ELECOMP CAPSTONE
VIRTUAL SUMMIT
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THE UNIVERSITY OF RHODE ISLAND

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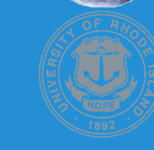

Drones and the Bay

A program for mapping ocean currents using drone footage

RHODE ISLAND CONSORTIUM FOR Coastal Ecology Assessment Innovation & Modeling

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Technical Director: Dr. Baylor Fox-Kemper | Associate Technical Director: Dr. Stephen Licht

Project Motivation

Green and renewable energy is becoming a necessity in coastal areas. Rhode Island being a coastal state with almost 150 square miles of bay area, there's no question why researchers are looking into new types of renewable energy. Researchers at the University of Rhode Island's school of oceanography are looking to place underwater turbines throughout the Bay. As part of this research, we need a low-cost and reliable method to measure ocean currents throughout the Bay.

Our team developed an accurate method to detect currents using a drone. This method is low cost when compared to using satellites, buoys or sonar and is much more convenient and precise than drifters. Using a still, downward facing video taken with a drone, our team can find water surface currents in a matter of hours, giving researchers the opportunity to take precise measurements of powerful, sufficient velocity, consistent and reliable waves for efficient use and placement of marine turbines.

Key Accomplishments

Functioning Code: The code was properly debugged and ran as expected (Fig 1 & Fig 2). The main issue in installation was finding the correct pathing for each individual user and the set up of the mediainfo resource tool. A simplified guide was created to help future users of the program install and use it; along with added instructions on how to calibrate the script, which is key to use with different drones and resolutions. An extremely useful method was added to the code which saves the analyzed data values that we look for into an excel sheet (Fig 3). The added feature created for convenient comparison and studying of the data.

User Friendly: The code has been adapted to make it as easy as possible for any user to install and run through the program each time without having to manually change pieces of the code. It is now much simpler to select the desired video and save the results obtained in MATLAB to selected folders. This causes less confusion running the program and limits touching the code which can lead to possible errors.

Github: A GitHub repository was successfully created to tackle or change the code more effectively as a team. The program allows for easier adaption of code changes or implementations completed by other members, opposed to digging through different parts of the code copy and pasting the changes. The repository allows for an easy one time update of any changes made which makes debugging many times easier. A section is dedicated to this in the guide if users are interested in making changes to the code.

Code Guide: The guide was created with the intent to help users have an easier experience installing and adapting the code for their own use. It includes the steps for installing the code along with its components (focused more for the windows OS). There are detailed instructions on how to create a calibration file when using a non DJI drone and a drone with a different resolution. A section is dedicated to the square size parameter (among other parameters) for comparison of how different values change the amount of windows for analyzing footage which affects accuracy, time and cost, all dependent factors the user seeks. An added section is included for other troubleshooting problems encountered when debugging and altering the code.

Flying Conditions: The user guide includes a section to show users the proper flying conditions of the drone including weather conditions, altitude above the water and proper lighting. The largest factors that affect the accuracy of the program are shaky drone footage, improper lighting and any light reflection coming off of the water, therefore the user guide walks potential research teams through the process of buying the correct drone for the project, and how to try to mitigate any negative effects caused by improper lighting.

Going Above and Beyond: The team has started collecting data at the Providence river near the Save The Bay campus, the data that is being collected will show the movement of hypoxia around Narragansett Bay. This will give Baylor's research group up-to-date information on how the Bay is changing over time, rather than working with past data, his research group now has the ability to collect data much faster than was previously possible.

