Multiple Extended Target Tracking Based On PHD Filter And Gaussian Processes

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Target tracking is a core problem in the development of more efficient and secure autonomous vehicles. During this project, an algorithm to track multiple targets at the same time was developed. More precisely the algorithm was extracting information coming from a LiDAR sensor placed on the car.

To achieve this, a Probability Hypothesis Density filter was implemented. The working principle of this filter is like a Kalman filter. However instead of estimating one single state at each time-step, this filter predicts multiple states at the same time. In the context of this project, each state was equivalent to a car in the field of view of the sensor.

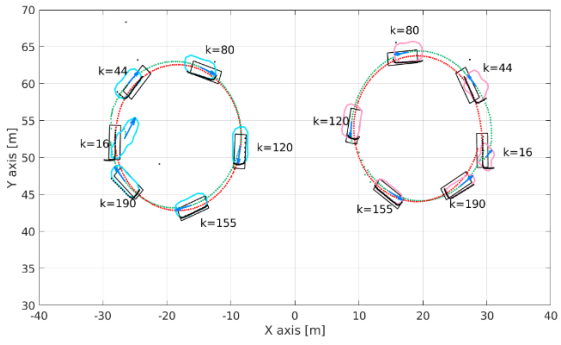
This filter was combined with a recursive Gaussian Process regression algorithm that allowed to model a very broad set of different shape.

Other algorithms were added to improve the tracking performance of the filter. Beyond them I developed an adaptive birth part that estimate, based on the measurement set, were the next targets were likely to appear. An occlusion model to handle temporary disappearance of some targets behind another target was also implemented.

The algorithm was implemented in Matlab and was tested on real and simulation data.

For the simulation scenarios, I used Webots, a robotic simulator and Robot Operating System, a collection of software framework that allows to interconnect easily some part of the simulator together. The results were evaluated using OSPA metric, an evaluation method for multitarget tracking algorithm. The first figure below is an example of what can be achieved with Webots. The yellow car is the measuring cars. In the simulation scenario we removed any non-moving object from the field of view and all experiment were performed with a measuring car that was not moving. An example of the tracking performance that could be achieved during one run is shown on the next figure where two cars are tracked.

Example of a simulation in Webots



Example of the tracking of two cars driving on two round-about

During the real scenario, the cars were driven by humans and there was no ground truth position. Therefore, no error was computed and the results are just assessed visually.

The algorithm gave some interesting results regarding the tracking and the shape estimation. However, there is still some improvements possible, especially for the adaptive birth algorithm.