DESIGN AND FABRICATION OF GYRO MONO RAIL

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Abstract— The gyro monorail, gyroscopic monorail, or gyro-stabilized monorail are terms for a single rail land vehicle that uses the gyroscopic action of a spinning wheel to overcome the inherent instability of balancing on top of a single rail. A monorail is a railway in which the track consists of a single rail, typically elevated. The dynamic stabilization of a mono rail or two wheeler automobile requires that a torque acting on a car from an outside be neutralized by a torque produce within the car by a gyroscope. The vehicle runs on a single conventional rail, so that without the balancing system it would topple over. a spinning wheel is mounted in a gimbals frame whose axis of rotation (the precession axis) is perpendicular to the spin axis. The assembly is mounted on the vehicle chassis such that, at equilibrium, the spin axis, precession axis and vehicle roll axis are mutually perpendicular. The Sweeney-Ferreira Gyro-Dynamics Monorail, like many other monorail concepts, never made it beyond the test track.

Keywords—Mono Rail,Gyro Mono Rail, Gyroscope Mono Rail, Single Track Rail.

INTRODUCTION

The purpose of this project is to establish the feasibility of implementing this schematic concept using available technology. If feasible the gyroscopically stabilized platform will be made at the most practical and economic size. The stable platform uses four interconnected gyroscopes that react to the tipping movement of an inherently unstable external body. In this system configuration, the gyroscopes act as actuators (commonly known as moment gyro's) and not as sensors, meaning they produce the torque that stabilizes the system. The proposed system has the gyroscopes arranged in such a way that it will stabilize an external body in the horizontal pitch and roll. Research has revealed that no such interconnected multi-gyroscopic system currently exists for stabilizing objects in both pitch and roll directions.

The single track gyroscopic vehicle problem is first considered in 1905 by Louis Brennan . Many extensions were later developed, including the work by Shilovskii and several prototypes were built . The differences in the various schemes lie in the number of gyroscopes employed, the direction of the spin axles relative to the rail, and in the method used to produce the acceleration of the spin axle. The online Museum of Retro Technology cites many articles and examples of gyro cars, including a 1961 Ford Gyrocar concept called the Gyros and a concept from Gyro Transport Systems of Northridge, California that was on the cover of the September, 1967 issue of "Science and Mechanics".

Other important application of gyroscopic stabilizers include to ships and ocean vehicles, as discussed in and robotics .Mathematical analysis of the two-wheeled vehicle gyroscopic stabilization problem first appears in and more recently in without derivation, or in where the derivation is by use of bond graphs. Our work is different in that we derive the equations of motion using Lagrangian mechanics, and in that we study several configurations, and propose linear controllers and stability analysis for the system based on the derived model. The control problem is to roll-stabilize an unstable cart. In the cart design, destabilizing forces are resisted by a gyroscope, which is driven by a motor. The gyroscope here is used as an actuator, not a sensor, by using precession forces generated by the gyroscope. When torque is applied to an axis normal to the spin axis, the gyroscope reacts by producing a reaction moment about a third axis, orthogonal to both the torque and spin axes.

The paper is organized as follows. In section II, we start by developing dynamic equations for a gyroscopically stabilized cart. We model the nonlinear dynamics of the cart and gyroscope using Lagrange's method. We study different configurations, including the single and double gyroscope cases. In section III, we develop a linearized model, and perform stability analysis of the closed-loop feedback system. The control problem is to roll-stabilize the cart. In section IV, we show simulation results. Finally, we discuss a scaled model that was built in section V.

Gyroscope Principles

Rigidity is the ability of a freely rotating mass to maintain its plane of spin when any external force is applied to it.

First Law of Gyroscopes

If a rotating wheel is so maintained as to be free to move about any axis passing through its centre of mass, its spin axis will remain fixed in space.

Second Law of Gyroscopes

When a torque acts on a spinning mass with an axis perpendicular to that of spin, then the latter will process about an axis perpendicular to both aforementioned axes, at an angular velocity.

