CCIT Report #402 October 2002

Sequential-Joint Estimation of Signal and Parameters Using the Unscented Kalman Filter with Application to Single- and Multi-Microphone Speech Enhancement

Sharon Gannot

Department of Electrical Engineering, Technion — Israel Institute of Technology,
Technion City, Haifa 32000, Israel
E-mail: gannot@siglab.technion.ac.il;
Tel.: +972 4 8294756; Fax: +972 4 8323041.

Marc Moonen

Department of Electrical Engineering, ESAT-SISTA
K.U.Leuven,
Kasteelpark Arenberg 10,
3001 Leuven-Heverlee, Belgium
E-mail: marc.moonen@esat.kuleuven.ac.be

I. Introduction

The problem of estimating both signals and parameters arises in many applications, such as,

- Sensor array direction finding.
- Multi path distinction.
- Single microphone signal enhancement.
- Multi microphone signal enhancement.

The most commonly used procedure for solving this estimation problem, when a statistical model with unknown parameters is given, is the *estimate-maximize* (EM) method [1]. This method is essentially an iterative solution for the *maximum-likelihood* (ML) parameter estimation. The signal (or its statistics) estimation is usually a by-product of the algorithm. The ML estimator looks for the parameters which explain the observation in the best way,

$$\max_{\boldsymbol{\theta}} \log f_{\boldsymbol{Z}}(\boldsymbol{z};\boldsymbol{\theta}) \rightarrow \hat{\boldsymbol{\theta}}_{\mathrm{ML}}$$

where, $\boldsymbol{z}$ is the *Observed data* (measurements). The iterative solution works with the *complete data* notation. Let,

$$\boldsymbol{z} = \mathcal{H}(\boldsymbol{y})$$

where, $\boldsymbol{y}$ is the *Complete data* and $\mathcal{H}$ is some arbitrary non-invertible transform. Then, instead of solving the original problem, we might solve the following problem.

$$\max_{\boldsymbol{\theta}} \log f_{\boldsymbol{Y}}(\boldsymbol{y};\boldsymbol{\theta}) \rightarrow \hat{\boldsymbol{\theta}}_{\mathrm{ML}}$$

This is done by applying the following iterations