Automatic Detection of Seagrass Holes Using Floating RGB Camera Platform

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The goal of this project is to develop an onboard algorithm for automatic detection of disturbances in seagrass beds. Seagrass meadows provide numerous benefits to the ecosystem such as CO2 absorption [1], marine habitat [2], and soil stability [3]. Unfortunately, the expansion of human communities around coastal waterways has severely impacted the seagrass beds. Boat propellers and anchor disturb the meadows, resulting in scarring and habitat loss. [5] Natural disturbances such as flooding, weather and invasive species also affect the productivity of the seagrass meadows. Mapping seagrass disturbances, such as potholes, helps assess seagrass health which can be beneficial to the conservation effort.

Side-scan sonar imagery has been shown effective in [5] for automatic detection of potholes. However, the algorithm was applied offline. Of interest in this research is using onboard detection that could be later used to guide autonomous missions. For example, potholes discovered during a course scan of a region could be used to autonomously plan a mission to follow the edge of the hole and collect more detailed imagery. For the current project, only the detection algorithm is being developed since the autonomous boat is under construction. Instead, a floating platform with an RGB camera with auto-focus is drifted or manually pushed to collect data. While RGB is not effective for deeper water where little light is allowed the reach the bottom, it can be effective for shallow water which is often rich in seagrass meadows. It will be interesting to evaluate in what conditions RGB will be viable and when the turbidity is too high. The basic implementation idea is as follows. First, collect initial data**:** Drift the platform at various locations in the Laguna Madre to collect seafloor imagery. Ensure that a variety of surface types, such as seagrasses and sand, are covered. Second, perform image enhancement since analysis is expected to perform better on images that are less affected by water-column light attenuation, noise, and the blur of the drifted camera platform. In this stage, image quality will be improved, but with an emphasis on efficient operations usable for onboard processing [6]. Images are to be clustered into benthic categories such as seagrasses, sandy, etc. For the purpose of pothole identification, the main categories of interest are “seagrass” and “not seagrass”. However, some types of images are unusable due to severe turbidity, such images should be considered “unknown” since they cannot be used to determine presence or absence of seagrass. The clusters should be generated and shown to the user with a group of representative images so that the user can specify which targets (seagrass) are and which are unknowns. The platform should be drifted or towed over an area to record the benthos. At an interval based on the drift speed, images will be recorded, categorized and added to a logical map of seagrass presence. By segmenting regions surrounded by seagrass, potholes and other disturbances should be detected as the map is being created.

Because the platform is being manually drifted in shallow areas, the person deploying the platform can record the presence of potholes. These can be compared to the holes found by the platform. Timestamps will be used when holes are found to evaluate the effectiveness of the onboard processing, by seeing how quickly holes are discovered after the needed imagery has been collected.

The research uses a novel floating platform with a GoPro in the water with onboard image processing using a single board computer. Also, using RGB camera for seagrass pothole mapping is a novel application.

Task Plan

1. Build Platform [Evan]

2. Collect data for clustering [Evan]

3. Image enhancement:

   A. Light correction [Mominul]

B. Blur correction [Evan]

C. Noise correction [Mominul]

4. Clustering images [Mominul]

5. Develop onboard algorithm for enhancement [Mominul]

6. Develop onboard algorithm for pothole detection [Evan]

7. Perform field test and evaluate [Mominul, Evan]

References

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