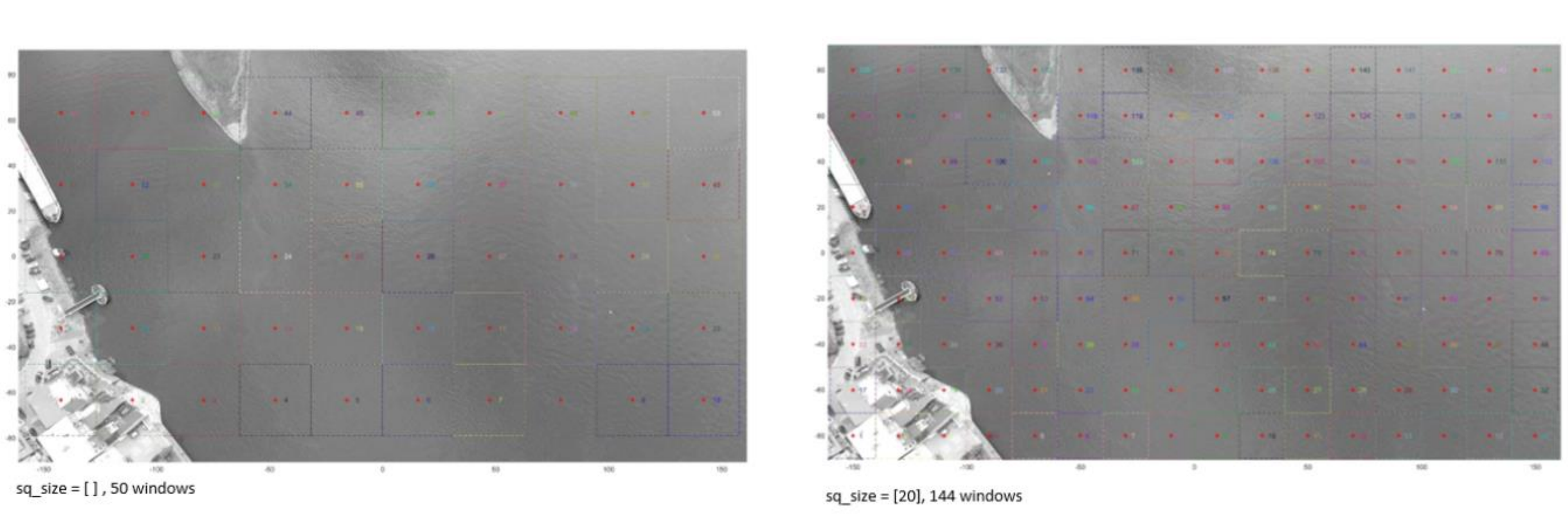

Fig 4: One of the changeable parameters (sq size) that dissects the video image from stcfit script into separate windows for more accurate analysis but at the cost of longer time (default value vs 20)

Anticipated Best Outcome

The best outcome is :

- A complete MATLAB program that is able to measure wave velocity fields and create a velocity gradient map for each video taken with a drone
- Instructions were also created for the program; so the project can easily be adapted by other users. It will include: optimal weather conditions, ocean conditions, a guide for drone flying, and how to install and run the program to obtain the most accurate wave velocities.
- Further steps have been taken to find the current fields throughout Narragansett Bay; this will help Dr. Baylor in his goals for finding where to place hydroelectric turbines.

Project Outcome

The Anticipated Best Outcome has achieved as confirmed by our Technical Director. A fully functioning system has been refined to give ocean current velocity vectors using a drone, a video and the Matlab Code.

