Electromagnetic Soil Moisture Sensor (ESMS)

Final Product Review (FPR)

Senior Design Project

Team 21

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Department of Electrical and Computer Engineering

Meet the Team

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Proposed Idea

- Small scale soil moisture mapping

- Local Farmers
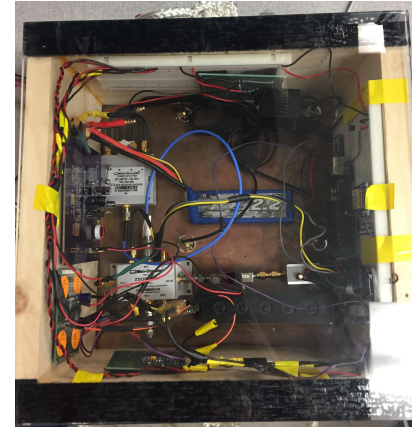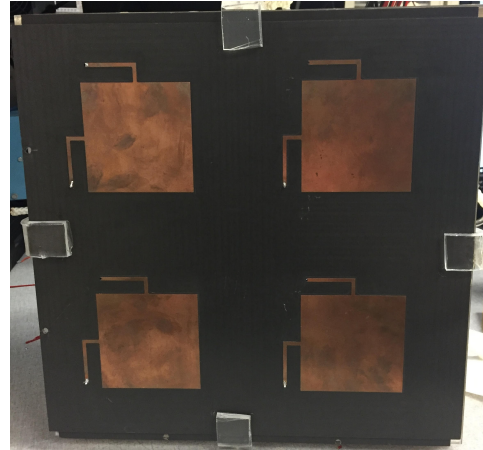
- Wetland Delineation

Current Solutions

- NASA's Advanced Microwave Radiometer (AMR)

- Hand held soil moisture sensors

Proposed Solution

- Total Power Radiometer to measure power radiated by soil

- Correlate Power to a brightness temperature

System Requirments

- Run Time:
  - Minimum of 30 minutes
- Radiometric Sensitivity:
  - $\Delta T < 5$ K
- Weight:
  - Under 5 kg

- Data:
  - Store data for the duration of run time
- Final Map:
  - Easy to interpret map of soil moisture over an area.

Final Product Specs.

- Size
  - All components contained in a 28.8x28.8x10 cm custom box
- Run Time
  - 2 Hours
  - Drawing 400mA from 11.6V battery
  - 4.64 W
- Cost
  - ~ $700 Not including Antenna, BPF

