

An Introduction to Track-to-Track Fusion and the Distributed Kalman Filter

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FORM

The tutorial will cover a half-day slot. All registered participants can obtain the slides as a download link when requested by email.

INTENDED AUDIENCE

The intended audience are engineers, PhD students, or interested people who are working in the field of distributed sensor data fusion. The algorithmic and theoretical background of track-to-track fusion, tracklet fusion, and the distributed Kalman filter should be of interest for the audience. Problems, questions and specific interests are welcome for an open discussion.

DESCRIPTION

The increasing trend towards connected sensors (“internet of things” and “ubiquitous computing”) derive a demand for powerful distributed estimation methodologies. In tracking applications, the “Distributed Kalman Filter” (DKF) provides an optimal solution under certain conditions. The optimal solution in terms of the estimation accuracy is also achieved by a centralized fusion algorithm which receives either all associated measurements or so-called “tracklets”. However, this scheme needs the result of each update step for the optimal solution whereas the DKF works at arbitrary communication rates since the calculation is completely distributed. Two more recent methodologies are based on the “Accumulated State Densities” (ASD) which augment the states from multiple time instants. In practical applications, tracklet fusion based on the equivalent measurement often achieves reliable results even if full communication is not available. The limitations and robustness of the tracklet fusion will be discussed.

At first, the tutorial will explain the origin of the challenges in distributed tracking. Then, possible solutions to them are derived and illuminated. In particular, algorithms will be provided for each presented solution.

The list of topics includes: Short introduction to target tracking, Tracklet Fusion, Exact Fusion with cross-covariances, Naive Fusion, Federated Fusion, Decentralized Fusion (Consensus Kalman Filter), Distributed Kalman Filter (DKF), Debiasing for the DKF, Distributed ASD Fusion, Augmented State Tracklet Fusion.

PREREQUISITES

Participants should have some background knowledge on basic operations in stochastic theory and linear algebra.

BIO OF THE PRESENTER

Felix Govaers received his Diploma in Mathematics and his PHD with the title “Advanced data fusion in distributed sensor applications” in Computer Science, both at the University of Bonn, Germany. Since 2009 he works at Fraunhofer FKIE in the department for Sensor Data Fusion and Information Processing where he was leading the research group “Distributed Systems” for three years. Since 2017 he is the deputy head of the department “Sensordata and Information Fusion”. The research of Felix Govaers is focused on data fusion for state estimation in sensor networks and non-linear filtering. This includes track-extraction, processing of delayed measurements as well as the Distributed Kalman filter and track-to-track fusion.