CSE161-prog1

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Abstract

Coastal analysis is important for engineering, logistical, and ecological purposes. This paper focuses on two video clips, one from Seabright and the other from Manresa beach, and attempts to analyze the swash zone for coastal erosion purposes. This is achieved by creating timeline, vector, and time exposure visualizations. The results were shown that there exists a swash zone on both beaches and that there is a greater wave up-wash over time. This could possibly lead to greater sediment deposit for this particular time.

1 Introduction

Beaches are structures of coastline that are formed by sediment being deposited by waves onto some base, usually bedrock, over time. There are two sections of beach, a dry and a wet beach. Wet beach contains the nearshore which can have structures called sandbars. Sandbars play an important role protecting the beach by dissipating wave energy and helping to prevent erosion. Dry beaches are comprised of areas called the runnel, berm, and berm crest and are influenced heavily by the swash process. The swash process is the continuous wave action that breaks on the shoreline and moves sediments and debris up and down the beach called cross-shore sediment exchange. This up-rush and back-rush of waves either significantly influences erosion or accretion. This is determined by the beach slope gradient and the resulting net impact of up-rush versus backwash, as backwash removes sediment and up-rush deposits it [7].

This understanding and subsequent analysis of coastal areas are important areas of research not just for environmental science but for engineers designing piers, wharfs, and various structures that extend out into water [4]. City planners must be aware of their coastal situations to prepare for rising sea levels, storm patterns, and other beach threats like human activity [3]. Proper management of these areas is critical, as is it estimated more than 100 million people live within one meter of mean sea level. Beach cities like San Francisco must prepare for the rise in sea elevation in order to protect important structures such as bridges, homes, and sewage lines to circumvent disaster [7]. Normally beaches would naturally move further inland, but in coastal communities beaches will disappear as there is no place for them to go.

Not only this, but storm patterns and wave movement tend to be strongest during winter in Santa Cruz. Strong storms in winter eat up coastline and push it underwater shrinking the size of beaches. Certain events like El Nino also contribute to fluctuations in beach sizes [3]. This fact is important to consider as the video gathered for this paper is dated from February 15th, 2019.

Traditional ways to monitor coastline often are expensive and involve the set up of numerous sensors and direct deployment of agents in the field to collect data. Remote sensing is more viable as it still can be autonomous and provide robust nearshore measurements. One such method for remote sensing is the installation of video monitoring systems to collect video data on shoreline movements and patterns that are stored on computers and can be later analyzed by teams. Now with the ubiquity of onshore surf cameras and live web streams all over the internet, we can collect this form of data and produce meaningful analysis of coastline changes cheaply and effectively [4].

This work is aimed to simply make simple analysis of provided video data in an effort to draw some conclusion about Santa Cruz coastlines in winter months.

2 Related Works

Due to the significance of coastal erosion, there are numerous examples and studies motivated to provide information on how to protect cities and structures from damage. Analysis of video streams has become common practice with methods such as timestack, timelines, and the creation of images such as Variance, Timex, Dark, and Bright. These can be used to identify sandbar locations, wave run-up distance, sediment plume identification, as well as wave break lines. In general, the lengths for these videos are around 10 minutes.

Time stack is visualization method that creates a slice along the horizontal axis of the beach over time. This visualization was originally produced with the intention of studying wave run up along the shore [4]. This can help identify swash zone over time on a particular spot of the beach.

Timeline creates a seed line of "buoys" which are laid across parallel to the shore line. This visualization allows us to see the invisible movements over time of sediment and currents. In our use of this, we display the original timeline in black and the changes to the vector field over time in blue.

Other methods include placing sensors with GPS transmitters in physical locations. LiDAR, aerial photography, satellite imagery, and wave radar are also used for coastal monitoring to solve similar problems [4]. With procured data, there are tools for analysis such as optical flow pattern detection, as well as machine learning models to identify certain unique features.

3 Data set

Data was presented as a .raw video of video taken from Seabright and Manresa beach in Santa Cruz, California. The Seabright video is a 4K resolution drone video taken by Fahim Khan and the Manresa video is a streamgrab from surfline.com. Manresa beach is at 39.83°N and 123.83°W, while Seabright beach was taken around 36.96°N and 122.00°W. There are four original files with each each beach having its own scalar and vector file [4].

