ECE 4370/1: Antenna Engineering Final Project

WaveRacers Competition

Overview

The goal of this project is to make a high-gain, lightweight antenna that allows for microwave (5.8 GHz) energy harvesting and conversion to mechanical energy.

Antenna Specifications

The antenna should have a targeted band of operation of the unlicensed ISM band from 5.725 GHz to 5.850 GHz. Your team should maximize peak gain and minimize weight for this application. There are 6 major components to completing this project:

Design – Choose an antenna design and explain your rationale in your report.

Simulation – Use the numerical tool of your choice (NEC, HFS, CST, and/or other) to simulate the performance of the antenna and hone your design parameters.

Fabrication – Build your antenna by any means necessary. The antenna must be SMA connectorized and contain only passive components.

Measurement – Measure your antenna impedance on the network analyzer as a function of frequency, estimating the 3dB bandwidth. Measure the antenna on the rooftop range on a designated measurement day to verify pattern and calculate peak gain, half-power beamwidth, sidelobe level, etc. The antenna will also be weighed and raced to estimate performance in the targeted energy-harvesting application.

The entirety of the measurement section of the report is written by the ECE 4371 members of the team. The grade on this portion of the project will contribute to the final project grade for these students. The rest of the project report contributes to the entire ECE 4370 project portion of the grade for all team members.

Analysis – Analyze how your antenna interfaces with energy-harvesting circuitry using any appropriate combination of theory and simulation. Translate this into an estimate of the distance traveled by your vehicle.

Documentation – Document the process in a final PDF report to be submitted electronically by the deadline specified in class.

Competition

Your team's antenna will receive a competitive rankings. The first rank, relative to your classmates' antennas, is based on how well your antenna maximizes the following parameter: [Peak Linear Gain]/[Weight]^0.5. The second rank, also relative to your classmates' antennas, is the total distance that the antenna can propel a small DC motor, connected to energy-harvesting circuitry and powered by a continuous wave 5.8 GHz magnetron. The final project rank will be based on an average of the "weigh-in" rank and the "race" rank.

The distance measurement will be made with the following "race" rules:

1. All race entrants shall be composed of a) a male SMA-connectorized 5.8 GHz antenna, b) a SMA-connectorized energy-harvesting circuit, c) a DC motor drive unit, and d) a chasis. Your team is free to design and specify these components or simply use the provided energy-harvesting circuitry and small DC motor. Starter kits with low-powered DC motors, Schottky diodes, circuit boards, and capacitors will be available at the Hive for ECE 4370/1 students. Ultimately, your group is free to use all, some, or none of the kit components in the final design.

2. The vehicle will be powered by a 5.8 GHz 700 Watt continuous wave magnetron driving a 20 dBi horn antenna, vertically polarized. The center of the horn will be approximately 20 cm from the ground.

3. The student team will place the vehicle anywhere in front of the transmit horn, but no closer than 1 meter. When the device is powered up, the total distance traveled by the vehicle is measured. If the distance traveled exceeds the available track distance for multiple antennas, tie-breaks between entrants will be determined by total time taken to reach the end.

4. Small dielectric rails will be used along either side of the illuminated race track in order to gently guide the vehicle down the center.

5. Students are free to design/add any assisting circuitry that they may find useful for the race. However, all components added must be passive and completely discharged at the starting line. The entire vehicle must be self-contained at the starting line (no grappling hooks and strings).

The grading will be based on quality and completeness of the technical presentation as well as the technical performance to the specifications relative to the rest of the class.