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Gyroscopic Stabilization of Two Wheeled Electric Vehicle

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Abstract: This paper report on research and fabrication of an electric vehicle prototype that will be capable of balancing itself without human effort. This vehicle will be implementing a control moment gyroscope for balancing purpose. The project also concerned about the environmental effects of conventional internal combustion Engines and to effectively use the alternative propulsion system which is electric traction system, where using Electric motors the vehicle is propelled. The system uses a control moment gyroscope to static balancing of the vehicle and using its angular momentum and precessional moment. Along with the fact that it uses a electric traction motor he implementation of new optimizations for power and mileage the efficiency is improved.
Keywords: EV (Electric Vehicle), Control Moment Gyroscope, Precession, Traction.

I. INTRODUCTION

About 93% of modern petroleum-based vehicles have found that by 2050, a 25% power output is used and rest is being wasted due to the need for a collision, due to the burning of dangerous and toxic gases that can be emitted into the air. Overcoming the above problem electric cars can help. EVs work much better than conventional driving trains and are less polluting compared to I.C Engines and EV's with better statistics and performance that can be used in the City Environment. Our project is an understanding of EV Integration in 2 simple wheels by operating at a low cost.

In terms of the power of 2 wheels we know that balancing 2 wheels in a standstill is a very difficult task to achieve because there is no pairing range from 2 wheels and due to gravity. To balance he vehicle using the active CMG system. With this opposing torque we make while measuring the car in vertical positions. We use single axis gimbals in our CMG system. This is simple, efficient and deals with small angular deviations known as unity. Two-wheeled vehicles offer many advantages such as greater mobility, smaller size, and greater efficiency.

II. OBJECTIVE

To fabricate an EV, this is simple and cost effective yet efficiently than already existing EV and to integrate it with a CMG stabilizer for better riding experience. Stabilize the vehicle at stand still so that there is no loss of balancing or falling of vehicle. The vehicle should be easier to ride and driven by a person with better riding experience.

III. WORKING PRINCIPLE

Electric vehicles (EVs) use an electric motor for traction, and chemical batteries, fuel cells, ultra-capacitors, and/or flywheels for their corresponding energy sources. The electric vehicle has many advantages over the conventional internal combustion engine vehicle (ICEV), such as an absence of emissions, high efficiency, independence from petroleum, and quiet and smooth operation.

The modern EV is built based on original body and frame designs. This satisfies the structure requirements unique to EVs and makes use of the greater flexibility of electric propulsion. The drive train consists of three major subsystems: electric motor propulsion, energy source, and auxiliary. The electric propulsion subsystem is comprised of a vehicle controller, power electronic converter, electric motor, mechanical transmission, and driving wheels. The energy source subsystem involves the Modern Electric, Hybrid Electric, and Fuel Cell Vehicles energy source, the energy management unit, and the energy refueling unit.

The auxiliary subsystem consists of the power steering unit, the climate control unit, and the auxiliary supply unit. Based on the control inputs from the accelerator and brake pedals, the vehicle controller provides proper control signals to the electronic power converter, which functions to regulate the power flow between the electric motor and energy source. The backward power flow is due to the regenerative braking of the EV and this regenerated energy can be restored to the energy source, provided the energy source is receptive. Most EV batteries as well as ultra-capacitors and flywheels readily possess the ability to accept regenerated energy.

The energy management unit cooperates with the vehicle controller to control the regenerative braking and its energy recovery. It also works with the energy refueling unit to control the refueling unit, and to monitor the usability of the energy source. The auxiliary power supply provides the necessary power at different voltage levels for all the EV auxiliaries, especially the hotel climate control and power steering units.

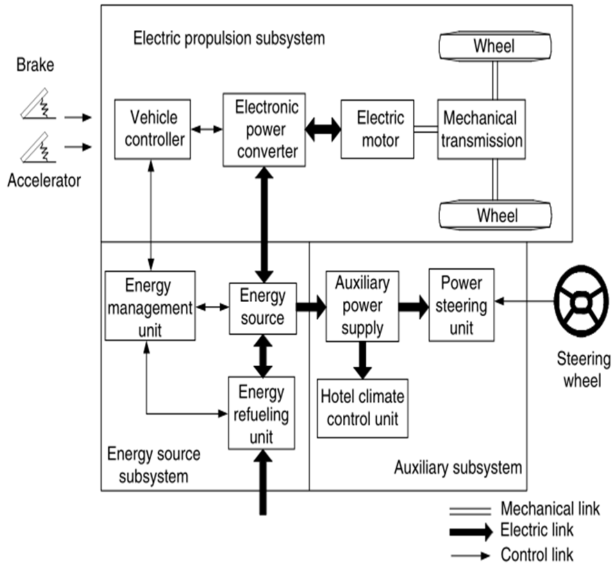

Fig. 1 Layout of EV system

IV. GYROSCOPE

Gyroscope is a device consisting of a wheel, rotor, or disc mounted on shaft so that it can spin rapidly about a spin axis which is free to alter directions. If a torque is applied to the spin axis, the orientation of the axis is unaffected by tilting of the mounting, according to the law of angular momentum conservation. Because of this the gyroscopes are useful for measuring or maintaining orientation. We are using this gyroscope to stabilize the vehicle,

