CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Dylon M. Tjanaka

Project Number

34605

Project Title

Using Active Tilt Compensation to Improve Rollover Stability of Large Trucks

Abstract

Objectives/Goals

The objective of this project is to reduce rollover accidents involving large truck by engineering an Electronic Stability Control system called Active Tilt Compensation (ATC). ATC detects tilt using an accelerometer and moves the truck center of gravity to compensate for the tilt.

Methods/Materials

I derive the equations that describe the conditions that cause large trucks to rollover. Then I use Lego Mindstorms kit to build an intelligent truck trailer. This trailer has a 3-axis accelerometer and the capability to move its load to shift its center of gravity. Next, I write a program to read back the acceleration values, filter the data using median filters, and move the trailer load to compensate for rollover force. I test the truck behaviors under static (non-moving) conditions on a ramp. The ramp angle is measured using a tilt angle app running on an iPod. I also test the truck behaviors under dynamic (moving) conditions on a test track with a known radius. I use my razor scooter to tow the truck trailer. I use a camera and stopwatch to measure the speed of the trailer turning on the test track.

Results

I use equations to compute expected values and correlate the values to experiment results. Under static conditions, the trailer moves its load if it is about to reach the critical tilt angle that will cause rollover. The average error between computed and measured critical tilt angles is 2.18%. Under dynamic conditions, the trailer moves its load when the accelerometer indicates that it is about to tilt. I create various test cases to measure the response of the ATC system. The test cases include a scenario that will cause the trailer to rollover. The system works as expected under dynamic conditions.

Conclusions/Discussion

I have successfully implemented the Active Tilt Compensation mechanism. My experiments agree with my theoretical derivations within reasonable errors. My model truck trailer reacts to external forces to compensate for rollover conditions. I find out that I have to use median filters to utilize accelerometer data effectively. I believe that my project will be useful to reduce rollover accidents involving large trucks. However, I also believe that I could still make future improvements, such as using a PID controller to shift the center of gravity.

Summary Statement

I am designing, constructing, testing, and analyzing the Active Tilt Compensation system that can be used to improve the rollover stability of large trucks.

Help Received

Ms. Woodward (Science Teacher) helped with science fair preparation; Bryon Tjanaka (Brother) helped me solve difficult Science and Math problems; Mother provided critical opinions and advice; Father provided technical advice and direction.