The Autonomous Dynamic Localization System

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Introduction

This project is designed to use hydrophones and cameras to achieve localization and virtual object marking. Hydrophones would be used to localize distance from a pinger based on time delay, while cameras would be used to track the movement of fixed objects through the frame. These two data sources can be combined to calculate a current position, as well as a direction vector.

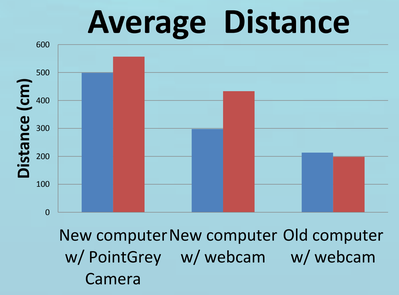
Method

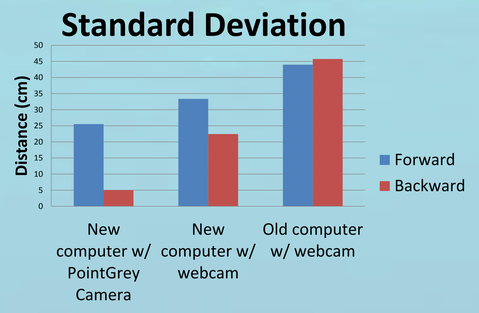
Optical flow is used to create a 2D vector field based on the difference of two consecutive image frames. By calculating the magnitude of each vector, the vehicle's distance traveled can be calculated. A differential filter is applied to the original image to emphasize features, increasing the accuracy of the vector field.

As a secondary system, a set of four hydrophones will be used to localize off of a pinger. By tracking this data over time, the accuracy of localization measurements will be increased.

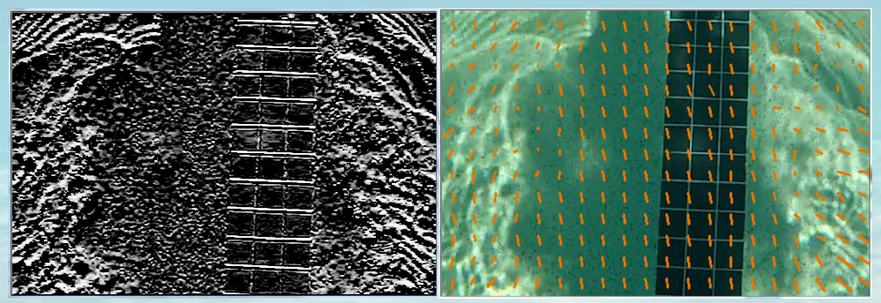
Current Test Results

Tests were conducted in a static lab environment over a distance of 5m. With the upgraded computer a higher frame rate was achieved. This higher rate allows for increased accuracy, due to the lower pixel deviation between frames. By switching to PointGrey cameras, the accuracy of the measured distance increased. By having a clearer image more data points were identified, which allowed for an increased number of samples. This lowered the standard deviation of measured distance significantly.





The following two images are from test video taken in the pool. The left image is filtered to accentuate features. The right image shows the vectors calculated from the video. The vectors are accurate for the area under the shadow of the vehicle. Regions with surface refractions are too noisy to be usable.



Challenges

- Electronics must be waterproofed
- Movement speed partially limited by frame-by-frame processing
- Image blurring increases with speed
- Low light environments
- Unfamiliar environments
- Limited power
- Changing camera distance from bottom surface

Conclusions

- Availability of processing power provided sufficient overhead for processing frames
- Superior image fidelity allowed for improved movement determination
- Surface refractions can cause unstable data
- Increased distance from bottom surface allows for quicker movement while retaining accurate measurements
- Current test results are promising for continuation of this project.

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