- Weight
  - 3.63 kg total
- Radiometric Sensitivity
  - $\Delta T = 0.81$ K (physical)
  - $\Delta T = 0.6$ K (ADC)
- Final Map
  - < 5s processing time for 30 minutes of data
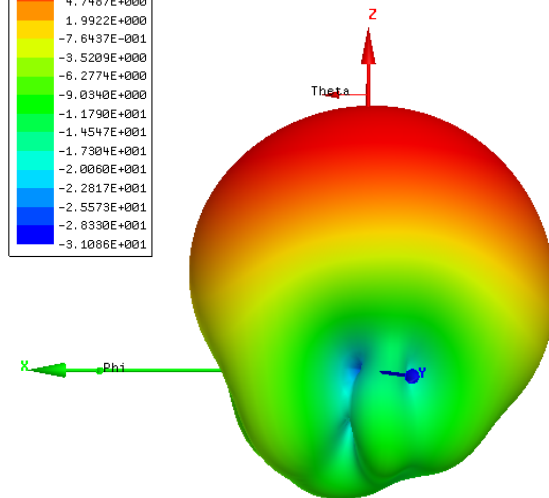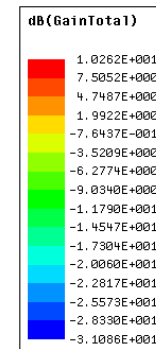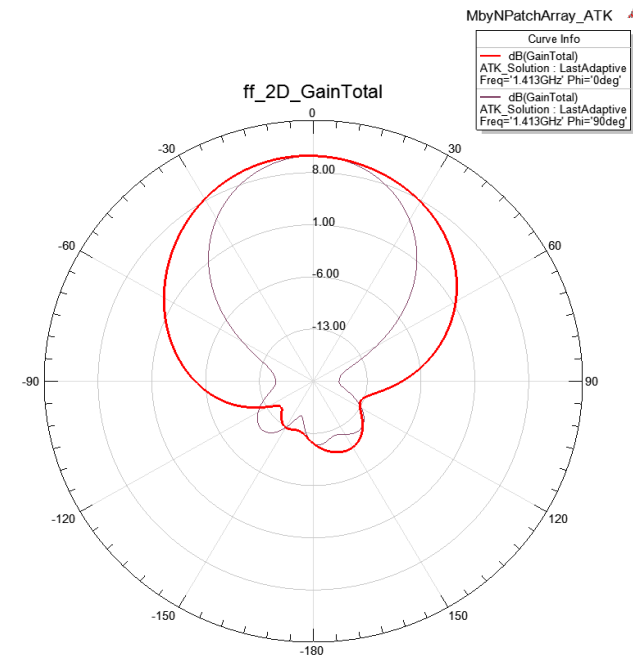
Block Diagram
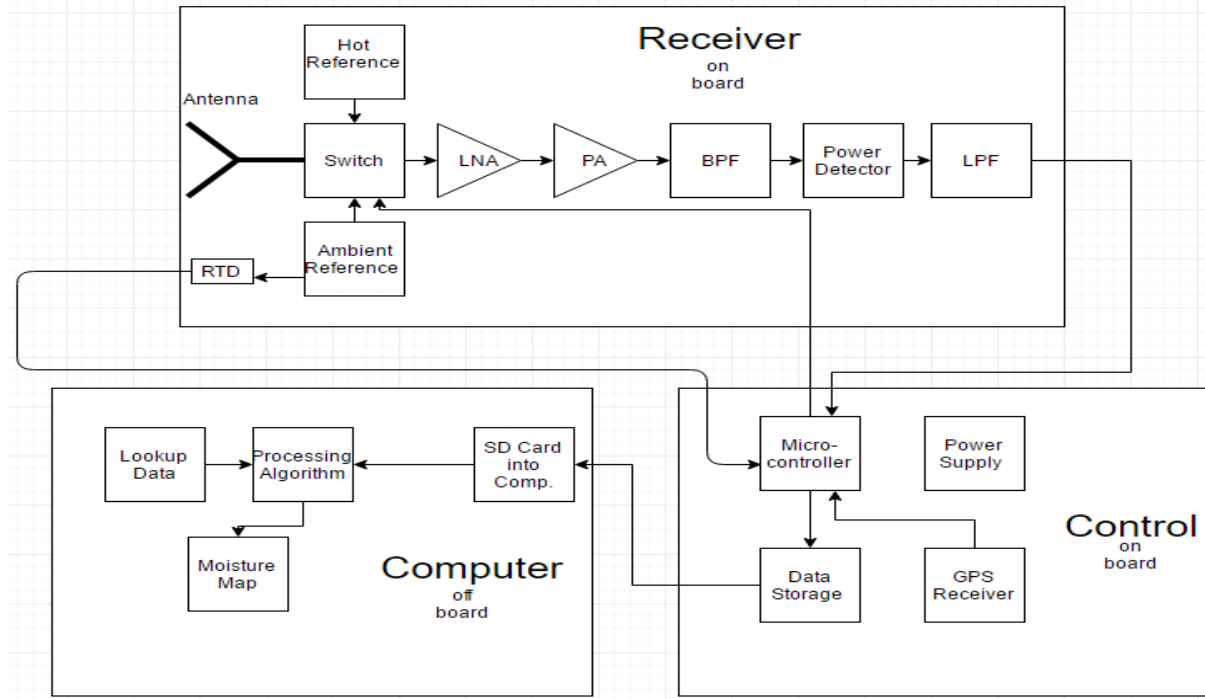
Antenna Radiation Pattern-HFSS

