

Bonn, October 10th – 12th, 2017



11th Symposium *Sensor Data Fusion: Trends, Solutions, and Applications*

Technical Program

Prior to its technological realization or the scientific reflection on it, sensor data fusion is an omnipresent capability. The result is a mental model of their individual environment, the basis of behaving appropriately. SDF Symposium 2017, the 11th in a row of annual conferences, addresses numerous application aspects of sensor data fusion, as well as methodology oriented topics. Its 24 presentations are grouped into 8 sessions. Particular emphasis is placed on advances in the theory of estimation and tracking, emitter localization, ground surveillance, resource management, and selected aspects of higher-level fusion. The contributions from industry, academia, and research institutions let us expect an exchange of ideas, lively discussions, and mutual cross-fertilization. For more detailed information see: www.fkie.fraunhofer.de/sdf2017.

Location: Universitätsclub Bonn e.V., Konviktstr. 9, 53113 Bonn, Germany. www.uniclub-bonn.de

Organisation

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Day 1 – Tuesday October 10th

Start of SDF Symposium 2017

09:00 – 10:00 Registration
10:00 – 10:30 Opening

Session #1: Estimation Theory and Target Tracking I

10:30 – 11:00 **Umut Orguner**
Approximate Analytical Solutions for the Weight Optimization Problems of CI and ICI

11:00 – 11:30 **Roy Streit**
Analytic Combinatorics in Multiple Object Tracking

11:30 – 12:00 **Muhammad Altamash Khan, Allan De Freitas, Lyudmila Mihaylova, Martin Ulmke, and Wolfgang Koch**
Bayesian Processing of Big Data using Log Homotopy Based Particle Flow Filters

Session #2: Automotive Applications I

13:30 – 14:00 **Ole Schumann, Markus Hahn, Jürgen Dickmann, and Christian Wöhler**
Comparison of Random Forest and LSTM Performances in Classification Tasks Using Radar

14:00 – 14:30 **Martin Michaelis, Philipp Berthold, Daniel Meissner, and Hans-Joachim Wünsche**
Heterogeneous Multi-Sensor Fusion for Extended Objects in Automotive Scenarios Using Gaussian Processes and a GMPHD-Filter

14:30 – 15:00 **Philipp Berthold, Martin Michaelis, Thorsten Luettel, Daniel Meissner, and Hans-Joachim Wünsche**
Radar Reflection Characteristics of Vehicles for Contour and Feature Estimation

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Session #3: *Navigation and Localization I*

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| 15:30 – 16:00 | Manuel Stübler, Stephan Reuter, and Klaus Dietmayer
<i>A Continuously Learning Feature-based Map using a Bernoulli Filtering Approach</i> |
| 16:00 – 16:30 | Christian Steffes, Wolfgang Konle, and Wolfgang Koch
<i>TDOA/TOA-based Geolocation using ADS-B Transponder Signals - Experimental Results</i> |
| 16:30 – 17:00 | Nikolai Kronenwett, Maxim Köhler, Jan Ruppelt, and Gert F. Trommer
<i>Personal Localization of Task Force Members in Urban Environments</i> |
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| 17:45 | Time of gathering for the Guided Tour
<i>Guided tour through the city of Bonn to the icebreaker reception at Brewery Machold at Heerstr. 52.</i> |
| 19:00 | Icebreaker Reception
<i>Brewery Machold</i> |



Day 2 – Wednesday October 11th

Keynote Talk

Lennart Svensson

09:00 – 10:30

Sets of trajectories, conjugate prior densities and metrics: three general tools for multi-target tracking



In this presentation, we will introduce three key tools for Bayesian multi-target tracking (MTT): sets of trajectories, conjugate prior densities and metrics. First, we will describe why sets of trajectories make up a natural representation for Bayesian MTT. In particular, we will elaborate on the conceptual advantages with this representation compared to existing methods and give examples of how it can be used to obtain tractable tracking algorithms. Second, we will provide an overview of conjugate prior densities for multi-target tracking. Conjugate prior densities have recently emerged as a key enabler for the development of efficient MTT algorithms. In MTT, all conjugate priors share similar components, and we will illustrate the relations between the different priors and provide insights into the pros and cons of the underlying priors and the corresponding algorithms. Finally, we will discuss two recently proposed metrics for performance evaluation of multi-target filters and MTT algorithms, respectively. These metrics have been designed to capture aspects that traditional MTT literature highlights as important indicators of performance. The first metric, the GOSPA metric, is a metric on sets of targets and penalises localisation errors for detected targets, false and missed targets. The second metric is a metric on sets of trajectories and additionally includes penalties for trajectory-switches. The first metric is suitable to evaluate multi-target filters whereas the second metric can be used to evaluate MTT algorithms.

