Cooperative Robotic Watercraft – Bathymetric Maps

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Introduction

- Cooperative watercraft or “airboats” are autonomous robots that promise to improve the long process of monitoring large and small bodies of water. The boats are equipped with various sensors that enable them to be suitable for applications such as flood mitigation, environmental sampling, and generating bathymetric maps.

Objective

- Develop scripts using Matlab to simulate the surveying of bodies of water by an airboat for the creation of bathymetric maps.
- Generate algorithms to construct bathymetric maps from noisy sets of data.

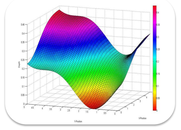
Process

1 Bathymetric Map from Mathematical Equations → 2 Generation of Noisy Data → 3 Bathymetric Map from Noisy Data → 4 Map Comparison

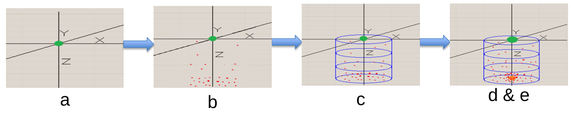
1. The navigation simulator was created using 3D surfaces of mathematical equations with features that simulate possible underwater environments. For example:

$$z = -(.2sin\left(.58y + \frac{\pi}{4}\right)^3) - (.2cos(.25x)^5)$$

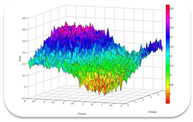
X and Y symbolize position and Z represents depth



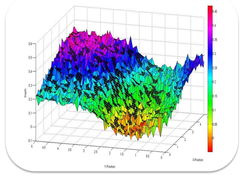
2. The simulation of collecting noisy data was achieved by utilizing the 3D surface from the previous process and adding a random normally distributed error to every element of each coordinate point. This process was repeated ‘X’ number times to mimic an boat surveying an area multiple times to increase the accuracy in the development of the bathymetric map.
3. Algorithm Pseudo Code



a) Obtain the exact coordinate where the boat was expected to arrive
b) Retrieve all of the data points collected near the exact coordinate point
c) Divide the location of the exact coordinate into cylinders
d) Count the number of points within each cylinder
e) Calculate the mean value of the points in the cylinder with the most number of data points, and save the point in order to create a surface
f) Repeat process until all of the expected coordinates have been analyzed
g) Generate a three dimensional surface from the points stored by the algorithm



4) Join the surface generated in the previous step with the surface generated in the first step and compare



Results & Observations

- Every point on the noisy surface had an absolute error value ranging from .05% to 14% of the actual value, the points on the surface from process 1.
- The difference between the points of the mathematically generated surface and the re-constructed data decreases as the number of surveys on the same area increases.

Future Work

- Obtain the error distribution for the gyroscope, accelerometer , G.P.S., and the depth sensor
- Modify the simulation scripts to account for the error in each navigational unit and the depth sensor
- Test the bathymetric map creating algorithms on data collected by the boats