Reliable localization of underwater objects using a mobile robot

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Subject : A reliable localization of objects (or seamarks) inside an underwater environment using a single underwater robot is a difficult problem, due to the fact that the GPS is not available under the water. By taking into account the measurements collected by proprioceptive sensors (such as the Lock-Doppler or the inertial unit) and exteroceptive sensors (e.g., cameras or sonars), it is possible to build a map of the environment, i.e., to localize objects that are met by the robot. This is the principle of SLAM (Simultaneous Localization and Mapping) techniques which appeared 20 years ago in the context of mobile robotics. The main techniques that are used to solve a SLAM problem are

- the EKF (Extended Kalman filter) which append the positions of object inside the state vector and solve the associated state estimation problem.
- Particle filter, which implements MonteCarlo methods in a probabilistic framework in order to estimate both the state of the robot and the position of the marks.
- Interval filter which uses interval-based method to solve the SLAM problem, by removing inconsistent parts of the search space.

The first objective of the project is to compare all these techniques used for SLAM in the context of underwater robotics. The second objective is to combine the particle filter and the interval filter in order to take advantage of the assets of the interval approach (a set containing all solutions is computed) and of the MonteCarlo approach (an approximation of the posterior probability distribution is provided). Some validations on simulations will be provided.

The internship will last 5 months and will take place at the University UFRGS, Brazil.