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SPECIAL SESSIONS

Title:
Special Session on Evaluation of Technologies for Uncertainty Reasoning

Organisers:
Paulo Costa,
George Mason University, United States

Kathryn Laskey,
George Mason University, United States

Anne-Laure Jousselme,
Center for Maritime Research and Experimentation, Italy

Erik Blasch,
Air Force Research Lab, United States

Valentina Dragos,
Onera, France

Jurgen Ziegler,
Industrieanlagenbetriebsgesellschaft mbH, Germany

Gregor Pavlin,
Thales, Denmark

Johan de Villiers,
University of Pretoria, South Africa

Claire Laudy,
Thales, France

Alta De Waal,
University of Pretoria, South Africa

Abstract:
The 2020 ETUR special session will focus on three topics: (1) to summarize the state of the art in uncertainty analysis, representation, and evaluation, (2) discussion of metrics for uncertainty representation, and (3) survey uncertainty at all levels of fusion.

The impact to the ISIF community would be an organized session with a series of methods in uncertainty representation as coordinated with evaluation. The techniques discussed and questions/answers would be important for the researchers in the ISIF community; however, the bigger impact would be for the customers of information fusion systems to determine how measure, evaluate, and approve systems that assess the situation beyond Level 1 fusion.

The customers of information fusion products would have some guidelines to draft requirements documentation, the gain of fusion systems over current techniques, as well as issues that are important in information fusion systems designs. One of the main goals of information fusion is uncertainty reduction, which is dependent on the representation chosen. Uncertainty representation differs across the various levels of Information Fusion (as defined by the JDL/DFIG models). Given the advances in information fusion systems, there is a need to determine how to represent and evaluate situational (Level 2 Fusion), impact (Level 3 Fusion) and process refinement (Level 5 Fusion), which is not well standardized for the information fusion community.

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Title:
Data Fusion for Industry 4.0

Organisers:
Claudio De Farias,
Federal University of Rio de Janeiro, Brazil

Jose Brancalion,
EMBRAER, Brazil

Abstract:
The Internet of Things (IoT) is a novel paradigm that is grounded on Information and Communication Technologies (ICT). Recently, the use of IoT has been gaining attraction in areas such as logistics, manufacturing, retailing, and pharmaceutics, transforming the typical industrial spaces into Smart Spaces. This leads to a novel paradigm called Industry 4.0. Since IoT data is usually dynamic and heterogeneous, it becomes important to investigate techniques for understanding and resolving issues about data fusion in Industry 4.0. Employment of Data fusion algorithms are useful to reveal trends in the sampled data, uncover new patterns of monitored variables, make predictions, thus improving decision making process, reducing decisions response times, and enabling more intelligent and immediate situation awareness.

Title:
Advances in Distributed Kalman Filtering and Fusion

Organisers:
Benjamin Noack,
KIT, Germany

Susanne Radtke,
KIT, Germany

Felix Govaers,
FKIE, Germany

Abstract:
The rapid advances in sensor and communication technologies are accompanied by an increasing demand for distributed state estimation methods. Centralized implementations of the Kalman filter are often too costly in terms of communication bandwidth or simply inapplicable - for instance when mobile ad-hoc networks are considered. Compared with centralized approaches, distributed or decentralized Kalman filtering is considerably more elaborate. In particular, the treatment of dependent information shared by different systems is a key issue. Distributed state estimation is, in general, a balancing act between estimation quality and flexible network design. Although distributed implementations of the Kalman filter that provide optimal estimates are possible, these algorithms are not robust to packet delays and drops, node failures, and changing network topologies. In practice, these problems deserve careful attention and have to be addressed by future research.

Title:
Information Fusion in Multi-Biometrics and Forensics

Organisers:
Naser Damer,
Fraunhofer IGD, Germany

Raghavendra Ramachandra,
Norwegian University of Science and Technology (NTNU), Norway

Kiran Raja,
Norwegian University of Science and Technology (NTNU), Norway

Abstract:
This session will focus on the latest innovations and best practices in the emerging field of multi-biometric fusion. Biometrics tries to build an identity recognition decision based on the physical or behavioral characteristics of individuals. Multi-biometrics aims at outperforming the conventional biometric solutions by increasing accuracy, and robustness to intra-person variations and to noisy data. It also reduces the effect of the non-universality of biometric modalities and the vulnerability to spoof attacks. Fusion is performed to build a unified biometric decision based on the information collected from different biometric sources. This unified result must be constructed in a way that guarantees the best performance possible and take into account the efficiency of the solution.

