CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S0919

Project Title

The Effect of Path Distance on the Loss of Signal Power between Receiver at Ground Level and Transmitter at Fixed Height

Abstract

Objectives/Goals

The objective of this project is to address the question: what is the effect of distance between a transmitter and a receiver on the propagation loss of signal power? Unlike other studies of its kind, this study was novel in that it emphasized on the propagation loss when the receiver was strictly at the ground level while the transmitter was at a fixed height above ground.

Methods/Materials

Received power in dBm was measured as a function of distance from the base of the transmitter to the receiver. The router was turned on and the receiver unit was placed at the first distance of 4 meters. After 60 seconds, the average power of the received signal for that time frame was generated by the spectrum analyzer software and then recorded. This process was repeated in 4-meter increments to 44 meters. 3 trials were conducted, and a total of 33 data points were collected. For transmitter, a Linksys home wireless router mounted on a vertical wooden plank at a height of 228 cm was used. For receiver, a laptop computer, a wireless USB device, and a spectrum analyzer software were used to measure the received power.

Results

Regression analysis showed a general trend of decreasing power represented by the equation: (Received Power in dBm) = -0.5409 (Distance) - 71.594; R-squared was 0.9396. The Log-Distance Model was used with another regression analysis to calculate the experimental n=1.999 with R-squared=0.7635. Removing anomalous data at four meters produced an experimental n=2.956 with R-squared increased to 0.9407.

Conclusions/Discussion

The t-Test results supported the hypothesis that the loss of signal power increases when path distance increases. More detailed regression analysis using Log-Distance Model showed that experimental n=2.956 was less than Two-Ray Model's n=4; because this study eliminates the reflected ray, it should minimize interference between direct ray and reflected ray and produce an n that is less than 4. The same experimental n=2.956 was more than Free-Space Model's n=2; this made sense because in terrestrial setting, propagation loss could not be better than that in free space. This study was novel in that it was the one that examined the boundary case of the Two-Ray Model where the receiver is at the ground level and the reflected ray is eliminated. The results could help in designing radio links to control machines or sensors that have antennas that are at or near the ground level.

Summary Statement

This project collected field data on received power as a function of distance and utilized path loss models to examine the propagation effects when the receiver is at the ground level.

Help Received

My teacher gave feedback throughout the project and my parents helped me on the background research and use of hardware and software.