

Electrical and Electronics Engineering Department, METU
EE604 SENSOR ARRAY SIGNAL PROCESSING

Spring 2016

Description:

The objective of this course is to present the theoretical and practical aspects of array signal processing, which includes, direction-of-arrival estimation, beamforming, source localization and calibration. The materials covered in this course give sufficient background to do research and contribute in these fields. Some of the topics that are covered in this course are array models, assumptions, performance bounds, classical and super-resolution techniques of direction-of-arrival estimation, array mapping, wideband processing, beamforming, localization and calibration.

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Course Outline

Week 1. Introduction, array geometry and mathematical model,
Week 2. Narrowband model and assumptions, performance analysis
Week 3. Cramer Rao Bound, practical methods of direction of arrival
Week 4. Monopulse, Watson-Watt, Interferometer, Pseudo-Doppler techniques
Week 5. Optimum and close to optimum methods of direction of arrival estimation, Spectral-MUSIC, Root-MUSIC, ESPRIT, Min-Norm methods
Week 6. Forward-backward Spatial Smoothing, Stochastic and Deterministic Maximum likelihood methods,
Week 7. Beamspace processing, Delay-and-sum beamforming, Filter-and-sum beamforming,
Week 8. Capon, MVDR beamforming, Sample Matrix inversion, Robust beamforming, Generalized Sidelobe Canceller
Week 9. Virtual Array Processing, Array Interpolation, Generalized Rotational Signal Subspace method, Manifold Separation
Week 10. Wideband model and wideband processing, Coherent and Noncoherent Wideband Processing
Week 11. Source localization, Triangulation, Least Squares methods, Error Ellipse
Week 12. Stansfield, Maximum likelihood methods, Single-Site Location Estimation
Week 13. Time-difference of arrival techniques for source localization
Week 14. Calibration, Online and Offline calibration

Grading: Attendance: %5, Midterm: %25, Final : %30, Homework: %15, Project: %25

Requirement For Final Exam: Each student should take the midterm examination. Attendance to course should be at least 50%.

Textbooks:

1. Harry L. Van Trees, *Optimum Array Processing*, John Wiley & Sons, Inc., NY, 2002.
2. T. Engin Tuncer, Benjamin Friedlander, *Classical and Modern Direction of Arrival Estimation*, Academic Press, 2009.
3. Sathish Chandran, *Advances in direction-of-arrival estimation*, Artech House, Inc., 2006.

Reference Materials

1. Petre Stoica, Randolph Moses, *Spectral Analysis of Signals*, Prentice Hall, 2005.
2. Jian Ji, Petre Stoica, *Robust Adaptive Beamforming*, Prentice Hall, 2005.
3. Don. H. Johnson, Dan. E. Dudgeon, *Array Signal Processing: Concepts and techniques*, Prentice Hall, 1993.
4. Richard A. Poisel, *Electronic Warfare Target Location Methods*, Artech House, 2005.