Thesis Topics – Prof. Jenn

A. Distributed Digital Arrays With Wireless Beamforming

1. Signal processing, beamforming and calibration (several students)

a. Array beamforming:
   i. Define requirements, preliminary design
   ii. Develop beam search and tracking algorithms and test (probably in Matlab)
   iii. Migrate to National Instruments hardware and Labview
   iv. Test (TBD)

b. Calibration and correction techniques
   i. Tolerance study for array and its components
   ii. Explore calibration and correction techniques that can be applied in the processing stage
   iii. Test (TBD)

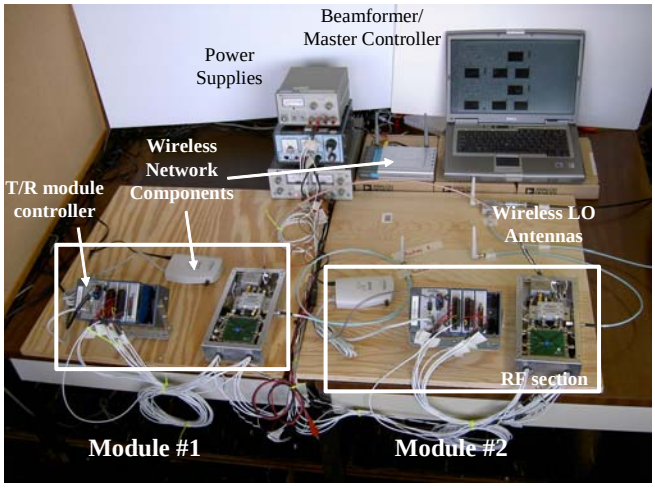
c. Demodulation and processing
   i. Extract modulation (FM, QPSK, pulse train, etc.) depending on application
   ii. Integration, matched filtering, etc. and other processing gains
   iii. Simulate and test (TBD)

2. Timing and phase synchronization techniques

a. Compare "beacon" vs. phased locked loop
b. Study RF pulse train for use in timing and synchronization
c. Define circuits; simulate in Matlab/Simulink
d. Apply to current NI hardware and LabView

3. Networking for Wireless Beamforming (several students)

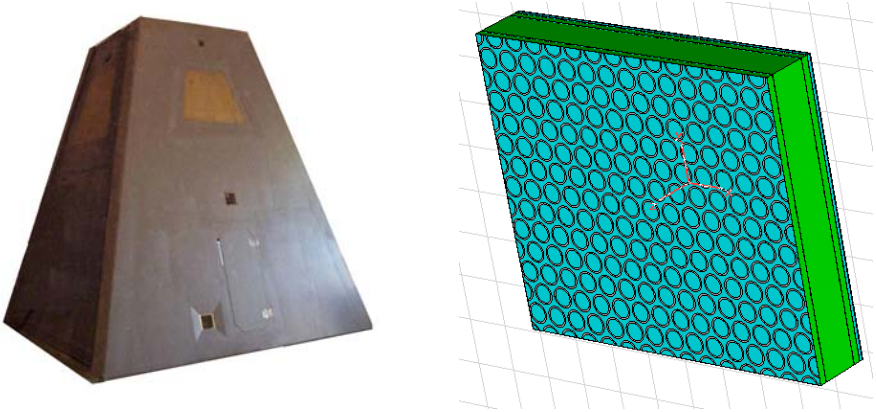
a. Study data transfer requirements (communications vs. radar)
b. Network configuration for wireless beamforming (likely time division duplex, TDD)
c. Simulate to determine hardware requirements
d. How do we reduce the amount of data sent between T/R modules and master controller? Distributed data processing at the T/R module to reduce data transfer



