Visual Navigation System for a Marine Robot

An ELE Senior Design Project (2-3 ELE & ECE Students)

Professor Stephen Licht
URI Ocean Engineering Department

Abstract:

The goal of this project is to create a vision system for the URI Autonomous Surface Vehicle. The vision system will enable the boat to complete an open water course by identifying and localizing visual channel markers, and will guide the vehicle during completion of a set of (as yet unannounced) goals. Previous competitions have required tasks such as directing a fire hose at an object, and navigating through narrow gates. The team members will have the opportunity (entirely optional) to travel to Virginia Beach, VA in June 2013 to participate in the AUVSI RoboBoat competition.

Project Description:

RamBoat, the URI Student Autonomous Surface Vehicle (ASV) is a Hobie Float Cat 60 customized over the course of several years to compete at the AUVSI RoboBoat challenge in Virginia Beach, VA (Figure 1). For the June 2013 competition, the team expects to retain much of the hull and propulsion design from previous years, and focus on revamping the sensing and navigation systems.

Figure 1: Ramboat 2012

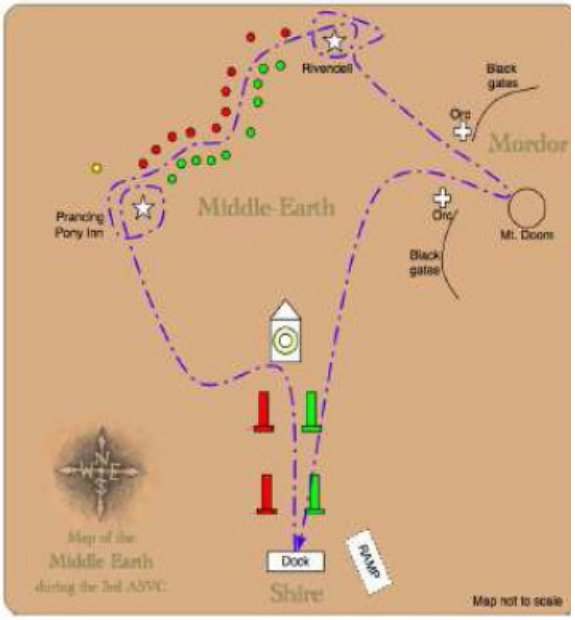

Figure 2: 2011 Course Map

A key component of the navigation system, based on the challenges goals from past years, will be the detection and mapping of visual course references, such as red and green channel marking buoys (Figs. 2-3).

The ASV currently uses two embedded processors during autonomous missions: an Intel Atom PC running OpenCV for image processing, and a custom Netburner 5282 mission computer. The mission computer fuses data from sensors including speed, heading, and global position estimates, and develops a navigation solution and action plan. The image processing computer will be responsible for fusing data from stereo cameras and one or more laser range finders to develop a course map and estimate the vehicle position relative to that map and/or particular objects on that map.

The goal of this project is to build a vision system by integrating sensor(s), processor(s), and software, to be used by the team at this year's competition. The resulting system is intended to establish a foundation for reuse and improvement by future teams.

Up to three ELE/ECE students will collaborate with other undergraduates on the ASV team (primarily from the Ocean Engineering department) to develop functional requirements, write hardware/software interface specifications, develop a detailed system design, and then implement, test, calibrate, and field the system during open water ASV trials.

Major deliverables (in addition to all ELE 480 course requirements) will include:

1) A vision system comprising sensors, processors, and software capable of
   a) identifying a set of objects of known size, shape, and color, and localizing those objects with respect to the autonomous vehicle in open water field conditions.
   b) providing a usable navigation solution with respect to a known map.
2) Detailed system design proposal, including rationale for major design decisions.
3) Archival quality system documentation (i.e. good enough that next year's team will be able to replicate, troubleshoot, and improve on the system without access to the system designers.)

Figure 3: Ramboat navigation buoys during open water trials.