The topic of this special session, Information Fusion in Multi-Biometrics and Forensics, requires the development of innovative and diverse solutions. Those solutions must take into account the nature of biometric information sources as well as the level of fusion suitable for the application in hand. The fused information may include more general and non-biometric information such as the estimated age of the individual or the environment of the background.

This special session will be supported by the European Association for Biometrics (EAB) and the National Research Center for Applied Cybersecurity ATHENE. This collaboration will provide technical support by addressing experts for reviews and will help with the dissemination and exploitation of the event.

Title:
Advanced Nonlinear Filtering

Organisers:
Daniel Frisch,
Karlsruhe Institute of Technology (KIT), Germany

Jindřich Duník,
University of West Bohemia (UWB); Honeywell, Czechia

Jordi Vilà-Valls,
Institut Supérieur de l'Aéronautique et de l'Espace (ISAE-SUPAERO), France

Víctor Elvira,
University of Edinburgh, United Kingdom

Ondřej Straka,
University of West Bohemia (UWB), Czechia

Fred Daum,
Raytheon Company, United States

Uwe D. Hanebeck,
Karlsruhe Institute of Technology (KIT), Germany

Abstract:
Methods for Bayesian inference with nonlinear systems are of fundamental interest in the information fusion community. Great efforts have been made to develop state estimation methods that are getting closer and closer to the truth. Further objectives are to increase their efficiency, reduce their requirements / assumptions, and to allow their application in more general settings.

Areas such as target tracking, guidance, positioning, navigation, sensor fusion, and decision-making usually require the use of linear or nonlinear state estimation methods (i.e., of broad interest for the information fusion community). These methods are used to provide a state estimate of a dynamic system, which is in general not directly measurable, from a set of noisy measurements. The development of state estimation started in the sixties with the appearance of the well known Kalman filter (KF), and the use of simple linearization approaches to deal with nonlinear dynamic systems. Satisfactory performance of these legacy KF-based methods was limited to system models with mild nonlinearities, together with a perfect knowledge of the system, that is, both system functions, noise statistics distributions and their respective parameters.
For the last three decades, a huge effort has gone towards the derivation of

- state estimation techniques able to deal with nonlinear and/or non-Gaussian models, following either a Bayesian or an optimisation approach, which allow a more informative description of the estimate through probability distributions or distribution parameters, and
- robust estimation techniques able to cope with a possible model mismatch (including uncertainties in the noise description) or measurements corrupted by outliers. These methods were subsequently improved to increase their efficiency, reduce their requirements/assumptions, and to allow their application in more general settings.

This special session focuses on recent advances in nonlinear state estimation (filters, smoothers, and predictors) for both discrete and continuous time system models with areas such as:

- Nonlinear and/or Non-Gaussian Estimation
  - Density specific estimators (e.g., Gaussian, Student's-t, transformed Gaussian, Rayleigh, Laplace) including nested, sigma-point, or stochastic integration based design.
  - Global estimators such as point-mass, Gaussian mixture, or sequential Monte Carlo methods, a.k.a. particle filters, and Monte Carlo sampling methods.
  - Particle flow, homotopy-based, and progressive estimators.
  - Performance evaluation of estimation methods.
- Robust Estimation
  - Robust techniques with partially unknown system models (system functions or noise statistics).
  - Robust techniques for measurements corrupted by outliers or unexpected model behaviours.
  - Linearly/nonlinearly constrained estimation.
- Efficient Estimator Design and Applications
  - State estimation in high-dimensional spaces.
  - Performance analysis of existing nonlinear filtering methods.
  - Applications of nonlinear state estimation methods.

