Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2003 and Spring 2004

1.0 Information

1.1 Project Title

Remote Aquatic Vehicle (RAV) with Active Buoyancy

1.2 Project Customers

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2.0 Background and Context

To achieve challenging new scientific missions in cluttered environments, the maneuverability and propulsive efficiency of Remote Aquatic Vehicles (RAV's) must be improved. Most conventional underwater vehicle designs employ a propeller as the main propulsion and shrouded thrusters and/or control fins for maneuvering. Vehicle designs for RAVs include: box-shaped bodies designed for maneuvering and station keeping, torpedo-shaped bodies streamlined for speed and range, and low speed maneuverability in the horizontal plane about the yaw axis.

In order to design a vehicle with such superior capabilities, our plan is to study nature as far as our basic understanding of the underlying science allows. Most attempts in underwater locomotion have focused only on propeller thrust generation or recently on flapping locomotion. Small RAVs have a wide variety of uses including, salvage, inspection, specimen gathering, surveillance, etc.

3.0 Objectives

3.1 Overall Objective

The overall objective of the proposed project is to conceive, design, fabricate, integrate, test and verify a Remote Aquatic Vehicle (RAV) small enough for a person to carry that has active buoyancy control and the ability for low speed maneuverability.

3.2 Active Buoyancy Control

3.2.1 Objective

As a customer goal, the RAV will be able to submerge, surface and balance up to a depth of 20 meters.

3.2.2 Discussion

This gives the RAV the ability to stop and inspect at any desired depth. It implies that the RAV has a control system that does not depend on pitch to maneuver vertically. The reason pitch will not be necessary for depth control is because there will be no forward velocity required for change in depth.

3.3 Low Speed Maneuverability

3.3.1 Objective

The RAV will be able to maneuver to reorient itself at zero straight-ahead velocity. This reorientation can be any angle about the vertical (yaw) axis as a minimum requirement, and strafing as a goal.

3.3.2 Discussion

This gives the RAV the ability to stop, inspect, and change direction. It implies that the RAV has a control activation system that does not depend on forward velocity to create a maneuvering force.

3.4 Mass

3.4.1 Objective

The RAV will have a mass of less than 50 lbs so that one person could easily transport the RAV.

3.4.2 Discussion

This makes the RAV practical for use in rapid response situations because it reduces the transportation resources necessary to preposition the RAV.

3.5 Speed, Stability, and Control

3.5.1 Objective

The RAV will have the ability to travel along a direct path submerged at speeds of at least 10 knots. It will deviate no more than 3 ft from this path in the horizontal plane. The minimum requirement for the vehicle is to travel along a path of a rectangular box whose size is TBD based on the Recreation Center Pool Size. The goal is for the vehicle to steer smoothly through an cluttered environment such as an underwater mine field.

3.5.2 Discussion

This defines the basic required speed, stability, and control of the RAV.

3.6 Self-Contained Power

3.6.1 Objective

The RAV will use only on-board power, with at least 1 hour of nominal operation.

3.6.2 Discussion

This means that the RAV cannot pass power from the outside.

3.7 Modules

3.7.1 Objective

Be able to access the components inside of the vehicle and return to operational status in under an hour as a requirement and under 30 minutes as a goal.

3.7.2 Discussion

This will allow for testing to completed in a more efficient manner.

3.8 Depth Capability

3.8.1 Objective

The RAV will not leak any required air tight compartments under a submerged water pressure equivalent to 25 meters depth.

3.8.2 Discussion

This constrains the types of seals, if any, used in the design.

4.0 Engineering Expertise

Technical Expertise	How Applied
Mechanical Design	Develop conceptual and detailed solid 3D models of the device components
Electomechanical Design	Buoyancy, actuator and propulsion subsystems
Hydrodynamic Design	Drag profile of the vehicle
Analog Electronics	Design of the buoyancy, actuator, and propulsion subsystems
Data Acquisition Software	Real-time measurement subsystem
Control Software	Real-time control subsystem (as needed)
Mechanical Fabrication	Part machining
Electronic Fabrication	Analog and digital electronic subsystems
Pressure Test	Verification of the depth capability

5.0 Resources

5.1 Facilities

5.1.1 Manufactuing Facilities

TBD.

5.1.2 Testing Facilities

University of Colorado Recreation Center Pool and hyperbolic chamber TBD.

5.2 Additional Advisors

Dr. Scott Palo

5.3 Funds

Proposals will be submitted to EEF and UROP.