Mini-Project: MUSIC for Direction of Arrival Estimation

Goals of the Mini-Project

Each mini-project proposes to examine in deep one of the statistical signal and data processing tools seen in class.

The goals of the mini project are:

- Implement one (or more) of the tools seen in class;
- Explore more advanced / specific tools related to the tools seen in class, via scientific literature and numerical implementation;
- Present the tools to the class with a demo and a performance comparison.

Such goals are achieved via specific tasks:

- Work as a team (everyone must contribute and be aware of every detail of the accomplished work);
- Implement the assigned tool seen in class (Python or Matlab);
- Test it on simulated and real data (real data will be provided);
- Submit a report on the test of the tool on simulated and real data (**Assignment #1**);
- Explore other advanced tools, not presented in class, outperforming the assigned tool (start from the suggested literature, and pursue the research of information on additional papers & books);
- Submit a report on the advanced tools (**Assignment #2**);
- Implement the new tools (Python or Matlab);
- Prepare a demo (on simulated and real data) comparing the tools;
- Prepare about 5 slides to present to your colleagues the tools, their comparison, a demo, and your conclusions.
- Submit the demo (with instructions), the presentation, and a short report (min 6 pages, max 10 page) on the mini-project (**Assignment #3**);

You will be evaluated on these tasks, on the quality of problem solutions, on the quality of your implementation, on the quality of the presented demo & results.

Description of the Mini-Project

MUSIC can be used without modification for the estimation of Direction Of Arrival (DOA), assuming that there is a known number of sources and that the sources are uncorrelated. You will find a detailed explanations in this report "DOA estimation based on MUSIC algorithm" by H. Tang.

In particular, as well as to complete the general tasks for mini-projects, we invite you to

- Derive an expression for the incoming wave, using far filed approximation and other standard assumptions, for example described in the report DOA estimation based on MUSIC algorithm by H. Tang.

- Use standard MUSIC algorithm to recover DOA for both uncorrelated and correlated sources. Observe what problems arise.
- Implement an improved MUSIC algorithm, as presented in the paper "DOA Estimation Based on Improved MUSIC Algorithm", by Z. Dai and Y. Du, and compare its performances on correlated and uncorrelated sources.

References:

- H. Tang. *DOA estimation based on MUSIC algorithm*.
- Z. Dai, and Y. Du. *DOA Estimation Based on Improved MUSIC Algorithm*.
- A. Paulraj, B. Ottersten, R. Roy, A. Swindlehurst, G. Xu and T. Kailath. *Subspace Methods for Directions-of-Arrival Estimation*. Handbook of Statistics, Vol. 10, K. Bose and C. R. Rao, eds., Elsevier, 1993.