We are designing the chassis model using *SOLIDWORKS*. After designing the chassis, the model is determined of its centre of gravity. The vehicle will be at its most stable position in its centre of gravity, placing the gyroscope in this position will be most optimum. The gyroscope contains a rotor and a Gimbal which is rotated using an electric motor. This rotating fly-mass generates huge amount of angular momentum, this momentum is necessary to counteract the falling force. This force is what counters the falling and balances the vehicle.

V. CALCULATIONS

1) Centre of gravity obtained for current design = *h*
2) Gyroscope rotor momentum:

$$I = n * M * R2$$

Where,

I= Inertia Force of the Rotor

n= profile of the Rotor

M= mass of the Rotor

R= Radius of the Rotor

Inertia obtained to sustain the load for the give mass, to counteract falling of vehicle balancing for gravity.

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3) The counteracting torque is calculated to overcome falling is

$$\tau = h * m * g * sin\theta$$

Where,
τ = counter torque
h= Centre of gravity in meters
m= mass of vehicle in kilograms
g= acceleration due to gravity
θ= lean angle=

This will give the required force that your gyroscope must generate to balance the vehicle at that angle.

4) Torque generated by Gyroscope

$$\boldsymbol{\tau_{gyr} = I_d * \omega_d * \omega_{axis} * sin\theta}$$

Where
τ_{gyr} *= torque by gyroscope*
I_d *= inertia of the disk*
ω_d *= speed of disk*
ω_{axis} *= speed of the axis*

Therefore two rotors of this size should be able to balance a 25 kg motorcycle easily. By this we can evaluate that doubling the rotor mass equals double the inertia or power of the gyroscope. However, by doubling the radius, you get 4 times the inertia. Therefore a rotor with a large radius can be implemented for better balancing couple.

VI. METHODOLOGY

The flywheel design employs a flywheel which rotates about an axis parallel to the bicycle's frame. 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. The flywheel design has several advantages. This design is very stable: the bicycle can balance even in a stationary position. The mathematical model of this system is the least complex of the considered designs. Due to the simplicity of the design, the model would most likely be the closest to reality of the three designs. As a result of the relative math simplicity and the ease of starting and stopping, the controller would be relatively straight forward to implement. This design would also allow the bicycle to travel in a relatively straight line with only small deviations.

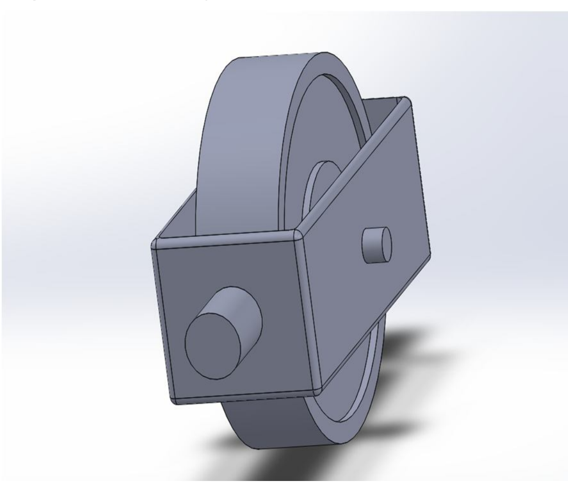

Fig. 2 Gyroscope Designed using solidworks

Fig. 3 Fly-mass / Rotor

One of the main disadvantages of this design is that it does not likely permit easy steering, especially for higher speeds, Also, the frame would have to be altered, causing the design to look less similar to a bicycle than others.

VII. ADVANTAGES

The gyroscope uses a passive kind of gyroscope, which doesn’t use any feedback signals. The model is fairly simple and easy to integrate to other models. The fabrication including EV can be modular in design, where upgradation of the model can be possible.

The vehicle can be introduced to markets which have more no. of newcomers to two wheelers. The self balancing provides high safety and can be used by elders.

VIII. LIMITATIONS

The model is complicated to design; the feedback loop is complex and will be having more no. of variables. Optimization of the flywheel is complex; overall design is to be optimized and should be dynamically balanced.

IX. FUTURE SCOPE

The free balancing concept is not suitable for dynamic stabilization. However, to perfectly balance the vehicle needs to be developed. A two-wheeler developed using this concept can be fully enclosed like a car and provided with all its safety features and amenities.

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