Passive Radar

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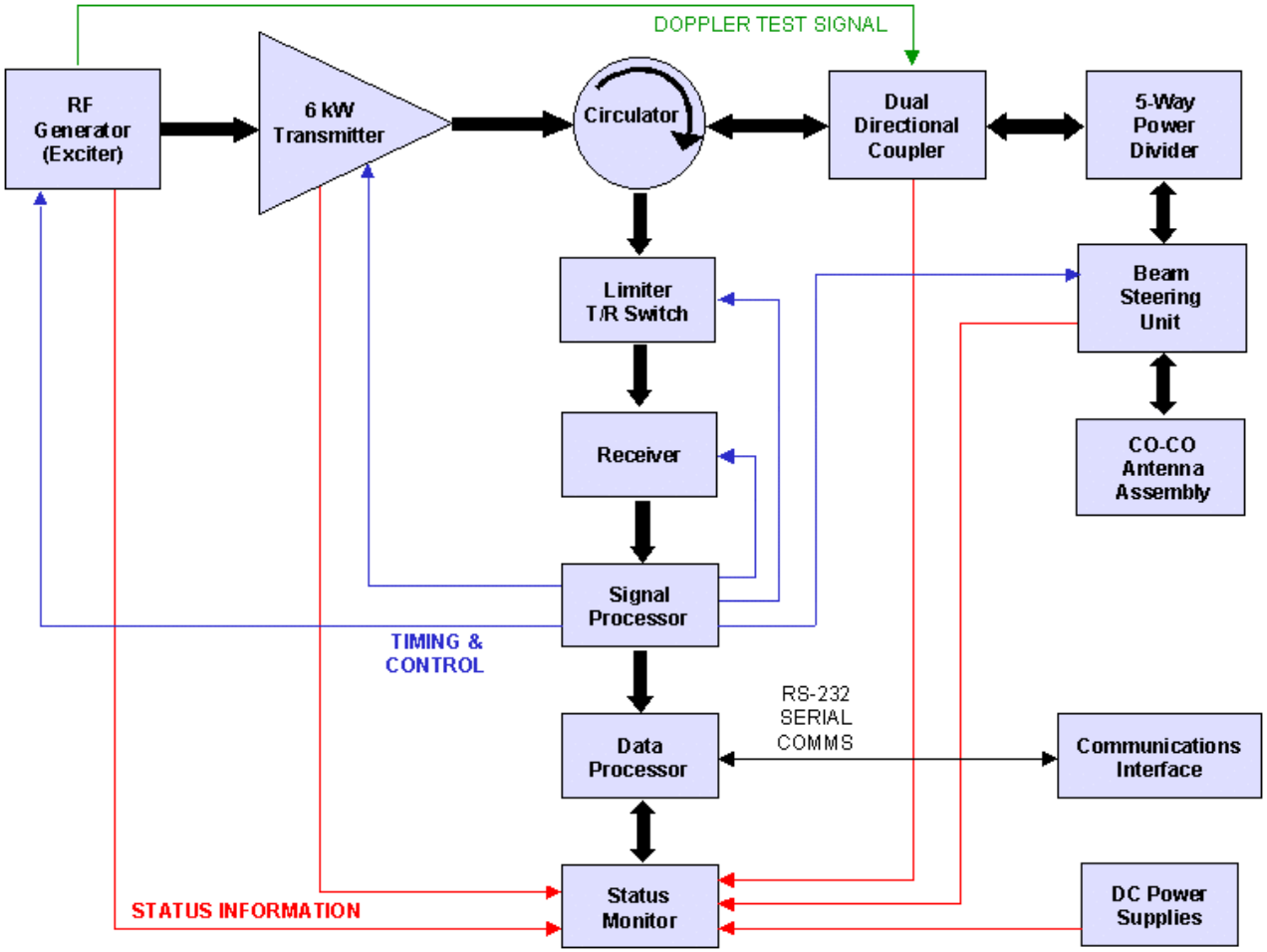
What is RADAR?

- RAdio Detection And Ranging
- A radio transmitter emits an electromagnetic pulse and waits for the echo.
- An object *t* seconds away produces an echo reflection of the transmitted signal, delayed by *t* seconds
- Each reflection scales the amplitude of the wave down by a factor.
- Echoes from objects in the environment consist of *scaled* and *shifted* (or delayed) versions of the originally transmitted pulse.

