Monte Carlo Methods For Multitarget Tracking

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Abstract

A major challenge in statistical signal processing has historically been the tracking of moving targets, let them be aircrafts, submarines, robots, or even, in less military areas, cells in a blood sample observed by microscope and fluorescence imaging, football players on a video, or even cellphones. The purpose of multiple target tracking algorithms is to detect, track and identify targets from sequences of noisy observations of the targets provided by one or more sensors.

Many approaches have been proposed to tackle the problem of multitarget detection and tracking. These range from the Kalman filter and its non-linear extensions to JPDAF trackers [1, 2] and the Probability Hypothesis Density (PHD) filter [3]. The latter has been proposed to estimate the targets' characteristics as well as the number of targets by modeling them as a random set. However its performance degrades significantly in highly cluttered environment [11, 12]. With the simultaneous advances in modern computational power and the developments in optimal inference for strongly non-linear models such as particle filters [4] and Markov Chain Monte Carlo (MCMC) [5], it is now possible to solve complex state space models efficiently, potentially achieving significant performance gains.

In this study, we will compare the performances of several Monte-Carlo methods on the challenging case of tracking an unknown number of independent targets in a hostile environment of heavy level of false alarm (clutter) and very low probability of detection. We evaluate the efficiency of the sequential importance sampling algorithm, the auxiliary particle filter as well as the MCMC-based particle method [6]. Our comparison metric is the optimal sub-pattern assignment (OSPA), recently proposed in [7] to evaluate the estimation quality of algorithms when the number of objects is unknown.

References

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