The overall goal of this project is to learn about narrowband adaptive beamforming. You will implement several adaptive beamforming algorithms and analyze their performance using simulated data. Two of the beamformers you will implement are modifications of a standard algorithm. Since these modifications are described in IEEE conference papers, you will have the opportunity to familiarize yourself with the literature and improve your technical reading skills.

**Background**

The goal of adaptive beamforming is to reject interference while allowing the signal in the direction of interest to pass with unity gain. This project will consider the problem of designing narrowband adaptive beamformers for passive detection and direction of arrival estimation. Specifically you will implement the following narrowband beamforming algorithms:

- Minimum Power Distortionless Response (MPDR) beamformer described by Van Trees [1]
- Dominant Mode Rejection Beamformer (DMR) defined by Abraham and Owsley [2] and discussed by Van Trees [1]
- Eigenvector/Beam Association and Excision (EBAE) form of DMR proposed by Kogon [3]
- Robust DMR with mismatch protection proposed by Cox and Pitre [4] (Section 4 of the paper)
- Conventional beamformer w/Dolph Chebychev weights (for comparison with the adaptive algorithms)

You will use the simulation example described by Kogon [3] to compare the algorithms.

**Project Definition**

**A. Implementation and Basic Testing**

In this part you will implement the 5 narrowband beamformers in Matlab and develop code to simulate narrowband planewave signals and noise. (You may modify/reuse code you have developed for previous assignments.)

**B. Analysis**

For this part you will use the simulation example proposed by Kogon [3].

1. Ensemble statistics: perform an analysis similar to that shown in Figure 1 of Kogon’s paper. In addition to the beamformers Kogon implements, you should include the Cox’s robust DMR algorithm.
2. Estimated statistics: analyze the performance of these algorithms when the statistics have to be estimated from snapshots.
iii. Mismatch: consider the performance of these beamformers when there is a mismatch due to inaccurate knowledge of the sensor positions.

Note: additional details on the estimated statistics and mismatch analysis will be provided on Nov. 30.

C. Report
Your report should include the following sections:

- Executive summary: a 1-page summary of your key results and what you learned from the project.
- Implementation and Basic Testing: description of your implementation of these beamformers and the basic testing you did to verify that your code is working.
- Appendix: listing of the Matlab code you develop for the project. Your report may include other appendices if you wish, but the only required appendix contains your code.

References


