Development of a Remotely-Operated Vehicle for Georeferenced Underwater Imaging

UNIVERSITY OF WASHINGTON
ELECTRICAL ENGINEERING

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BACKGROUND

In collaboration with Booz Allen Hamilton's Seattle office, UW Electrical Engineering has begun a new series of senior industry design capstones that expose undergraduates to real-world engineering challenges. This research is an extension of Booz Allen's OceanLens project focused on mapping dynamic data sources (images, etc.) to existing bathymetric datasets to create a data-rich, navigable 3D environment for undersea visualization applications.

OPENROV

OpenROV is a low-cost open source tele-robotic submarine built with the goal of making underwater exploration and education affordable. Used as a vital component in the development of our georeference-underwater imaging-system. The specific model in our research is a OpenROV 2.8 Mini-observer class ROV, which is 30cm long x 20cm wide x 15cm high and weights about 2.6kg. The performance of the ROV is a maximum depth of 100m and maximum forward speed of 2 knots.

GEOREFERENCING

MAGNETOMETER

- Provides the heading of the buoy with respect to the magnetic north.

GPS

- Receives the information on the buoy position, including latitude, longitude, altitude etc.

BUOY

- The "brains" of the localization system, coordinating differential GPS, magnetometer, and acoustic ranging data
- Also contains networking equipment and power supply

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SYSTEM OVERVIEW

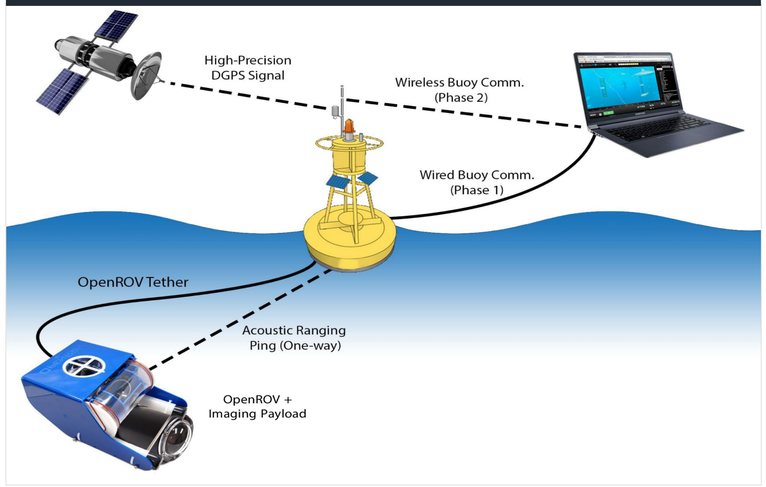

IMAGE ACQUISITION SYSTEM

PURPOSE

The imaging system is to acquire the visual data of the seafloor and terrain. The system is separated for efficient transfer of large data coming from two video streams.

COMPONENTS

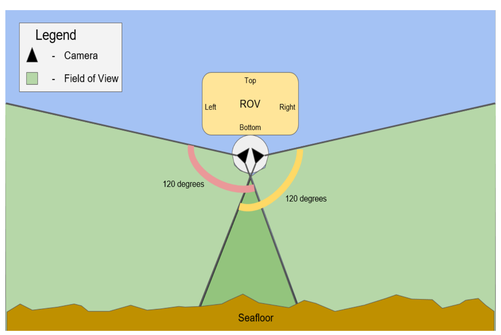

Figure 1: Imaging System field of view

- 2 x Ethernet Adaptors
- 100m two wire tether
- Water proof, sealed containment vessel
- Microcontroller
- 2 x USB Webcam
- 2-port USB Hub
- External Battery (5V)

ACOUSTIC LOCALIZATION

ACOUSTIC COMMUNICATION

- Three receiver array attached to the buoy spaced roughly 1 meter apart at 120 degrees from each other.
- Receivers respond to incident sound wave and output a voltage when a decibel threshold has been reached.
- Each acoustic receiver is connected to a microcontroller that measures the time between sent and received pings
- Time differences in acoustic propagation are converted to spatial differences using the speed of sound in water

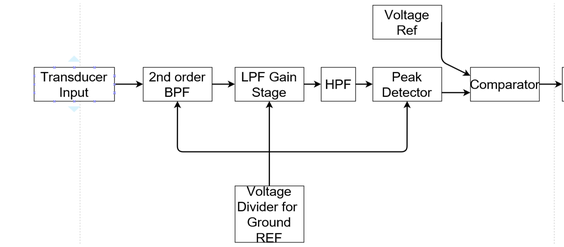

Figure 2: Acoustic communication System Block Diagram

TRILATERATION

- The set of three distances calculated from the acoustic communication system is then used to set up equations for three spheres.
- The solution of the three equation is the position of the ROV underwater.

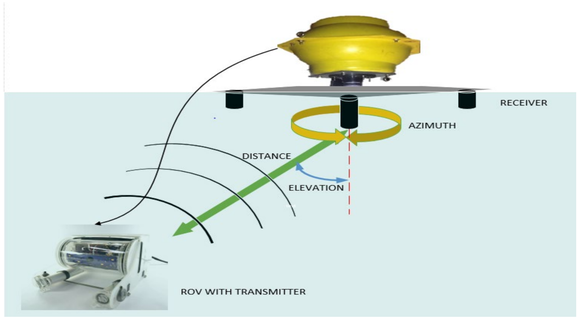

Figure 3: Distance measurement between the ROV and Acoustic Receivers for trilateration

FUTURE RESEARCH

Possible future research includes extended acoustic receiver array design (longer baseline and more total elements), wireless buoy communication, and various imaging payload upgrades (panoramic camera, housing, etc).