

Reliable localization of an underwater robot based on tubes and topological degree

Simon Rohou

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A mobile robot can be described as a dynamical system with bounded uncertainties. In this talk, we will first present an interval framework for enclosing the feasible trajectories in a non-linear and bounded-error context.

We will then introduce Simultaneous Localization And Mapping (SLAM), a concept that links the problem of estimating the state of a mobile robot to the mapping of an unknown environment in which the robot evolves. A SLAM algorithm exploits similarities in the environment to compute *loop closures* corresponding to places visited several times by the robot. Loop closures allow to propagate information from known states to states with large uncertainties. We will explain how the interval framework can deal with these inter-temporal measurements.

When the environment is wide and homogeneous, as is the case for the seabed, loop closures are difficult to guarantee due to ambiguities in the observations. To prove that a robot has completed a loop, whatever the uncertainties in its evolution, we use the notion of topological degree that originates in the field of differential topology. We will show that a verification tool based on the topological degree is an optimal method for proving robot loops. As these tools avoid bad convergences in SLAM algorithms, we will be able to apply them in difficult homogeneous environments with challenging scene recognitions. The presentation will be illustrated by real data from an Autonomous Underwater Robot performing a navigation at sea.

This is joint work with Luc Jaulin, Peter Franek and Michel Legris.