The scalar video is composed of three RBG values. The type of the scalar video was unsigned char. Collected vector files were composed of two vector components, X and Y, to indicate direction and movement and were presented as datatype long.

For both data sets, the video frame size is 1028x720 and consists of 512 frames. This means for vector values there are a total of 943,718,400 values captured in the multiplication of dimensions 2x1028x720x512. Similarly, the scalar data sets have a total of 1,415,578,000 values. The frames of each data set were analyzed in order to produce visualizations.

Since data files here were compressed and trimmed to accommodate to undergraduate work, there is some loss in these data sets and be seen later in the results section as not all values were preserved in the transition to raw state. The data sets were trimmed and processed using Pyhton's OpenCV library [4].

4 Methodology

4.1 user interface

Users should have python3 installed. If on a Unix or Windows machine, users should cd into the directory with the program they want to run and execute the file from there by running command:

python3 <name of file >.

Users then have the ability to input the file path of Manresa or Seabright raw files. There are four program files in total.

manresa_vector.py and **seabright_vector.py** file was used to produce the timelines. It takes the _vector.raw files and outputs a GIF timeline. Note, manresa and seabright both take the long encoding. **timestack_scalar.py** takes _scalar.raw files of the respective beaches and produces both a static PNG and a moving GIF of the timestack. Finally, **timeex_scalar.py** takes the same file type as _scalar.py types and produces a static time exposure image.

4.2 Approach

For the purpose of analyzing swash zone three visualizations were produced. The approach to create these visualizations will be discussed below.

Timestack

Since time stack is a slice of the beach at a given position, we were able to cut each frame in half and collect the array of scalar RGB values from the raw file. This was done at the half way point between 0 and 1280 which was deemed to be 640.

After taking this slice, we ended up with 512 arrays and appended them together, first to create a static PNG, and secondly to create a moving GIF to allow viewers to get a sense of the temporal distance between slices.

TimeEx

Time Exposure is the average of all pixels on the screen over time. Thus for each pixel we calculated the average starting from the top left most point of every frame and adding them consecutively in an array. At the end each RBG component for every boxel was divided by number of used frames, the number of frames we chose, to produce the average colors for the time duration.

Timeline

Timeline required a good starting seed to determine a visualization that wasn't too crowded but still provided good information on flow. This was done by trail and error. Eventually a seed of 40 was determined for Seabright and a seed of 160 chosen for Manresa.

In addition to this the timeline seed location was important. Since timeline needs to be placed parallel to the shore this was straight forward in the Seabright case since we could use a straight line. In Manresa however we calculated a slope angle of .3 to seed along. The starting seed point was in the bottom left and ended in the top right. Later, the seed points were connected using a blue line on every frame while the initial seed line was left in black.

5 Results

5.1 Timestack

These are the two visualizations produced.

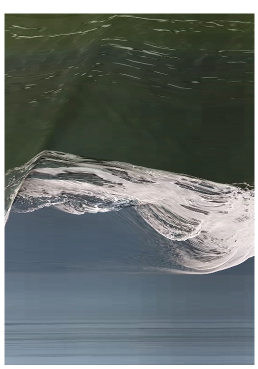

Figure 1: Seabright timestack

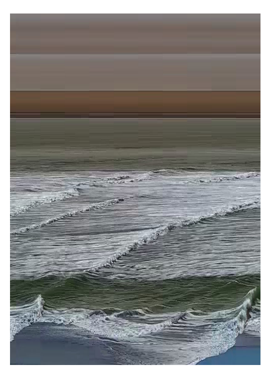

Figure 2: Manresa timestack

5.2 Timeline

These are the figures produced from the timeline. These are images of the .gif produced.

We begin with the Manresa timeline files.