A Modern Radar Detection System



Passive or Active Radar?

- Active radar systems transmit a known signal.
  - Most systems are active.
  - Such systems can be detected and jammed.
- Passive radar systems rely on *ambient* signals, and their reflections.
  - Signal processing
    - Reference signal and reflection signals
  - Hard to detect or jam.
  - Efficient power usage

Challenges involved in Passive Radar

- Extra signal processing must occur to select and detect the reference signal
- Receiver and transmitter are in different locations
- Reference signal must be filtered out of the input received by the receiver

Goals and Assumptions

- Segment space into regions, and to classify valid signals in each space.
- Select a good reference signal.
  - Fits energy and modulation criterion
- Receiver remains stationary
- Use signals from the FM band
- Simulations will provide much of the environment for refining theories.

Progress

- Radar signal processing theory
  - How can we use reflections to detect objects
  - What constitutes a typical radar system
  - What separates active from passive radar.
- Electromagnetic Wave propagation theory
  - Time delays in reflections
  - Amplitude scaling in reflections
  - Beamforming and wavefronts
- A coherent model of a passive radar system.
- MATLAB code.
  - A radar simulator
  - A beamforming weights generator
  - A beamformer

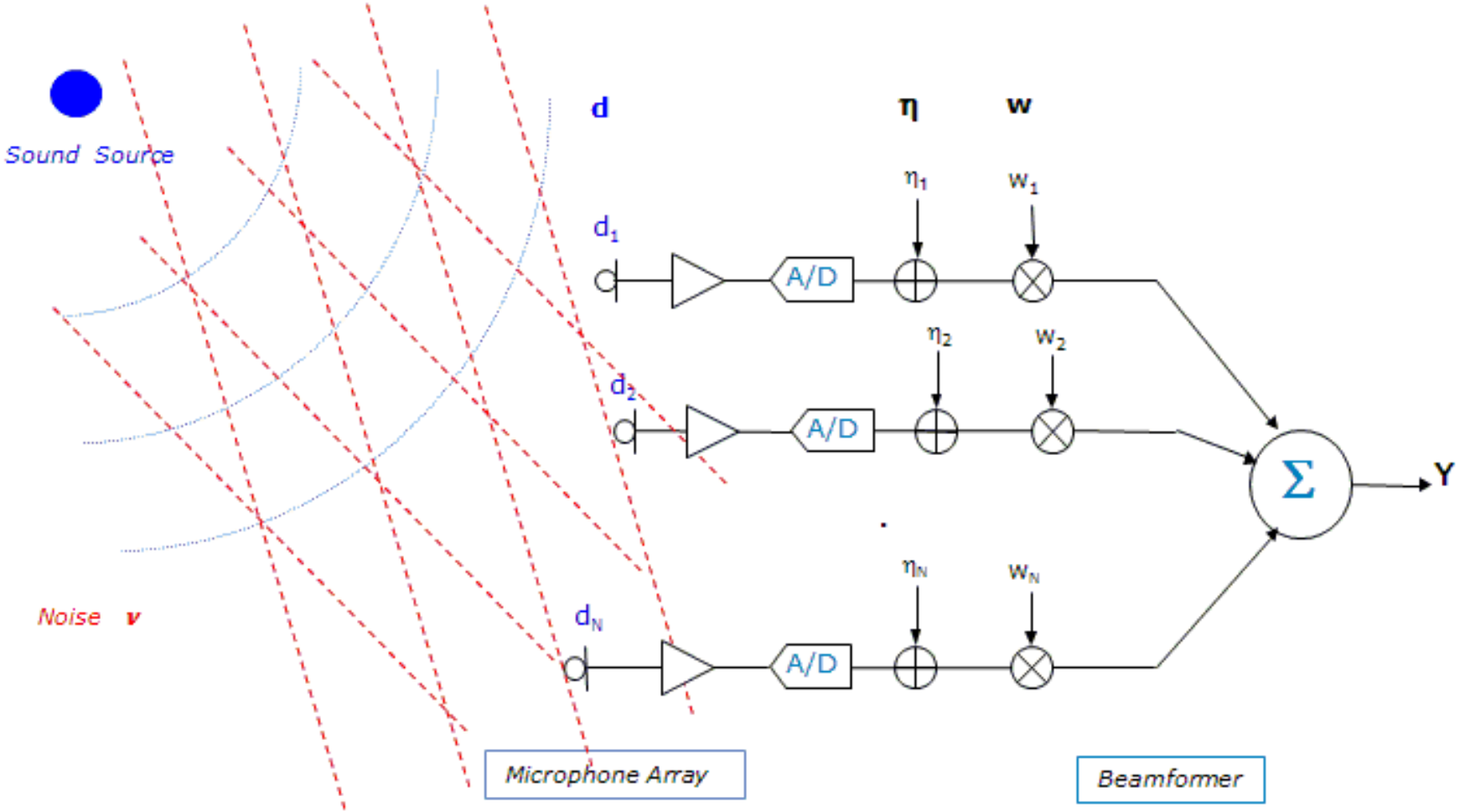
The Current Model

- Beamformer
  - Allows us to sweep the environment spatially
  - Segment space into different regions
- Classifier
  - Determines the properties of ambient signals.
  - Statistically chooses a reference signal.
- Detector
  - Filters out the reference signal
  - Determines the reflections of the reference signal
- Conventional Radar Techniques

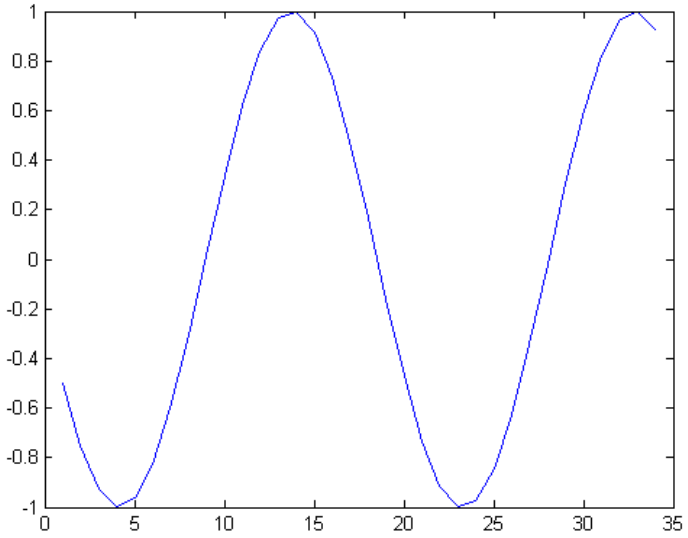
Beamformers

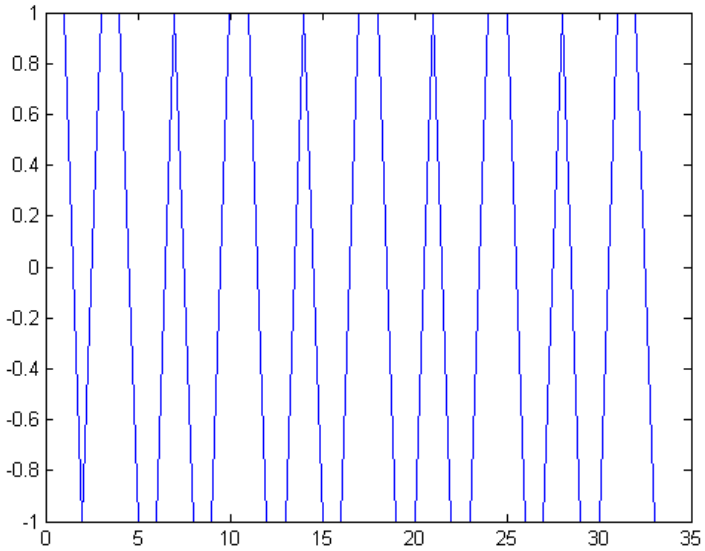
- Typically implemented with a phased array of omnidirectional antennas.
- All electromagnetic plane waves have wavefronts.
- These wavefronts hit different receivers in the phased array at different times, based on the incident angle of the waves.
- By applying digital weights to each antenna, we can digitally steer the array of antennas.

