CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
Robert J. Becerra

Project Number
J0703

Project Title
What Are the Effects of Weather on Laser Communications? Free-Space Optics

Abstract

Objectives/Goals
The purpose of the project was to test fog and rain effect on laser communications(free-space optics) systems using a laser transmitter of three different wavelengths and a receiver with a light detector. The hypothesis was that the amount of light being scattered is a function of its wavelength and ultimately reduces signal strength in laser communications(free-space optics) systems.

Methods/Materials
Three different lasers(532nm, 650nm, 980nm) were set up in a transmitter circuit and aimed through a Fog Testing Cube and Rain Simulator. A test signal was sent to the transmitter using a signal generator and the output from the receiver was measured in decibels using a spectrum analyzer. I'd gather the results from the spectrum analyzer and log the data. I also set up a light scatter detection circuit at a 90 degree angle to the laser to measure light scatter through fog and took measurements using a multimeter.

Results
My results showed the 532nm green laser had the most scatter through rain and fog due to the fact that shorter wavelengths scatter more than longer wavelengths. The 532nm laser communicated the best through rain in the transmitter circuit. The 980nm infrared laser had the least scatter through rain and fog due to its longer wavelength and had the largest fade margin. It's also the best to communicate through fog. The 650nm red laser was the worst to use of the three and also had the smallest fade margin. Overall, the 532nm laser is the best to use in the transmitter circuit.

Conclusions/Discussion
My hypothesis was correct. The amount of light being scattered through fog and rain is a function of its wavelength. I was able to find out which wavelength had the most scatter through rain and fog. By plotting data on a graph, one can see a difference in light scatter. The 980nm infrared laser had less scatter because it had the longest wavelength of the three and the 532nm green laser had the most scatter due to its short wavelength.

Summary Statement
The amount of light being scattered is a function of its wavelength and ultimately reduces signal strength in free-space optics systems.

Help Received
My father downloaded the Spectrum Analyzer software to help gather data and helped me build the Fog Testing Cube and the Rain Stimulator. He also ordered the materials for my project and built the display case.