Figure 3: Manresa timeline at begining of video

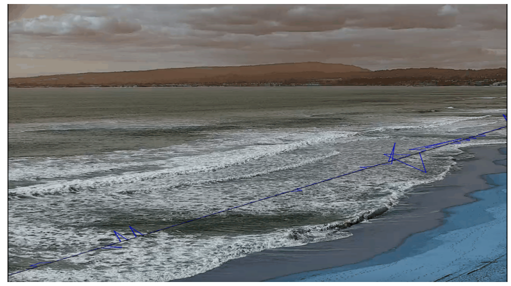

Figure 4: Manresa timeline towards end of video

This is the corresponding timeline for Seabright.

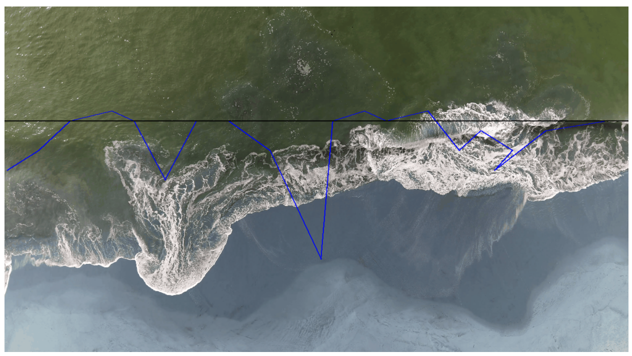

Figure 5: Seabright timeline at end of video

5.3 TimeEx

This was the result of the time exposure.

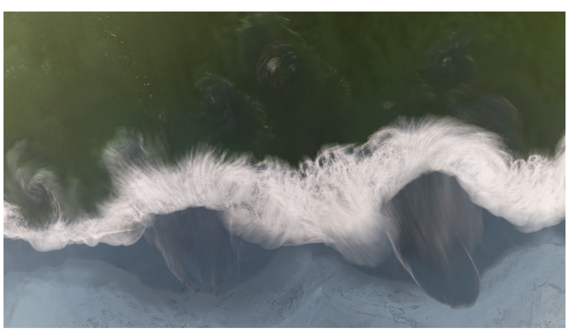

Figure 6: Seabright time exposure after 128 frames

Figure 7: Manresa time exposure after 128 frames

6 Analysis

In the timeline we can see the vector flow of the current for Seabright seems to be moving towards the beach. There is much less movement in the Manresa timeline so it difficult to say the total extent of the coastline behavior.

In both timestack images we can see that the waves are moving closer to shore in the interval they are in. We can clearly see the wave run up begin towards the end of the timestack for Figure 1 and a slight forward bump in Figure 2. Due to the thickness of the waves coming up onto the beach it might be reasonable to say that the wave velocity is not very fast. This could be explained perhaps by a beach slope gradiant that is not very high. While timestack allows us to see the back-wash and up-wash behavior, time exposure is interesting because we can see the extent of the swash zone. In Figure 6 and 7 we can see and delimit the zones of the beach. The white part shows us the swash zone and beyond where there are darker parts are possible sandbars. Figure 6 shows us no dark sandbars, but we do see that the right side of the beach experiences a larger swash zone. It might be possible that this segment at the beach was experiencing strong wave energy, since the swash height is higher. This coupled with Seabright's timeline in Figure 5 helps show the fluctuations along the beach with a stronger wave run-up in the center.

Manresa beach on the other hand does have a darker region indicating possible sandbar. Not only this but we see the full extent of the up-wash across the beach which seems to be a long swash zone area. Despite all the wave energy we still see a rip dominate the lower middle left of the field. Seeing the rip could further support the existence of a sandbar. This sandbar may help prevent erosion on this beach.

It might be reasonable to say that in both beaches at the time of collection there was a relative net deposit of sediment onto the beach.

7 Limitations

With the coastline being such a dynamic place of change, it is quite certain that these results need more analysis to support them. It is unknown further what time of day the data was collected which could also alter results and corresponding analysis. Not only this, we are limited to these sections of beach in this study, and thus future work would have to involve the collection of larger stretches of beach for a longer duration.

A Appendix

To access files and GIFs for these visualizations please go to the link here.

The link is also provided here:

https://drive.google.com/drive/folders/1wXTwrHUqaYFm8TuVjdDb2x5LcKdLM4lF?usp=sharing

B References

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