

Subjugator : A RECONFIGURABLE AUV

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Abstract

Graduate and undergraduate students at the University of Florida have developed an autonomous submarine, *Subjugator*, for subaqueous research and for entry in the annual ONR/AUVSI underwater vehicle competition. *Subjugator* was designed for operation down to 100 feet, and can be quickly configured to optimize for mobility or speed. *Subjugator*'s body has mounts to support up to ten motors, each of which may be oriented in multiple directions. The vehicle is controlled through a single-board computer running the Linux operation system and custom software. The on-board sensor suite includes a digital compass, a fluidic inclinometer, a sonar altimeter, and a depth pressure sensor. In addition to the standard complement of navigational sensors, a computer vision system was developed for object recognition and tracking. In this paper the mechanical makeup of *Subjugator* will first be discussed. The electronics systems and processing hardware will follow with an analysis of vehicle control.

1 Introduction

As one of the last unexplored regions of the Earth, the ocean, is a fascinating environment for research and discovery. Vehicles which can sustain themselves and operate autonomously underwater are necessary to facilitate the exploration of this underutilized domain. Scenarios in which autonomous underwater vehicles have applications include object recovery and delivery, identification, exploration, and mapping. Tele-operated machines exist which allow limited implementation of the above applications, but they re-

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quire constant supervision and a human for control. It is the goal of this research to develop a system capable of navigation and environmental interaction without the requirement of human control.

The Autonomous Unmanned Vehicle Systems International (AUVSI)[1] and the Office of Naval Research (ONR) sponsor an annual autonomous underwater vehicle competition which was recently held in San Diego at the SPAWAR facility. The competition could best be described as task-based. Each year the platform and sensor suite are redesigned or reconfigured to suit the needs of the prescribed mission to be accomplished.

The submarine must be capable of navigating within the underwater environment while also performing tasks. In a past competition 18 targets bearing unique bar codes were placed in a known configuration. The submarine had to clear an initial gate leading to the competition arena and then attempt to identify and pair each target's height with the number encoded on its surface. A computer vision system was used to locate and identify the targets.

This paper will cover the design of the submarine in addition to the reconfigurable aspects of both the hardware and software.

2 Mechanical System

As a third-generation vehicle, *Subjugator*[2] embodies the lessons learned in four years of autonomous underwater vehicle (AUV) development [3, 4, 5, 6]. Several key design criteria, including hydrodynamics, diverse mission adaptability, deep water survivability, and salt water survivability, were considered and refined over the years. *Subjugator* has evolved into a robust, reliable platform for underwater research.

Hull

The 36" long octagonal shape is composed of 0.25" thick aluminum plate and 0.5" thick square bar. A bulkhead on each end fastened with quick-release latches keeps the internals dry, while allowing access