Two element test array for wireless beamforming

B. Aperstructure Design (US only)

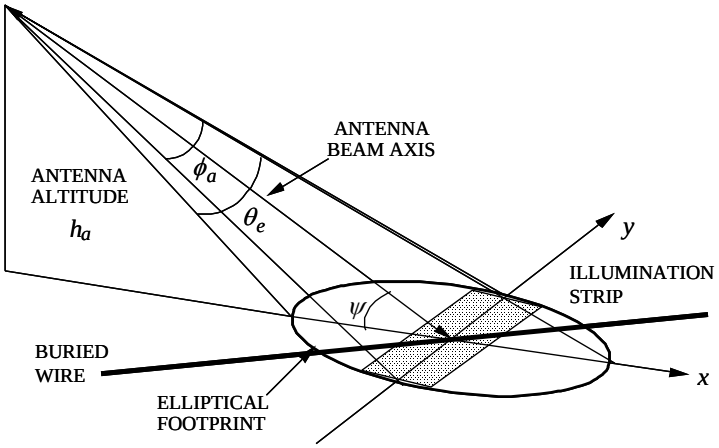
a. Model imbedded phased array elements with Microwave Studio
b. Model frequency selective surfaces with Microwave Studio
c. Combine the array and FSS (tune the combination)
d. Prototype selected pieces (time permitting)
e. Test and measurement (time permitting)



Integrated deckhouse antenna (left) and array panel modeled with FSS (right)

C. Radar for Buried IED Command Wire Detection

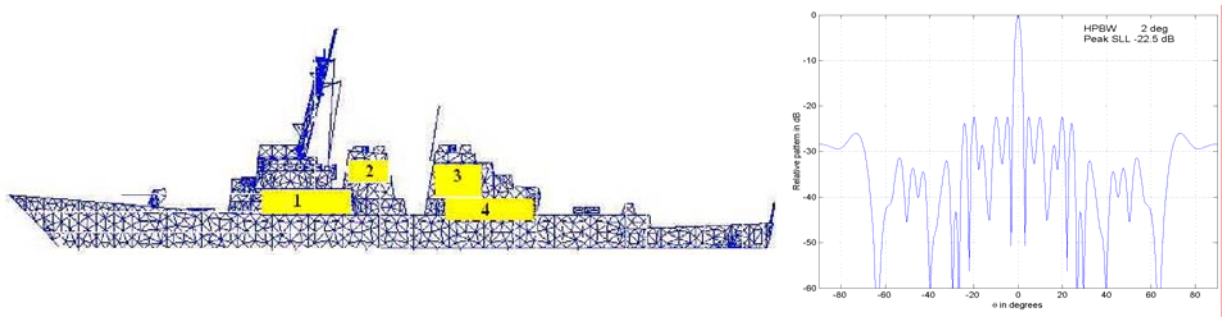
a. System requirements
b. Model ground clutter
c. Model wire scattering
d. System level study with tradeoffs (i.e., radar range equation)
e. Processing to improve SNR, probability of detection



Antenna footprint for wire detection

D. Subarraying Techniques for Large Phased Arrays

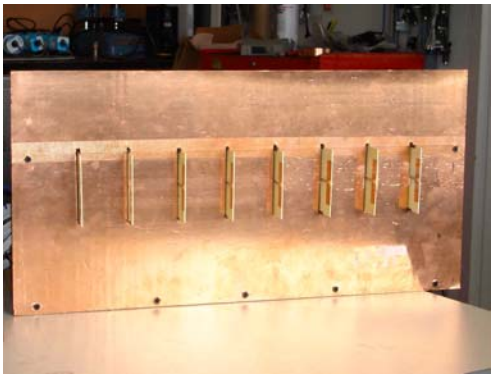
a. Model large arrays on ships with various subarray arrangements (CG(X) and DD(X) type ships)
    i. radiation patterns (grating/quantization lobes)
    ii. radar cross section (Bragg lobes)
b. Techniques to mitigate quantization effects
c. Two-way pattern design for radar applications



Distributed arrays on an AEGIS cruiser (left) and two-way pattern (right)

E. UAV Tracking Array Development and Testing

a. Review requirements (SOCOM)
b. Model digital tracking array system (Matlab)
    i. use actual hardware parameters
    ii. verify design
c. Beamforming, acquisition, tracking and demodulation software
d. Hardware integration (National Instruments)
e. Test (time permitting)
    iii. bench test
    iv. anechoic chamber pattern tests
    v. field test at Camp Roberts



Prototype tracking array

F. Doppler Effects on Phased Arrays

a. Review Doppler effects on phased arrays and apply analysis to extended distributed arrays
b. Perform an analysis to determine if inverse Doppler occurs for phased arrays
c. Investigate displaced phase center arrays (advantages and limitations)