algorithms to Self-Balance Bicycle with various disturbances applied on it. Our findings will be related to any application involving the control of a two wheeled aligned vehicle. Paper is based on development of self-balancing two-wheel bicycle by using various mechanisms and control algorithms for stability purpose. This Techniques will assist the future development of stability controllers for bicycles and will open doors to automation of bicycle transportation of the future.

II. RELATED WORK

A. Overview of the Literature

Challenges over controlling the bicycle that is Balancing the two wheeler bicycle without support of any extra legs or wheels is on e of the biggest challenges for human also from long time.

There are various general categories of research that pertain of this paper like research on dynamic model of the bicycle, self-stability control approach, benefits, current research and experiment performed earlier.

B. What is New in this Review

Author [1] has designed a Self-Balancing Bicycle Using Object State Detection technique. In this paper, we could see the self-balancing techniques based on by maintaining the center of gravity, done by controlling falling angle based on proportional-integral controller (PID). This self-stability is generated by a combination of several effects that depend on the geometry, mass distribution, and forward speed of the bike. If the steering of a bike is locked, it becomes virtually impossible to balance while riding. One other way that a bicycle can be balanced, with or without locked steering, is by applying appropriate torques between the bike and rider. The aim of this paper was to make the cycle balance on its own by controlling its handle.

Author [2] has designed a Self-Balancing Two Wheeler Vehicle using Gyroscope. Gyroscopic effect occurs by the rotation of Mild steel disc fitted on the motor shaft. Due to rotation of the gyroscope, a counter-acting reactive gyroscopic couple leads to the stabilization of the prototype. The motor and gimbal axle assembly is designed in such a way that the Centre of gravity lies above the gimbal axle. when the motor is started the body is about to fall on either side, the only possible way for motor to attain the stability is to either lean forward or backward and also the motor assembly is leaning this causes the precession of spin axis. Due to this precession, the reactive gyroscopic couple acts on the frame which nullifies the effect of the disturbing couple and thus stabilizes the vehicle.

Author [3] has derived Self Balancing Bike Prototype using two gyroscopes to keep the bike upright when stopped. The bike has “landing gear” which is deployed when parked to keep the bike upright. The gyros are fully controlled by the bike, enabling a steer-by-wire system that allows the bike to lean itself into and out of turns, maintaining stability at all times. The bike will have a uni-body chassis with reinforced doors, seat belts, and multiple airbags. Further, the most important safety feature is gyro stability system, which allows the bike to resist the forces of a collision. Safety is one of the top priorities with this bike.

Author [4] designed a prototype of self-balancing two wheelers. The paper deals with an experiment carried out to produce gyroscopic effect on the prototype. The prototype is a two-wheel vehicle in which rotating discs imparted act as gyroscope to produce a counter balancing force i.e. gyroscopic effect when the vehicle prototype loses balance on either sides. Thus the vehicle stabilizes itself. Wherein even if an external force is applied to the system the gyro sensors deployed in it sense the force and develop a force of similar magnitude but in opposite direction due to presence of two gyroscopes used in the vehicle, thus the vehicle does not loose it’s balance even if the external force is applied to it.

Author [5] has designed an algorithm for the regulation of sensor data to keep the two-wheeled robot standing for a long time. It is clear that the Dynamic Regulator will more suitable to control the self-balanced robot. This paper presents a real-time. Dynamic Regulator methods will use inertial sensors, data fitting, nonlinear least squares method and the error model of experimental error characteristics. Estimated attitude will solve the problem of random drift error compensation. This paper will use the integrated navigation system as the research object.

Author [6] has designed a special kind of wheel working on gyroscopic effect which could resist itself from falling down, that would replace the front wheel of bicycle and would eliminate the use of training wheels for a new bicycle learner. In order to do so designed a Gyro wheel inside which a flywheel would be rotating at high rpm with the help of battery operated motor. This rotational motion would create a self balancing effect due to which wheel would remain stable. Hence, a new learner would not hesitate or fear to ride a bicycle.

Author [7] has designed an Automatic Balancing Bicycle, Murata Boy. Murata Boy uses a reaction wheel inside the robot as a torque generator, reaction wheel consists of a spinning rotor, whose spin rate is nominally zero. An accelerometer and a gyroscope is used for measuring the tilt angle. These two sensors prove useful when calculating the bicycle’s tilt angle. This design models the bicycle as a pendulum with a fixed pivot where the bicycle wheels meet the floor. As the bicycle begins to fall to one side, a motor mount to the bicycle exerts a torque on the flywheel, causing a reactionary torque on the bicycle, which restores the bicycle’s balance. This design is very stable: the bicycle can balance even in a stationary position.

Author [8] has derived self-stabilizing bike using gyroscope principle device which is known as CMG (Control moment Gyro). CMG (Control moment Gyro) control the angular direction of the entire device. The entire unit is the combination of mechanical and electronic (PD controller and inclination sensor) components and devices which makes it possible. Firstly, the heavy rotor is fit to bike chassis which will act as a gyro wheel. The electronic sensor will sense is angle of inclination with velocity and acceleration of tilting movement of bike. After sensing these details from the gyroscope sensor, this detail will get processed in microcontroller. The tilting motion to rotor will produce anti-torque to bike’s tilting motion which will oppose bike inclination and will keep the bike in stable vertical position.