- 2x2 Microstrip Patch Antenna Array
- fc =1.413 GHz
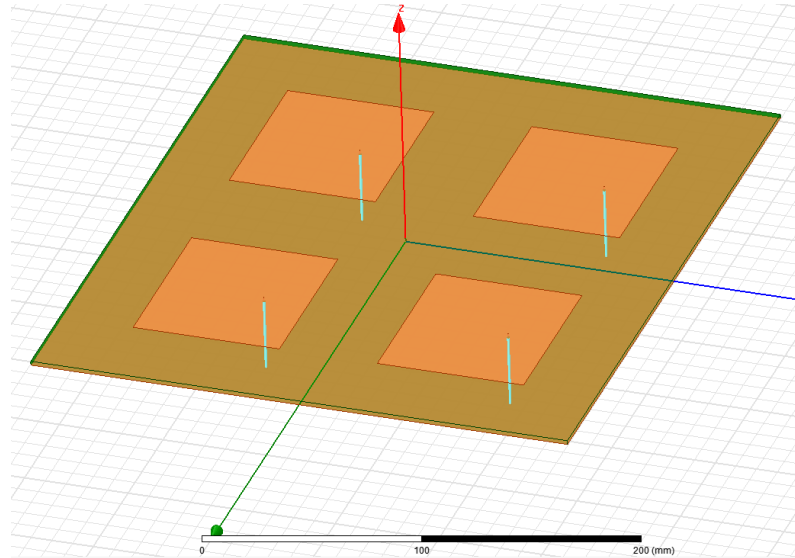
Antenna Lobes

- Half power beam width at 8dB ~60°

- At 10ft, covers circle with radius 5.77 ft

- Area: 104 ft^2

Subsystems

- Receiver Circuit
  - Samples 3 sources: Ambient, Noise Diode, Antenna
  - Noise Figure = 5.42 dB
  - Noise Temperature = 1307.6 K

- Power Distribution
  - Supplies 15v and 5v to active components

- Control
  - Saves Data to SD card
  - Switches between sources
  - Logs GPS and temperature data
  - Upgraded to 15-bit ADC

- Off Board Processing
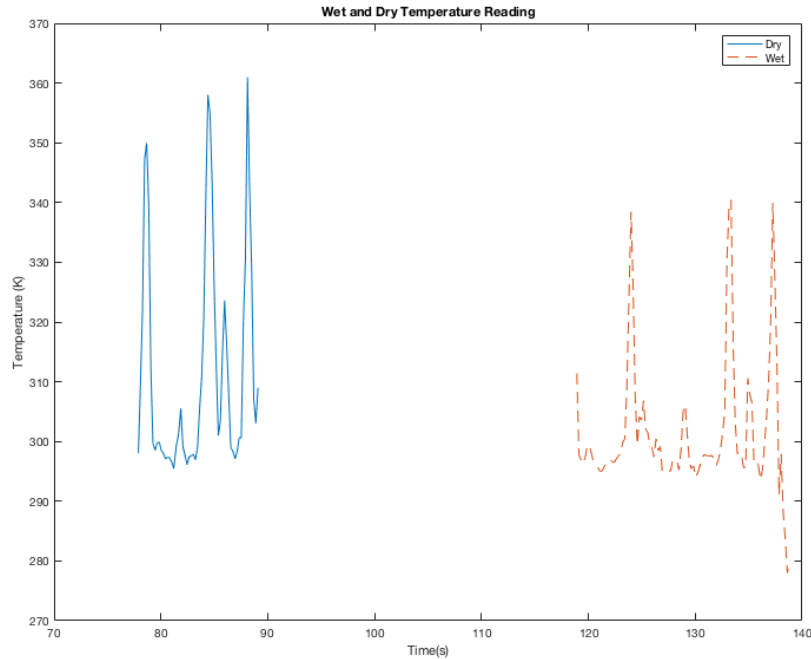 - Calibration
  - Produce Map

Data File

Ambient	Diode	Antenna	Long.	Lat.	Temp	Timer (ms)
24231	16134	24255	4223.60	7231.76	271	657829
24212	15120	24320	4223.60	7231.76	271	658025
24220	14747	25367	4223.60	7231.76	270	658221
24238	17499	24255	4223.60	7231.76	271	658415
24224	15037	24407	4223.60	7231.76	271	658611

Testing Dry vs. Wet Soil

Detecting Dry vs. Wet Soil

- Dry Mean = 311.7 K
- Dry is blue

- Wet Mean = 301.3 K
- Wet is red

Testing with GPS Location

What's Next

- Improve testing system for demo day
- For future SDP Groups:
  - RF PCB
  - Better Area Coverage

Questions, Comments, Suggestions?