Title:
Advances in Motion Estimation using Inertial Sensors

Organisers:
Manon Kok,
Delft University of Technology, Netherlands

Gustaf Hendeby,
Linköping University, Sweden

Abstract:
Accelerometers and gyroscopes (inertial sensors) measure the movement of the sensor in terms of its acceleration and angular velocity. These sensors are nowadays widely available in smartphones and VR / AR headsets but also in dedicated sensor units (inertial measurement units). Due to their small form-factor, they can non-intrusively be placed on people and devices. Measurements from mobile sensors carried by or placed on people, vehicles and robots can be used to track or classify their movements. Resulting from technological advances, the availability of these sensors as well as their accuracy has steadily increased over recent years, opening up for many exciting applications. Since inertial measurements only give accurate position and orientation information on a limited time scale, inertial sensors are typically combined with for instance additional sensors or with motion models. Challenges lie both in obtaining accurate (sensor and motion) models as well as in the choice and development of algorithms. This Special Session "Advances in Motion Estimation using Inertial Sensors" features contributions describing recent developments in the use of inertial sensors, with focus on localisation, calibration and biomedical applications. New requirements in applications call for advances in motion estimation using inertial sensors, hence deserving a forum at FUSION 2019.

Title:
Special Session "Context-based Information Fusion"

Organisers:
Jesus Garcia,
Universidad Carlos III, Spain

Lauro Snidaro,
University of Udine, Italy

Abstract:
The goal of the proposed session is discussing approaches to context-based information fusion. It will cover the design and development of information fusion solutions integrating sensor data with contextual knowledge.

The development of IF systems inclusive of contextual factors and information offers an opportunity to improve the quality of the fused output, provide solutions adapted to the application requirements, and enhance tailored responses to user queries. Contextual-based strategy challenges include selecting the appropriate representations, exploitations, and instantiations. Context could be represented as knowledge-bases, ontologies, and geographical maps, etc. and would form a powerful tool to favor adaptability and system performance. Example applications include context-aided tracking and classification, situational reasoning, ontology building and updating.

Therefore, the session covers both representation and exploitation mechanisms so that contextual knowledge can be efficiently integrated in the fusion process and enable adaptation mechanisms.

Title:
Machine Learning Methods for Classification and Decision Making

Organisers:
Lyudmila Mihaylova,
The University of Sheffield, United Kingdom

Allan De Freitas,
University of Pretoria, South Africa

Abstract:
Sensors provide enormous amounts of data – for surveillance, medical purposes, intelligent transport, agriculture and many other areas. CCTV cameras are widely deployed in public and private and can operate simultaneously with infrared thermal sensors, e.g. for robust action recognition, tracking for human behaviour analysis and anomaly detection as part of the next generation of autonomous systems. Detecting and classifying autonomously hidden patterns is a very challenging problem and enormous efforts are devoted on it. This special session calls for theoretical and practical works in the domain of machine learning methods for classification. The call is open to everybody working in the area – including behaviour analysis, computer vision and surveillance.

Title:
Special Session on Directional Estimation

Organisers:
Florian Pfaff,
Karlsruhe Institute of Technology, Germany

Kailai Li,
Karlsruhe Institute of Technology, Germany

Uwe D. Hanebeck,
Karlsruhe Institute of Technology, Germany

Abstract:
Many estimation problems of practical relevance include the problem of estimating directional quantities, for example, angular values or orientations. However, conventional filters like the Kalman filter assume Gaussian distributions defined on R^n. This assumption neglects the inherent periodicity present in directional quantities. Consequently, more sophisticated approaches are required to accurately describe the circular setting.

This Special Session addresses fundamental techniques, recent developments, and future research directions in the field of estimation involving directional and periodic data. It is our goal to bridge the gap between theoreticians and practitioners. Thus, we welcome both applied and theoretical contributions to this topic.

Title:
Explainable AI for Information Fusion

Organisers:
Lauro Snidaro,
University of Udine, Italy

Jesus Garcia,
University Carlos III de Madrid, Spain

Abstract:
Currently, development of "explainable" intelligent systems has been identified as a key area of research and a possible major step in AI. The recent DARPA "Explainable Artificial Intelligence" (XAI) program is the subject of significant funding and is expected to close by 2021 . Most of current machine learning techniques are difficult to explain since their models are complex, usually of black-box type, and therefore not easily interpretable. Other classical methods are instead inherently interpretable, as is the case of rule-based systems, decision trees, causal networks, logical reasoning.

