From the Editor-in-Chief:

December 2017


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Guest Editorial: Foreword to the Special Issue on *Extended Object Tracking*

Multi-Object tracking, i.e., the successive determination of the number and states of objects based on sensor measurements, is an enabling technology in many areas such as surveillance, (mobile) robotics, autonomous driving and automation. Traditional multi-object tracking algorithms are based on the "small target" assumptions, i.e., (i) objects evolve independently, (ii) objects can be modelled as a point, and (iii) objects gives rise to at most one measurement per scan. These assumptions are usually valid for target objects that are far away from the sensor or for a low sensor resolution, e.g., in air surveillance.

However, due to recent advances in sensor technology, as well as novel applications involving objects in the near-field of sensors, it is becoming increasingly common that the objects occupy several sensor resolution cells. Hence, there is an increasing demand for so-called extended object tracking algorithms that can deal with objects that gives rise to multiple measurements from different spatially distributed measurement sources.

Extended object tracking comes with many new challenges: For example, in contrast to a point target, it is necessary to determine the shape of the object, which is a highly nonlinear problem. Furthermore, data association becomes much more challenging for multiple extended objects because a huge amount of association events is feasible. Extended object tracking is applicable to many different sensors, such as radar, lidar, and camera.

The special issue consists of five articles, some of which are significantly extended versions of papers that have been presented at the International Conference on Information Fusion (FUSION) within the special session "*Extended Object and Group Tracking.*"

The first paper by Granström, Baum and Reuter, titled "*Extended Object Tracking: Introduction, Overview and Applications*," gives a tutorial introduction to the extended object tracking problem. The most common methods are discussed and overviewed. Furthermore, several real-world applications of extended object tracking are illustrated.

The second paper by Schuster, Reuter and Wanielik, titled "*Multi Detection Joint Integrated Probabilistic Data Association Using Random Matrices with Applications to Radar-Based Multi Object Tracking*," is about an extended object version of the Joint Probabilistic Data Association (JPDAF) filter that allows for multiple detections per object and employs the random matrix approach for shape estimation. The method is experimentally evaluated by means of vessel tracking using a high-resolution radar sensor.

The third paper by Vivone, Braca, Granström, Natale, and Chanussot, titled "*Converted Measurements Bayesian Extended Target Tracking Applied to X-band Marine Radar Data*," deals with the tracking of marine vessels using X-band marine radar and the random matrix extended target model. X-band radars are flexible and low-cost tools that provide high resolution measurements in polar coordinates. To track targets modelled in Cartesian coordinates, it is necessary to convert the measurements from polar to Cartesian coordinates before they are input into the tracking algorithm. The paper presents a method for modelling detections affected by polar noise, and derives an efficient estimator. The estimator is evaluated using 10 real-world datasets.

The fourth paper by Wyffels and Campbell, titled "*Priority Based Tracking of Extended Objects*," presents a framework for allocating computational resources to achieve tracking with variable precision for different objects. Inspired by human perception, higher relevance is given to objects that are closer to the sensor, i.e., closer to, e.g., the robot or ego-vehicle. Three levels of relevance are used, with more accurate, and computationally expensive, models used for objects with higher relevance, and cheaper models used for objects with lower relevance.

The fifth paper by Bordonaro, Willett, Bar-Shalom, Luginbuhl, and Baum, titled "*Extended Object Tracking with Exploitation of Range Rate Measurements*," considers the raw measurements (range, bearing and range rate) from a single scan and develops an expectation maximization (EM) algorithm that provides the target position, velocity, heading and turn rate. The obtained single scan estimate is subsequently used in a Kalman filter for recursive estimation.

The special issue covers several different aspects of extended object tracking, and represents an excellent sample of current research trends in the area, and of state-of-the-art methods and results. We sincerely hope that you will find reading the papers as interesting and enjoyable as we have. We would like to extend our sincere gratitude to the JAIF Editorial Board for the possibility to prepare this special issue, and to the Editor-in-Chief for the support and the encouragement. Finally, we wish to thank the authors for their contributions to the special issue and to the research area in general.

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