Tracking an Extended Object Modeled as an Axis-Aligned Rectangle

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Target tracking methods usually assume that the object extension is negligible in comparison to the sensor noise. However, due to the high-resolution capabilities of modern sensors, this assumption is not always justified. Therefore, target tracking algorithms have to take into account that measurements may stem from different locations, named measurement sources, on the extended target object. Scenarios for tracking extended objects occur in military surveillance with radar devices, but can also be frequently found in many other areas like robotics. Extended object tracking methods are also used for tracking a collectively moving group of point targets. If the point targets move closely together compared to the sensor resolution, it is hard to cope with the data association problem. In such a case, it is appropriate to consider the group of point targets as one single spatially extended object, since there is a high interdependcy between the point targets.

In this paper, the extended target object, whose true shape is unkown, is modeled as an axis-aligned rectangle in two-dimensional space. At each time step, several position measurements corrupted with stochastic noise are received. These measurements are known to stem from unknown measurement sources on the target surface. In contrast to common approaches, no (statistical) assumptions on these measurement sources have to be made. This is a realistic point of view since the true shape and properties of the target surface are usually unknown. For instance, when tracking an aircraft formation, the behaviour of a single group member is nearly unpredictable due to the high complexity of the group behaviour. Furthermore, consider the tracking of a ship with a high-resolution radar device. Due to the unknown shape and characteristics of the ship, it is unpredictable which scattering center on the ship is responsible for a measurement. Standard methods are not able to incorporate this lack of knowledge such that more or less heuristical assumptions about the measurement sources have to be made.

The presented approach was recently introduced for circular discs by the authors and is applied here to axis-aligned rectangles. Since no statistical assumptions on the measurement sources are made, the problem can be decomposed into a deterministic and a stochastic part: The deterministic part considers the problem of finding the set of all rectangles that enclose the measurements. This set is uniquely determined by the smallest enclosing rectangle of the measurements. The stochastic part treats the incorporation of noise-corrupted measurements and statistical knowledge about the size of the extended object.