CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

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Project Number

S0210

Project Title

Creating a SensorGVS: A Sonar/Accelerometer Guided Vehicle Stabilization System

Abstract

Objectives/Goals

The goal is to create a SGVS system for improving vehicle safety and reducing vehicle body motion caused by uneven road surfaces. The system scans the road with sensors and the embedded computer controlled system adjusts suspension according to a predictive algorithm to keep the wheels firm on the ground and reduce undesirable vehicle body motion.

Methods/Materials

First, we studied the behavior of the entire SGVS system by creating s C++ simulation model of system components including a virtual road model. An embedded computer with an on-board accelerometer, sonar, and a USB data logger was built and driven around local streets to collect actual road data. The road data was used in simulation. The simulation environment was used to model different control algorithms, servo motor capabilities, and road data.

Once the characterization of the system was understood within the simulation environment, a prototype of the SGVS system was built using a Parallax microcontroller, sonar sensors, accelerometers, an H-bridge, a servo motor, and a wheel assembly. The closed-loop control system used a sonar sensor to locate the position of the wheel. A second sonar sensor scanned the road ahead. An on-board accelerometer was used to create a mathematical virtual gyroscope as a reference point as if it is mounted on a motionless body. The virtual reference point was used to stabilize the vehicle body.

The video tape of SGVS prototype performance was examined frame-by-frame and the prototype data was back annotated into the simulation model.

Results

An average passenger car requires a 15.5 KW servo. That is about 17% of overall vehicle power. An SGVS in a rover would require a 0.047kW servo. This makes practical use of SGVS in rovers or high-end automobiles. A mid-sized car going 10mph requires a 20 horsepower servo, which is 17,267 times more powerful than our prototype. A rover going 5cm/sec requires a 0.06 horsepower servo, which is 52 times as powerful as our prototype. Our prototype was able to adjust 9.7cm/sec.

Conclusions/Discussion

We found simulation and system modeling to be crucial to understanding and characterizing complex systems such as an SGVS. A closed loop control system allowed accurate positioning of the wheels. This experiment shows the practicality of an SGVS system in high-end vehicles and rovers on rough terrain. This project has the potential of being patented.

Summary Statement

A predictive computer controlled system for enhancing the safety of vehicles and reducing body motion caused by uneven road surfaces.

Help Received

Our adivor, Mr. Simon Zarrin, explained basic concepts to us, then we applied them to the project.