CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
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Project Number
S1011

Project Title
Intelligent Repeater for Fifth Generation (5G) Cellular Networking

Abstract

Objectives/Goals
Next generation 5G cellular networks are expected to provide orders of magnitude improvement in data rates and capacity by using higher millimeter wave frequencies. However, millimeter wave signals require a direct path between a transmitter and receiver because of much higher path loss and absorption, as compared to 4G signals. The objective of this project was to determine whether a novel beamforming repeater can be built that could amplify and actively reflect the millimeter waves to solve this problem, and to predict how an intelligent repeater would function in a physical environment.

Methods/Materials
The very first 5G repeater with narrow beams was designed and built using millimeter wave phased arrays, radio frequency modules, and two printed circuit boards. Experiments were performed where a source transmitter had its direct path to the final destination receiver blocked. The experiments used the repeater to actively reflect the signal and provide an indirect path to the destination. The end receiver was connected to a spectrum analyzer which displayed the received signal. System software simulations were also carried out through MATLAB.

Results
The experiments demonstrated that with the use of the repeater the signal transmitted by the source was received at the destination, whereas without the repeater no signal was received. Software simulations for adding repeaters to a cell area demonstrated increased coverage, higher realized capacity, and a lower price per bandwidth as compared with the small cell alternative.

Conclusions/Discussion
The experiments and simulations showed that beamforming repeaters can improve the coverage and capacity of 5G networks by amplifying and redirecting signals. Repeaters can also reduce the installation time and cost of implementing 5G networks because they eliminate the need for installation of optical fiber. Based on these conclusions, fifth generation intelligent repeaters are the least time consuming and most cost effective method of implementing 5G networks in our physical environment.

Summary Statement
In order to make the deployment of next generation cellular (5G) networks feasible, faster, and cost effective, the very first 5G repeater was designed, built, and tested.

Help Received
I designed and built the 5G repeater by myself. Sam Gharavi who is a Systems Engineer at Movandi granted me access to professional equipment and helped me understand the functions of a Radio Frequency Module.