Data Visualization and Control Systems for Autonomous Underwater Vehicles

ECE Capstone Design Project, Spring'13

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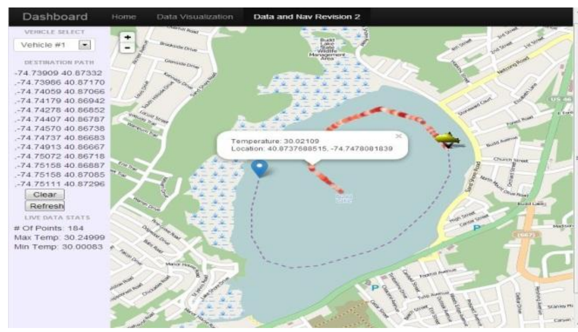
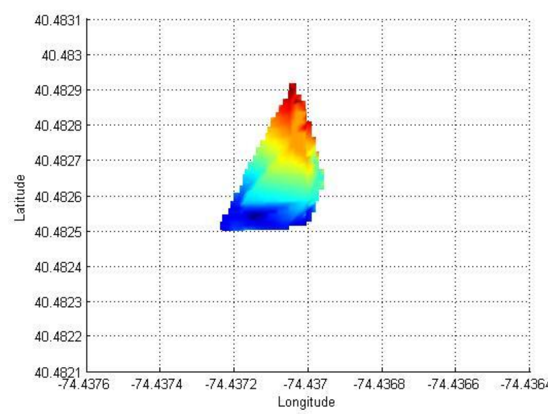
Introduction: The goal of the project is to modify an existing vehicle to operate autonomously so to assemble an autonomous underwater vehicle (AUV). This vehicle will gather and transmit oceanographic data (temperature, oxygen) to an onshore console. A visualization program will then reconstruct the phenomenon (temperature gradient, rate of photosynthesis) in real time. In addition, the same program will be used to monitor and control the vehicle's location and destinations.

Motivation: AUVs are equipped with underwater sensors and facilitate information gathering of various ocean phenomena such as rate of photosynthesis and temperature gradient. Smart sampling techniques will minimize time and energy of AUVs by directing them to areas of interest. This is opposed to a basic, constant sweep of the entire area. This would be a boon to oceanographers in their research, including areas such as weather prediction. Real-time visualization will facilitate continuous monitoring of natural ocean phenomena and may serve as an early warning when there is a significant change in any one of them.

Design: The first branch of the project consists of the fully operational vehicle that is able to collect values concerning location and temperature, and transmit them back to an onshore console. In addition, it can travel autonomously to the selected waypoints, which can easily be changed on the fly. The core components of the vehicle are an Arduino Mega, which controls the servomotors, GPS, and magnetometer; a RaspberryPI, a credit-card sized computer that houses the communication protocols and the Artificial Intelligence (AI) programs; and a thermal sensor (other small sensors can easily be added inside the vehicle).

An onshore console is able to wirelessly connect to the vehicle where it can send commands and receive real-time updates of its location and the collected data. This is all done through a web interface hosted on a locally run server. This interface controls and monitors the movement and collected data in real time (shown in the top image). The exact temperature reading and the location of the samples can be obtained with a simple click on the map. Once the data is collected, it can be interpolated to reflect the entire area within a certain margin of error. This is shown in the bottom image.





Conclusion: This project established a working model of an AUV and an interface through which multiple AUVs, along with the data they collect, can be monitored and directed. The next step forward is to implement a team of AUVs that utilize intelligent sampling algorithms to determine sampling locations. Additionally, the visualization program should be expanded to reflect data gathered at different depths. In conclusion, the vehicle developed during this project has proven to be suitable for use in sampling techniques; the overarching goal of a team of AUVs intelligently monitoring the ocean or lakes is becoming a tangible aspiration.