Master’s thesis proposal on

Parametric spectral estimation using convex optimization

Department of Electrical Engineering, Signal Processing.

Project description
Estimating the frequency, amplitude and damping parameters of sinusoidal signals from noisy measurements is an important part in many applications such as radar, sonar and wireless communication. Because of its many applications the problem has been extensively investigated in the past. To determine the unknown parameters by a direct minimization of a quadratic data term leads to a non-convex problem which is difficult to solve using non-linear programming methods when the number of sinusoidal components is large. If the measurements are formed into a Hankel matrix, then in the ideal noise free case, the rank of the Hankel matrix will correspond to the underlying system order and properties in the Hankel structure can be used to directly calculate the sinusoidal signal parameters without non-linear programming. Therefore, the problem can instead be formulated as a least squares optimization problem to find a Hankel matrix which approximates the matrix of measurement has a pre-determined rank. This kind of optimization problems can be solved in multiple ways and new methods has recently been introduced in the literature.

Objective:
The thesis will:

1. Evaluate different formulations of the optimization problem and how it affects the accuracy of the estimation.
2. Compare optimization solvers in terms of robustness and computational properties.
3. Investigate how well the proposed methods handle special cases such as missing measurement values, e.g. the missing data case.

Prerequisites:
Background in signal processing and/or optimization is recommended.

Further information:
This thesis is suitable for one or two students.

Supervisors: Jacob Klintberg, Tomas McKelvey.
Examiner: Tomas McKelvey

Send your application to tomas.mckelvey@chalmers.se or jacobkl@chalmers.se. Attach your CV and a transcript of your course achievements.

\[1\] A Hankel matrix has equal elements on the anti-diagonal.