



Band 12

Michael Schuster

Multiple Object Tracking for Extended Targets using JIPDA filters



Multiple Object Tracking for Extended Targets using JIPDA filters

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Abstract

Autonomous moving systems require very detailed information about their environment and potential colliding objects. Thus, the systems are equipped with high resolution sensors. These sensors have the property to generate more than one detection per object per time step. This results in an additional complexity for the target tracking algorithm, since standard tracking filters assume that an object generates at most one detection per object. This requires new methods for data association and system state filtering.

As new data association methods, in this thesis two different extensions of the Joint Integrated Probabilistic Data Association (JIPDA) filter to assign more than one detection to tracks are proposed. The first method that is introduced, is a generalization of the JIPDA to assign a variable number of measurements to each track based on some predefined statistical models, which will be called Multi Detection - Joint Integrated Probabilistic Data Association (MD-JIPDA). Since this scheme suffers from exponential increase of association hypotheses, also a new approximation scheme is presented. The second method is an extension for the special case, when the number and locations of measurements are a priori known. In preparation of this method, a new notation and computation scheme for the standard Joint Integrated Data Association is outlined, which also enables the derivation of a new fast approximation scheme called balanced permanent-JIPDA.

For state filtering, also two different concepts are applied: the Random Matrix Framework and the Measurement Generating Points. For the Random Matrix framework, first an alternative prediction method is proposed to account for kinematic state changes in the extension state prediction as well. Secondly, various update methods are investigated to account for the polar to Cartesian noise transformation problem. The filtering concepts are connected with the new MD-JIPDA and their characteristics analyzed with various Monte Carlo simulations.

In case an object can be modeled by a finite number of fixed Measurement Generating Points (MGP), also a proposition to track these object via a JIPDA filter is made. In this context, a fast Track-to-Track fusion algorithm is proposed as well and compared against the MGP-JIPDA.

The proposed algorithms are evaluated in two applications where scanning is done using radar sensors only. The first application is a typical automotive scenario, where a passenger car is equipped with six radar sensors to cover its complete environment. In this application, the location of the measurements on an object can be considered stationary and that it has a rectangular shape. Thus, the MGP based algorithms are applied here. The filters are evaluated by tracking especially vehicles on nearside lanes.

The second application covers the tracking of vessels on inland waters. Here, two different kind of Radar systems are applied, but for both sensors a uniform distribution of the measurements over the target's extent can be assumed. Further, the assumption that the targets have elliptical shape holds, and so the Random Matrix Framework in combination with the MD-JIPDA is evaluated. Exemplary test scenarios also illustrate the performance of this tracking algorithm.

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