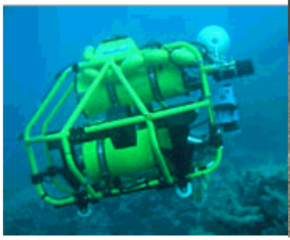
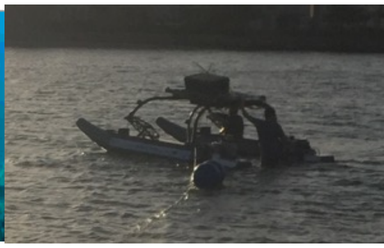
MCHA3900 Project: Cooperative navigation (Maritime RobotX)

Distributed sensor data fusion to enable multi-agent navigation


Overview

The US Office of Naval Research (ONR) organises an autonomous waterborne surface vehicle student competition known as the Maritime RobotX Challenge (see www.RobotX.org). The inaugural event was held in Marina Bay Singapore 20-26 Oct 2014. The Challenge consists of teams of students using a standard maritime platform that students outfit with sensors, actuators, computer hardware and software. The vehicles are required to complete a course based on a variety of maritime surface vehicle missions. Five countries were involved in 2014: USA, Japan, Singapore, South Korea and Australia. In 2014, only three Australian teams were selected to participate: UoN, QUT, and joint team consisting of Flinders and Aust. Maritime College.

The competition is designed to evolve into multi-platform competition to include maritime, aerial and submersible tasks to broaden students' exposure to robotics applications and technologies.

This project considers the problem of distributed navigation of surface, underwater and aerial vehicles operating within their respective domains to complete various tasks.

Required tasks

Item	Description
1	Develop mathematical models to describe the dynamics of a fully-actuated surface vessel and construct measurement likelihood functions for IMU (gyro, accelerometer, magnetometer), GPS and visual bearing sensors. Assume the competition course provides several visual landmarks in predetermined locations. Estimate the pose and pose rate states of the surface vessel using a state estimator with these models and demonstrate in simulation.
2	Develop mathematical models to describe the dynamics of an underactuated multirotor helicopter and construct measurement likelihood functions for IMU, GPS, radio LPS and visual bearing sensors. Assume the surface vessel provides an obvious visual landmark, e.g., IR beacon, and a corresponding radio LPS tag. Estimate the pose and pose rate states of the aerial vehicle using a state estimator with these models and demonstrate in simulation.
3	Develop mathematical models to describe the dynamics of an underwater vehicle tethered to the surface vessel and construct measurement likelihood functions for IMU and hydroacoustic sensors. Assume a hydroacoustic pinger is mounted to the underwater vehicle and a hydroacoustic microphone array is mounted to the surface vessel, which transmits signal-processed results to the underwater vehicle over a communication link. Estimate the pose and pose rate states of the underwater vehicle using a state estimator with these models and demonstrate in simulation.
4	Estimate the joint pose and pose rates of each vehicle in a monolithic state estimator to determine accurate positions of each vehicle in global coordinates. Demonstrate in simulation.
5	Merge the posterior pdfs from the local vehicle estimators Tasks 1,2 & 3 so that each vehicle receives state corrections from the others without using a monolithic estimator. Assume a perfect communication channel is available between all the vehicles. Demonstrate the distributed estimator in simulation and validate against Task 4.

Optional tasks

Item	Description
1	Update the local state estimators to deal with sensor measurements that arrive with a constant, but known delay time.
2	Update the distributed state estimator to deal with state corrections that arrive with a constant, but known delay time.
3	Update the state estimators to deal with measurements and distributed corrections that arrive out-of-order, but with known time stamps.