GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL OF ELECTRICAL ENGINEERING

ECE 4271 SPRING 2016

Topics for Final Project and Guidelines Ideas

1.0 Compressive sensing applications in Inverse Spatial Aperture Radar (ISAR)

2.0 Compressive sensing application in Image Processing

3.0 Estimation of emitter in 1-D Spatial Array Configuration

Project Description: Given a coplanar system of multiple transmitters and multiple receivers (1D for RX), analyze received signal at each receiver to estimate:

- The number of transmitters (sources).
- Frequency components of the received signals.
- Direction of arrival (DOA) of each transmitter with respect to one of the receivers (RX1).

4.0 Code Division Multiple Access (CDMA) through phase-shift keying (PSK) in Matlab:

4.1 Generation of orthogonal codes

4.2 PSK line encoding

4.3 Noise Generation

Project Description: The goal of this project would be to simulate Code Division Multiple Access (CDMA) through phase-shift keying (PSK) in Matlab. Four input sequence are generated randomly. Each sequence contains a sequence of 1, 0, or -1. The sequences are then combined using CDMA to generate sequences of integers from -4 to 4. These sequences are then coded using phase-shift keying of 9 different phases. Noise is then added to the output signal. At the receiver end the signal is reassembled into sequences of integers from -4 to 4 using the Goertzel algorithm. This data is then decoded using CDMA. Performance is evaluated based on the error rate vs. SNR.

5.0 Simulation of a Radar (velocity) system using Matlab.

Project Description: The Radar velocity detection problem is essentially composed of the following tasks:

5.1 Generate an appropriate signal to be transmitted to the hypothetical object.

5.2 Artificially generate a received signal by creating a frequency shifted version of the transmitted signal and adding white noise to it.

5.3 Detect the amount of frequency shift between the received and transmitted signals.

5.4 Calculate the velocity from this shift by the equation given above.

5.5 Compare the calculated velocity to the true velocity (which would be known to us).

6.0 Demodulator in communication system

1) AM demodulator using envelop detector
2) FM demodulator using phased locked loop (PLL)

- Students choose one music file and use freeware (e.g. goldwave) to cut the music for short time period
- Use MATLAB function waveread() to load wave data of the music file. This data will be used for the test of implementation 1) and 2)
- interptf() function can be used for upsampling if needed
- 1) Proper selection of R (resistance) and C (capacitance) is important for correct demodulation
- 2) Linear negative feedback should be used for PLL

7.0 Image deconvolution problem

- A kernel is defined to obtain convolved image for the test. It is assumed that we do not have any information about original image and our goal is to estimate original image using kernel and convolved image data
- e.g. Y : 305×305 image , W = 50×50 image,

  The image Y is created by convolving 256×256 image X with W. Our goal is to find what X must have been.

  $N \times N$ image X can be turned in to a vector x of length N^2 for easy matrix inversion operation

  x = reshape(X, N^2, 1);
- 2D convolution should be implemented and also transpose of 2D convolution may be needed depending on the algorithm used for matrix inversion
- One possible decent way to handle this problem is using ‘Steepest descent algorithm’

8.0 Performance comparison of QPSK versus pi/4-DQPSK modulation

- pi/4-DQPSK is a variant of QPSK which uses same constellations as QPSK but rotated by 45 degree
- Pi/4- DQPSK has phase shifts at $\pm\pi/4$ and $\pm 3\pi/4$. Thus, there is no 180 degree phase shift in pi/4-DQPSK and which also means that there is no abrupt magnitude transition in pi/4-DQPSK
- Performance comparison should be done in a variety of ways

e.g. Performance comparison in the presence of Gray coding

Different fading channels can be considered (AWGN channel, Rayleigh fading channel)

9.0 Performance comparison of coherent, differential and non-coherent modulation

- Observe the performance degradation depending on detections such as coherent BPSK, differential PSK and non-coherent BPFSK

Understanding of demodulation algorithms for each scheme is required and pros and cons of each algorithms are investigated