Figures

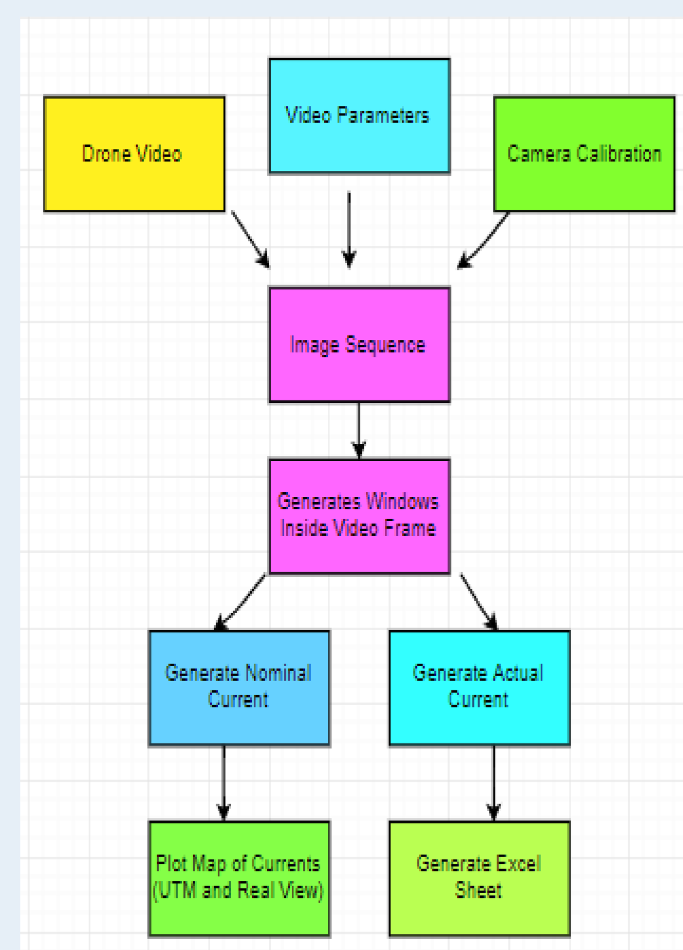

Fig 1:Software flow diagram

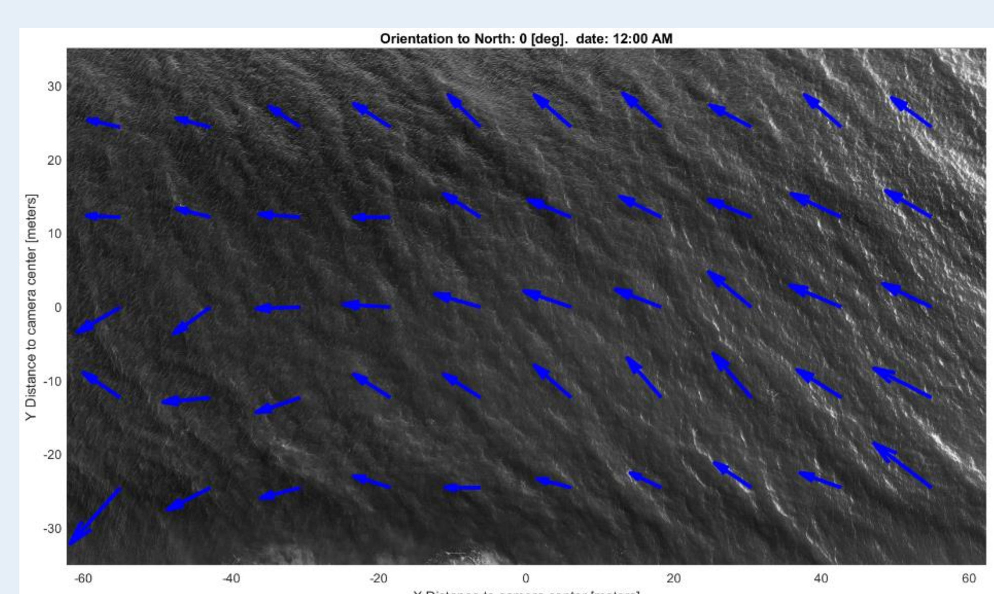

Fig 2: Video taken 300 ft above the shore of Misquamicut Beach, analyzed for 30 seconds: Program run time: 1.917 Hours

0.3	0.82	29.456294	Longitude	41.32272396	time_limits	0	3
0.3	0.78	27.486823	Latitude	-71.80347595	dt	0.1	
0.3	0.7	22.427654	Height	102	sq_size_m		
0.3	0.52	22.796457	Timestamp	0.000418888	sq_dist_m		
0.2	0.4	26.821364	Yaw	0	mask_2D		
0.2	0.25	27.187211	Pitch	-90	nan_percentage_thr	5	
0.2	0.01	29.141185	Roll	0	Ux_limits_FG	-2	2
0.2	-1.38778E-16	25.578819	Extra	1	Uy_limits_FG	-2	2
0.4	0.22	25.034687	Run Time	10 Minutes	U_FG_res	0.1	
0.3	0.5	20.131553	Frames	75	w_width_FG	1	
0.1	-0.18	36.562853			U_SG_res	0	
0.2	-0.21	27.305234			w_width_SG	0.5	
0.2	-0.2	35.482657			waveLength_limits_m		
0.1	-0.17	44.655572	**Date**	11/13/2020	wavePeriod_limits_sec		
0.2	-0.17	41.901763	**Drone**	Mavic Mini	water_depth_mask_2D	10	
0.2	-0.3	41.317685	**Location/Coordinates**	Misquamicut Beach: 41.3248893127819, -71.79057074319458			

Fig 3: Excel implementation to automatically save important analyzed data (portion of full data saved)

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