Comparison of Centralized and Distributed Fusion Architectures in a Sensor Network

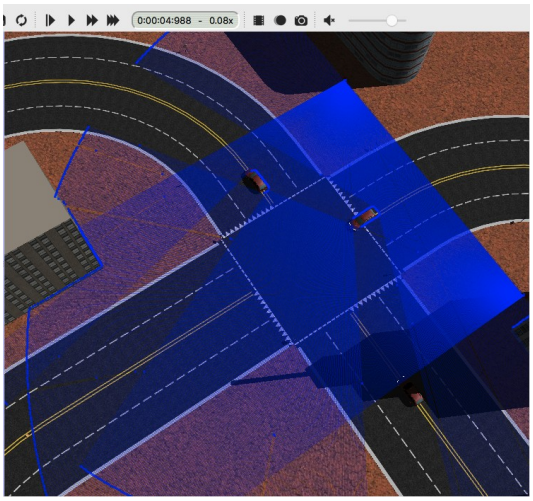
Loïc Veyssiere

Professor : Alcherio Martinoli
Assistant(s) : Milos Vasic

The development of intelligent vehicle technologies is booming thanks to the increased capabilities offered in term of data processing or information collection. Car safety systems, consolidated traffic data, alerting or driving assistance are valued by car companies. While the GPS enabled to know approximately the position of isolated cars, the emergence of autonomous vehicles will require the knowledge of all the kinetic data in a defined area.

In this project, we address the problem of the Distributed Multi-sensor Multi-target Tracking (DMMT). Based on a generalization of the single-target Bayesian framework, the multi-target tracking filter develops a natural technique to fuse contribution in a centralized approach. In a distributed approach, each contributor exchanges non-independent information so the optimal estimation is impossible. Fusion techniques have to be developed for our specific representation (Gaussian Mixture implementation) of probabilistic states. The choice has been made to use a generalization of the Covariance Intersection (GCI) for intensities. The Gaussian Mixture representation constrained us to use some approximation and heuristics. Therefore it is important to evaluate the performance of such distributed architecture.

For this purpose I implement a configurable Matlab simulator running realistic data sets from the Webots platform. The implemented system tries to by as realistic as possible with real world limitations like communication delays. The performed experimentations underline the limitations of the GCI fusion.



Occlusion phenomenon on the Webots platform

Experiments have shown that after the fusion, the cardinality seems to be underestimated on too many points. It is a bad omen considering that events like occlusions lead also to an underestimation of the cardinality. However, OSPA analysis has shown that the accuracy of the estimation is often better in the distributed architecture than in the centralized one. It is unexpected but promising knowing that the centralized framework provides a solution that is statistically optimal. Also experiments were conducted to propose the good information to share through the communication network.