EE16A - Lecture 19 Notes

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Positioning (Acoustic Locationing)

- Need $d + 1$ known points/distances to determine position in d dimension
- 2D - intersection of 3 circles

Keep track of Time

- Determine distance from time it takes signal to arrive at receiver divided by the speed of the signal
- Need reference time t_o
- Synchronized clocks between receiver and beacon

Time Sampling

- Continuous signal is a function $a(t)\mathbb{R} \mapsto \mathbb{R}$
- Sample the signal every T seconds (sampling period (secs))
- Sample frequency $\frac{1T}{H}z$
- This defines a new **discrete time signal** that is defined only the integers: $a(t), \mathbb{Z} \mapsto \mathbb{R}$
- $a_[n] = a_{CT}(nT_s)$ discrete to continuous
- Compute delay between receiver and beacon in terms of samples and map make to continuous time using the time period (inverse of frequency)
- $y'[n] = y[n - k]$ implies that y' shifts y to the right by k discrete time samples (k sample delay)

Signal Delay Linear Algebra:

- Stack all values of discrete time signals into a vector
- Account for delay by cyclicly shifting down
- Use a Circulant Matrix to do the cyclic shift
- Example:
  - Let y = signal received, a, b, c = signal from beacons a,b,c
  - Let S^{N_k} Circulant Matrices that represent delay from beacon k to receiver
  - Each signal has an attenuation coeff. (not in scope of class)
  - $y = \alpha S^{N_A}a + \beta S^{N_B}b + \gamma S^{N_C}c$
  - Find $N_A, N_B, N_C \rightarrow$ delay $_A$, delay $_B$, delay $_C \rightarrow$ distance $_A$, distance $_B$, distance $_C$
  - Want all $S^{N_k}k$ to be nearly mutually orthogonal
  - Orthogonal vectors have dot product of 0

Orthogonality

- To measure 'similarity' of vectors, use dot products $\rightarrow$ inner product
- Inner product: $\langle \vec{x}, \vec{y} \rangle = x^T y^*$
- y^*: complex conjugate of y
- Complex conjugate of $a + ib = a - ib$ where $i = \sqrt{-1}$
- Complex values not in scope of class, so inner product = dot product for non-complex vectors
- Dot product: $x \cdot y = x^T y$