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Session #4: Multi Sensor Fusion and Distributed Estimation

- 10:30 – 11:00 **Michael Ulrich, Florian Maile, Andreas Löcklin and Bin Yang, Bernhard Kleiner, and Nils Ziegenspeck**
A Model for Improved Association of Radar and Camera Objects in an Indoor Environment
- 11:00 – 11:30 **Sascha Graebnitz, Michael Mertens, and Francesco Belfiori**
Sequential Data Fusion Applied to a Distributed Radar, Acoustic and Visual Sensor
- 11:30 – 12:00 **Chee-Yee Chong**
Forty Years of Distributed Estimation
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Session #5: Video Processing and Process Refinement

- 13:30 – 14:00 **Hayder M. Amera, Christos Tsotskasb, Matthew Hawesa, Patrizia Francob, and Lyudmila Mihaylova**
A Game Theory Approach for Congestion Control in Vehicular Ad Hoc Networks
- 14:00 – 14:30 **Achim Kuwertz, Jennifer Sander, Uwe Pfirmann, and Sergius Dyck**
High-Level Information Management in Joint ISR based on an Object-Oriented Approach
- 14:30 – 15:00 **Yifan Zhou and Simon Maskell**
Moving Object Detection Using Background Subtraction for a Moving Camera with Pronounced Parallax
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Session #6: Navigation and Localization II

- 15:30 – 16:00 **Sebastian Kram, Christian Nickel, Lucila Patino-Studencki, Jochen Seitz, and Jörn Thielecke**
Spatial interpolation of Wi-Fi RSS Fingerprints using model-based Universal Kriging: Potential and Limitations
- 16:00 – 16:30 **Jorge Trincado, Jorge Sánchez, Jose Manuel Molina, and Jesús García**
Analysis of real data with sensors and estimation outputs in configurable UAV platforms
- 16:30 – 17:00 **James A. Douthwaite, Allan De Freitas, and Lyudmila S. Mihaylova**
An Interval Approach to Multiple Unmanned Aerial Vehicle Collision Avoidance
- 17:00 **Get Together**
Piano recital and Dinner

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Day 3 – Thursday October 12th

Session #7: Estimation Theory and Target Tracking II

- 09:00 – 09:30 **Stefano P. Coraluppi, Craig A. Carthel, and Alan S. Willsky**
Multi-Sensor Tracking of Move-Stop-Move Targets
- 09:30 – 10:00 **Sebastian Woischneck and Dietrich Fränken**
Range/Doppler Tracking with the Kalman Filter and its Relatives – A Comparative Study
- 10:30 – 11:00 **Hoe Chee Lai, Rong Yang, Gee Wah Ng, Felix Govaers, Martin Ulmke, and Wolfgang Koch**
Bearings-Only Tracking and Doppler-Bearing Tracking with Inequality Constraint
- 11:00 – 11:30 **Vincent Nimier and Kaouthar Benameur**
Supervised data fusion algorithm
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Session #8: Automotive Applications II

- 12:00 – 12:30 **Florian Particke, Markus Hiller, Lucila Patino-Studencki, Christoph Sippl, Christian Feist, and Jörn Thielecke**
Multiple Intention Tracking by a Generalized Potential Field Approach
- 12:30 – 13:00 **Josef Steinbaeck, Christian Steger, Gerald Holweg, and Norbert Druml**
Next Generation Radar Sensors in Automotive Sensor Fusion Systems
- 13:00 **End of SDF Symposium 2017**
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Stone Soup Workshop

- 14:00 – 16:00 **Paul Thomas (DSTL, UK)** gives an introduction to the Stone Soup Working Group (see description on the next page). There will be an open discussion afterwards.
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Stone Soup Workshop at SDF 2017

An Open Source framework for Tracking and State Estimation

Tracking and state estimation researchers and practitioners have a requirement to benchmark their own work to objectively assess which algorithms meet requirements. However this means a lot of effort recreating state-of-the-art algorithms rather than developing new approaches.

Therefore an international collaborative initiative has started to create an open source framework for production, demonstration and evaluation of Tracking and State Estimation algorithms. The initiative will develop a (MIT-licensed) software platform for researchers and practitioners to test, verify and benchmark a variety of multi-sensor and multi-object state estimation algorithms. The initiative is so far supported by four government laboratories, who will contribute to the development effort for the framework.

This workshop is to make interested parties aware of this effort and to extend an invitation to anyone who wishes to participate. The tracking and state estimation community will derive significant benefits from this work, including: access to repositories of verified and validated tracking and state estimation algorithms, a framework for the evaluation of multiple algorithms, standardisation of interfaces and access to challenging data sets.

The workshop will at Uniclub in the afternoon of Thursday, October 12th, immediately following SDF 2107.