Auto-Adjusting P2P Microwave Link

{ Alex Roissier, Anthony Valverde, Robert Wells } University of California, Riverside BCOE

Introduction

This project is motivated by the fact that during natural disasters and missile tests, links can become misaligned and communications can go down.

With this project, after misalignment, the links will find each other and connect to the strongest signal detected automatically. Normally, you would have to send technicians out to the dish locations and manually realign the dishes again, however, this project will save time, money, and effort.

Objectives

The receiving antenna ideally aligns perfectly with the transmitting antenna. To come close to ideal outcomes we need the following to be true for realistic implementation:

1. The transmitter is within the search range of the receiving antenna.
2. The received signal is identifiable as a sampled version of the transmitted one.
3. Align to the measured max power received
4. The process takes less than 8 minutes

Materials & Methods

The following materials were required to complete the project:

- Servo motor
- Linear Actuator
- Adafruit GPS chip
- Arduino Mega2560
- USRP 2901
- Antenna
- LINX Toolkit for LabVIEW
- PC with LabVIEW

- The distance between the antennas was determined by the Haversine equation.
- We used 2D geometry approximation to determine the initial positioning and search range.

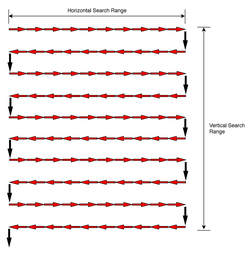


Figure 5: Search Pattern

Results 2

After the full search by wireless transmission, the minimum loss with -11 dB and 25 dB gain of the TX and RX respectively, was 76 dB. Over a cable, the Power Spectrum of the sampled simple sinusoid showed a 36 dB loss. A 30 dB difference with the wireless transmission with the same gains.

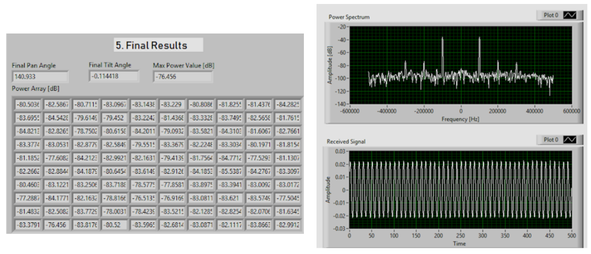
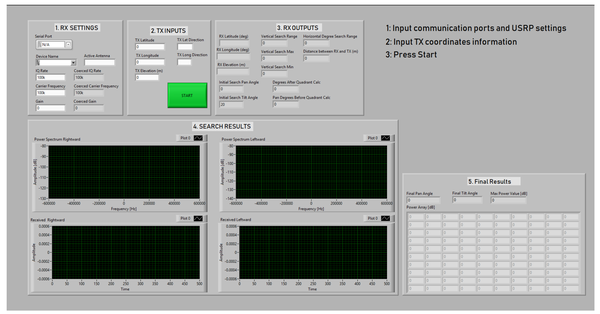


Figure 4: (a) Results of Search (b) 1kHz sinusoid

We were limiting the output power of the transmitter (-11 dB gain), Though, on the U-NII-3 band there aren't any gain or TX power reduction limits for fixed P2P systems, so the max power received could be improved.

Results 1



[In Degrees]	Servo	Actuator	
Range	20-165	-17-18	
Total Range	145	36	
Increment	0.25	3	
Time	**Required**	**Initial**	**Increment**
GPS	10s		
Servo	< 0.5s	1s	1s
Actuator	15s	15s	5s
Sampling	< 1s		1.5s
Program	< 6min		

Figure 1: The GUI

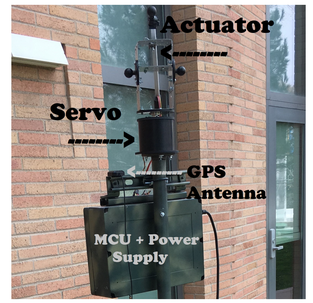


Figure 2: RX with antenna detached

We found that the GPS' antenna is the more inaccurate when we were next to a building just to our west, where the error was approximately 100 meters. However, with a building to our south, we had no error greater than the chip was rated for. Our solution for consistency was to operate not adjacent to a building.

Conclusion

Figure 3: The RX antenna

- In our tests, transmitting antenna was within search range of the receiving antenna.
- Of points searched within the range the receiving antenna aligns to the direction of the max power received
- The whole process takes little more than 5 minutes
- The actuator had a large increment of control
- The servo had small increments of control

Graphical User Interface

Provides a place for the user to input their specific radio parameters and the TX location information (in decimal). The program won't run until the user presses Start. The GUI shows GPS the calculations, after the start, and current PS data of rightward and leftward scans as the Antenna moves. Lastly, the GUI shows all max powers scanned in an array and the position of lowest dB loss that it finally moves to.

Future Work

PID control could be utilized to minimize the overshooting of the servo and actuator. Implementing a digital gaussmeter could be useful so the operator wouldn't have to initially face the receiver north. Implementation of a filter could greatly improve the clarity of the measured power spectrum, because at low dB levels, the noise is somewhat high, relatively. We also could improve the GUI with more user feedback: e.g. scan percentage, GPS calculation indicator, Scanning lights.

Contact Information

Alex Roissier
Email aroissier97@gmail.com
Anthony Valverde
Email valverde.anthony97@gmail.com
Robert Wells
Email wells.robert.parker@gmail.com