WORKING PRINCIPLE

The vehicle runs on a single conventional rail, so that without the balancing system it would topple over. Basic principle of operation: rotation about the vertical axis causes movement about the horizontal axis. A spinning wheel is mounted in a gimbal frame whose axis of rotation (the precession axis) is perpendicular to the spin axis. The assembly is mounted on the vehicle chassis such that, at equilibrium, the spin axis, precession axis and vehicle roll axis are mutually perpendicular. Forcing the gimbal to rotate causes the wheel to process resulting in gyroscopic torques about the roll axis, so that the mechanism has the potential to right the vehicle when tilted from the vertical. The wheel shows a tendency to align its spin axis with the axis of rotation (the gimbal axis), and it is this action which rotates the entire vehicle about its roll axis.Ideally, the mechanism applying control torques to the gimbal ought to be passive (an arrangement of springs, dampers and levers), but the fundamental nature of the problem indicates that this would be impossible The equilibrium position is with the vehicle upright, so that any disturbance from this position reduces the height of the center of gravity, lowering the potential energy of the system. Whatever returns the vehicle to equilibrium must be capable of restoring this potential energy, and hence cannot consist of passive elements alone. The system must contain an active servo of some kind. If constant side forces were resisted by gyroscopic action alone, the gimbal would rotate quickly on to the stops, and the vehicle would topple. In fact, the mechanism causes the vehicle to lean into the disturbance, Resisting it with a component of weight, with the gyro near its unperfected position.

Inertial side forces, arising from cornering, cause the vehicle to lean into the corner. A single gyro introduces an asymmetry which will cause the vehicle to lean too far, or not far enough for the net force to remain in the plane of symmetry, so side forces will still be experienced on board.

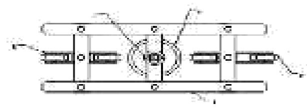
In order to ensure that the vehicle banks correctly on corners, it is necessary to remove the gyroscopic torque arising from the vehicle rate of turn.

A free gyro keeps its orientation with respect to inertia space, and gyroscopic moments are generated by rotating it about an axis perpendicular to the spin axis. But the control system deflects the gyro with Respect to the chassis, and not with respect to the fixed stars. It follows that the pitch and yaw motion of the vehicle with respect to inertial space will introduce additional unwanted, gyroscopic torques. These give rise to Unsatisfactory equilibrium, but more seriously, cause a loss of static stability when turning in one direction, and an increase in static stability in the opposite direction. Encountered this problem with his road vehicle, which consequently could not make sharp left hand turns.

Brennan and Sheryl were aware of this problem, and implemented their balancing systems with pairs of counter rotating gyros, processing in opposite directions. With this arrangement, all motion of the vehicle with respect to inertial space causes equal and opposite torques on the two gyros, and are consequently cancelled out. With the double gyro system, the instability on bends is eliminated and the vehicle will bank to the correct angle, so that no net side force is experienced on board.

When cornering, the counter-rotating gyros avoid instability on corners .Shilovsky claimed to have difficulty ensuring stability with double-gyro systems, although the reason why this should be so is not clear. His solution was to vary the control loop parameters with turn rate, to maintain similar response in turns of either direction. Offset loads similarly cause the vehicle to lean until the center of gravity lies above the support point. Side winds cause the vehicle to tilt into them, to resist them with a component of weight. These contact forces are likely to cause more discomfort than cornering forces, because they will result in net side forces being experienced on board. The contact side forces result in a gimbal deflection bias in a Shilovsky loop. This may be used as an input to a slower loop to shift the center of gravity laterally, so that the vehicle remains upright in the presence of sustained non-inertial forces. This combination of gyro and lateral cg shift is the subject of a 1962 patent. A vehicle using a gyro/lateral payload shift was built by Ernest F. Swingy, Harry Ferreira and Louis E. Swingy in the USA in 1962. This system is called the Gyro-Dynamics monorail.

DESIGN OF GYRO MONO RAIL



CONCLUSION

From the data collected as per the report and discussion made with the people about the project we got idea for development of made in the future and our project has a good scope in future. This is new development of made in our project gives as idea for future development. To reduce the energy to run the vehicle to reduce the Pollution, fuel consumption level demand to run vehicles of gyroscope make this project most successful in the future.

REFERENCES:

I. Graham, R (February 1973). "Brennan, His Helicopter and other Inventions". Aeronautical Journal.

II. Hamill, P.A. (December 1972). et al. "Comments on a Gyro- Stabilized Monorail Proposal". LTR-CS-77. Canada: Control Systems Laboratory.

III. Rogers, G.F.C.; Mayhew, Y.R.(1972). Engineering Thermodynamics, Work and Heat Transfer (third ed.). Longman.

IV. Spilhaus, Athelstan; Spillways, Kathleen (1989). Mechanical Toys. New York: Crown Publishers. pp.

V. Tomlinson, N (1980). Louis Brennan, Inventor Extraordinaire. John Halle well Publications.

VI. "The Sheryl Gyroscopic Monorail Car". Scientific American. January 22, 1910."The Schakowsky Gyroscopic Monorail System". The Engineer. January 23, 1913