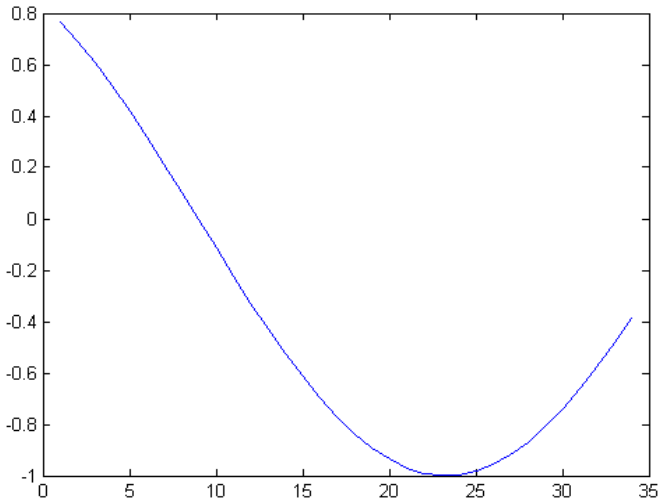
Beamforming System



Simulator Output
3 Transmitters, 3 Point Reflectors, 6 Receivers

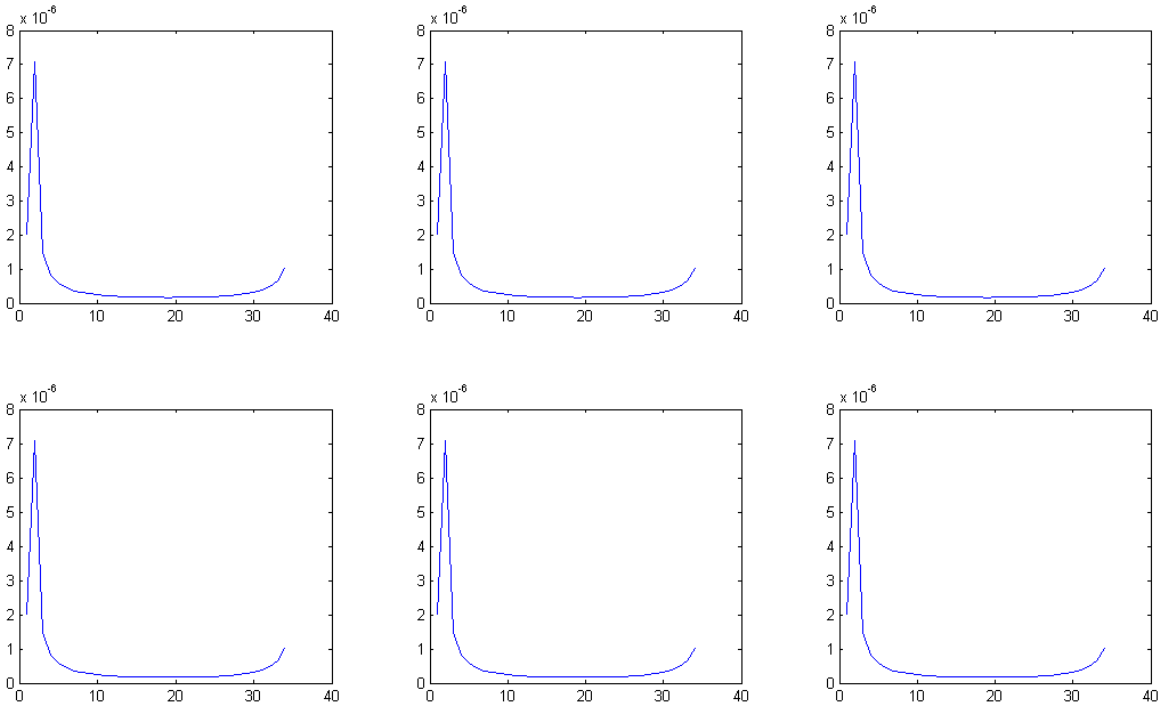






Inputs

Simulator Output
3 Transmitters, 3 Point Reflectors, 6 Receivers



Outputs

Work to be Done

- Segmentation of the environment spatially
- Statistically classify ambient signals
- Analysis of the energy and frequency modulation properties of signals.
- Make a correct choice for a passive radar reference signal.