Author [9] has designed a system for the self-balancing of a two wheeler. The Gyroscope mechanism is implemented for the balancing. The control system was made automated by using the Arduino and android phone. The Arduino then drives the motor driver circuit to control the wiper motor and thus the wiper motor controls the orientation of the hub motor to stabilize the chassis. Walton Primo NX android mobile was paired with Arduino mega successfully and communication was made successfully between these two devices. The gyro stability system will keep the vehicle upright even in a collision, preventing the vehicle from flipping or rolling.

III. PROPOSED METHOD

This proposed system aimed to design a bicycle bot, powered by an electric motor, which could balance by itself and move along a particular path. The primary aim was to make the cycle balance on its own by controlling its handle and as a secondary measure we give specially designed frame which conveniently shifts the center of mass to the opposite direction of the falling angle.

A. Balancing Proposed Technique

Proposed system is consisting a wireless actuated twowheel bicycle with inbuilt capability to balance itself while riding at particular speed. To achieve this with machine learning phase and embedded system we are proposing the system. This proposed system aimed to make a bicycle bot, powered by an electric motor, which could balance by itself and move along a particular path. The primary aim was to make the cycle balance on its own by controlling its handle and a specially designed frame which conveniently shifts the center of mass to the opposite direction of the falling angle.

A bicycle remains upright when it's all ground reaction forces are steered so that exactly balances the all the internal and external forces that are hindering the stability of the bicycle such as gravitational if leaning gyroscopic if being steered, and aerodynamic if in a crosswind.

In this effort we are not only using a single self-balancing method but three fail safe methods. From our rigorous researches and experiments we believe that single balancing method is easily failed leading to catastrophic results. So in this project we are introducing and modified method of weight column which is entire frame of the bicycle acts as a weight Column by actively shifting the center of mass of the bicycle according to the leaning or gyroscopic effects. This will be actively produced using a simple servo motor which will shift the orientation of the frame with the active signals from the MEMS gyroscope and accelerometer.

B. Gyroscopic Effects

Gyroscopic forces are not important for the stability of a bicycle - as you can see if you read on below - but they help us to control the bike when riding with no hands. More important than anything is "the trail". The front wheel makes contact with the pavement at a point that lies behind the point where the steering axis intersects with the pavement - and the distance between these is called the trail. The trail is not zero because the steering axis is tilted and the front fork is bent. The trail works to stabilize a bike in much the same way as castors work on a tea trolley. When you lean to the right, say, on your bicycle force at the contact point on the pavement will push the front wheel to the right. This helps you to steer effortlessly and it allows for hands-free steering through leaning slightly left or right. The gyroscopic effect helps but the trail is the more important factor.

It is almost certain that gyro effects are important at the initial stage of steering maneuvers. Many riders (especially motorbike riders) tell me that they notice the effect of "counter steering" above a certain speed. This is where any movement of the handle bar to the right (say) causes the bike initially to fall to the left. This is exactly as would be expected from the gyroscopic effect acting on the front (steering) wheel). The more sudden the steering maneuver the more pronounced will be the effect - because the gyro effect is a couple (a moment, a torque - call it what you like) that results from the rate of change in direction of the angular momentum of the wheel. The larger the change of angular momentum, and the shorter the time over which the change takes place then the bigger the gyroscopic couple. But what happens after the initial gyroscopic transient is then no longer gyroscopic - you're then down to the effect of the trail and other steering geometry effects. The bike with the reverse-spinning wheel shown below would not exhibit any counter-steering effect because the front wheel has no net angular momentum.

- Misconception 1: Some people think, incorrectly, that the gyroscopic effect exists because a wheel is spinning and that two spinning wheels must increase the gyroscopic effect - just like two heaters in a room are hotter than one. But the direction of the gyroscopic couple depends on the direction of spin and anyone who has tried this out by holding a bike wheel will know this. This means that two bike wheels spinning in opposite directions will produce couples in opposite directions and these will cancel. Misconception 2: Anyone who has held a bike wheel.

- In their hands and has felt the huge gyroscopic effect will swear that the forces are huge - so large that they simply must be important when riding a bike. Misconception 3: The gyroscopic effect holds a bike

- Up so you can ride a bike with the handlebars locked. NO You fall over immediately. The easiest way to do this is with a rope. Tie handlebars to the cross bar and then tourniquet the rope really tight. we will have trouble even getting started.

C. MEMS Gyroscopes

Gyroscopic sensors is becoming next major application for the MEMS industry in the mere future mostly used in applications such as vehicle stability control, navigation assist, roll over detection, are only used in high-end cars, where cost is not a major factor. 3D input devices, virtual reality, platform stability, robotics, camcorder stabilization, and more are some of the examples of consumer applications.

IV. CONCLUSION

Stabilization of a two wheeled vehicle plays a major role in the complex transportation system around the globe. In this paper, we could review the various self-balancing techniques based on various ideologies such as maintaining the center of gravity, done by controlling falling angle Balancing two wheeled vehicle is an enormous difficult task hence it needs lot experience and it is proper balanced by maintaining centers of gravity in motion and rest state by developing different methods we are trying to provide self-balancing ability to two wheeled vehicles by using various effects or with balancing or cancelling ground reaction forces on it with different possibilities and difficulties for stability in during moving in different path. This will let the us develop automated guided vehicle from two wheelers.

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