CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Scott M. Elder

Project Number
S0705

Project Title
Minimizing the Effect of GPS Multipath on a Autonomous Mobile Vehicle

Abstract

Objectives/Goals
The objective of my project is to minimize the effects of reflected GPS multipath signals on an autonomous mobile vehicle. Alice was the name of the autonomous vehicle team Caltech entered into the DARPA Grand Challenge. My goals were to create a controlled multipath environment, research/design a multipath blocking fixture, define the multipath Fresnel zones for the vehicle, and then mount my fixture on Alice for autonomous mobile operations.

Methods/Materials
This project incorporated two former science projects. Building upon the results and knowledge of these first two projects, I applied my experience by designing a fixture to minimize the effects of GPS Multipath. First, I created a GPS multipath environment and then tested various materials for the GPS reflection characteristics. Once I determined the best material, I analyzed the multipath reflective Fresnel zones on Alice and built a fixture that would block these signals. I tested the fixture and then was approved by team CalTech to place the fixtures on Alice.

Results
I was able to determine that PVC pipe was the best material for my fixture. I built two fixtures for the two GPS antennas on Alice. I collected 500 data points for an antenna unprotected from multipath and 500 data points for one protected by my fixture. The unprotected antenna altitude range variance was 15 feet. The protected antenna altitude range variance was 4 feet. The 4 foot variance is attributed to DOP error and not multipath.

Conclusions/Discussion
I began working with Team Caltech in June of 2003 and was again accepted as a team member in Feb. of 2005. I worked on my project throughout the summer and in Aug. I presented my design and testing results to the Terrain team. I was given the OK to install my fixtures on Alice#s two GPS antennas. Further analysis from the vehicle testing verified that the fixtures did reduce multipath while not having any negative effect on GPS positioning. The fixtures were used during the DARPA Grand Challenge qualification tests and final race.

Summary Statement
Building on past science projects, my current project of multipath testing/analysis/fixture design and through working with CalTech on their DARPA Grand Challenge entry #Alice#, I was able to minimize the effects of multipath on an autonomo

Help Received
Dad helped with transportation and building the fixture. Dr. Murray and Team CalTech supported my research and allowed me to use #Alice#.