The "next wave of AI" challenges should place emphasis on "explainable models" instead of "black box" paradigms. The key is providing explanations to the users about the decisions taken or proposed, especially in mission-critical applications required to facilitate human-machine interaction.

While previous AI milestones have been characterized by manually crafted knowledge (expert systems) and statistical machine learning, the open challenge is focused now on learning paradigms with explainable models and context adaptation to gain in generalization capability. Explainable AI (XAI) can benefit from recent developments in IF systems, context enhancement, and decision support systems.

This special session will discuss central topics around this line of research and also the interplay and similarities with research in the development of IF systems for decision support, where the representation of the world according to a certain model should explain the decisions taken.

Title:
Intelligence for situation understanding and sense-making

Organisers:
Lauro Snidaro,
University of Udine, Italy

Jesus Garcia,
University Carlos III of Madrid, Spain

Kellyn Rein,
Fraunhofer FKIE, Germany

Abstract:
The exploitation of all relevant information originating from a growing mass of heterogeneous sources, both device-based (sensors, video, etc.) and human-generated (text, voice, etc.), is a key factor for the production of a timely, comprehensive and most accurate description of a situation or phenomenon in order to make informed decisions. Even when exploiting multiple sources, most fusion systems are developed for combining just one type of data (e.g. positional data) in order to achieve a certain goal (e.g. accurate target tracking) without considering other relevant information (e.g. current situation status) from other abstraction levels.
The goal of seamlessly combining information from diverse sources including HUMINT, OSINT, and so on exists only in a few narrowly specialized and limited areas.

In other words, there is no unified, holistic solution to this problem.

Processes at different levels generally work on data and information of different nature. For example, low level processes could deal with device-generated data (e.g. images, tracks, etc.) while high level processes might exploit human-generated knowledge (e.g. text, ontologies, etc.).

The overall objective is to enhance making sense of the information collected from multiple heterogeneous sources and processes with the goal of improved situational awareness and intelligence including topics such as sense-making of patterns of behaviour, global interactions and information quality, integrating sources of data, information and contextual knowledge.
The proposed special session will bring together researchers working on fusion techniques and algorithms often considered to be different and disjoint. The objective is thus to foster the discussion of and proposals for viable solutions to address challenging problems in relevant applications.

Title:
Fusion of spatial and GIS data

Organisers:
Inger Fabris-Rotelli,
University Of Pretoria, South Africa

Renate Thiede,
University Of Pretoria, South Africa

Victoria Rautenbach,
University Of Pretoria, South Africa

Abstract:
Spatial data is of growing importance in society due to the increase in handheld devices used by general public capable of collecting location data. Big spatial data shows computational complications, more intense than non-spatial big data due to the inherent dependence present. Spatial data is also of multiple types – lattice data, remote sensing imagery, map data, point location data (point patterns) and geostatistical data, and further into spatio-temporal data with dependence in both space and time. This session presents cases of these types.

Concepts and Topics of Discussion:
- Fusion of spatial data and big spatial data – latest methods
- Access to applicable spatial data for fusion
- Fusion across multiple types
- Fusion cases that require further research

Title:
Extended Object and Group Tracking

Organisers:
Marcus Baum,
University of Göttingen, Germany

Karl Granström,
Chalmers University, Sweden

Uwe Hanebeck,
Karlsruhe Institute of Technology (KIT), Germany

Wolfgang Koch,
Fraunhofer FKIE, Germany

Peter Willett,
University of Connecticut, United States

Abstract:
Traditional object tracking algorithms assume that the target object can be modeled as a single point without a spatial extent. However, there are many scenarios in which this assumption is not justified. For example, when the resolution of the sensor device is higher than the spatial extent of the object, a varying number of measurements from spatially distributed reflection centers is received. Furthermore, a collectively moving group of point objects can be seen as a single extended object because of the interdependency of the group members.

This Special Session addresses fundamental techniques, recent developments and future research directions in the field of extended object and group tracking.