Panama Canal Tracking
Counting boats through the locks
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Abstract

Every day, over 50 ships go through the Panama Canal. And as security tightens around every port, the canal will become an important area to keep track of ships that are traveling. Currently, multiple types of ships go through the canal, from small recreational boats to large container ships and cruise ships. In this project I seek to be able, given webcam images, to distinguish among types of boats, and give counts of each type over a certain time period. In this preliminary analysis, I have determined some characteristics of certain types of ships and the methods by which I hope to do determination.

Introduction

There are thousands of cameras being used every day to record public and private spaces. Some of these cameras are published onto the Internet, and become public webcams for everyone to see. At the Panama Canal, there are three webcams, each of which has a different focus[1]. Through these webcams, you can track who goes through the locks and when, and how long it takes. With the recent increases in security, especially those in shipping, it could be beneficial to be able to automatically count the different types of ships that go through the locks, as a verification method for the kept records.

Background

The Panama Canal was officially opened on August 15, 1914, and the land and operations were controlled by the United States. In 1999, Panama finally gained full control of the land and the locks.

The Panama Canal is of strategic importance because it significantly reduces transit times from the Pacific Ocean to the Atlantic Ocean. For example, for the transit from San Francisco to New York, the distance before the canal was 14,000 miles, as they had to go all the way around Cape Horn. Now it is closer to 5,000 miles[2]. This reduction in distance makes it an essential part of trade today.
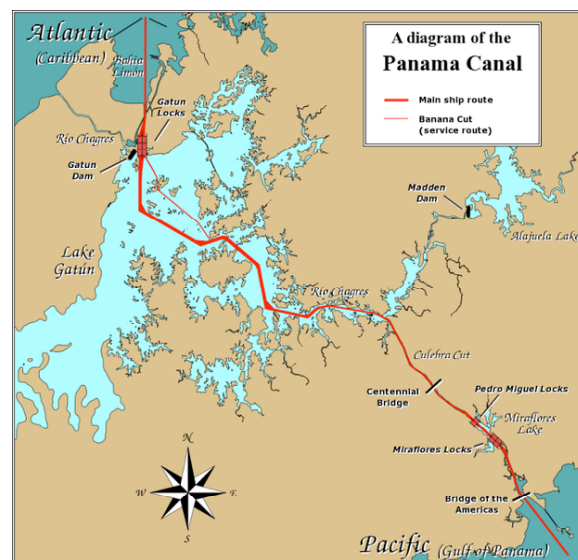
A number of different types of seagoing vessels use the Panama Canal. These vessels (in this paper I refer to them as boats) can range from small motorboats to large freight carriers as well as cruise ships. Small motorboats and tugs count as

"small" boats, while freighters and cruise lines are "large" boats.

A false negative would be when the program does not find a boat that is within the picture, and a false positive occurs when it marks a region which is not a boat as a boat.

Methods

My intent for the project was to create a program that could determine whether or not there is a boat in the field of view of the camera, and then mark each boat that it found. Using a set of images taken from the Centennial Bridge every two minutes over the course of approximately three days, I performed some mathematical analyses to see how I could mark a region where a boat was in the image.

The first step was to create an average image against which to compare an image for boat detection. I decided that, given the issue of changing daylight patterns and lighting throughout the course of a day or a week, that a moving average would provide the best ground for a comparison. Five images provided an average that can be seen below:


In this image, you can see the ghost of a freight ship passing through the image,

as well as a couple images of a smaller boat going in the opposite direction. Although the ghosting exists, its presence is still significantly less than that of an actual boat.

From the average, I took a standard deviation for the image, which appeared as so:

Again you can see some of the ghosting and water movement, but it is small, as the picture is relatively dark. I then compared this image against the difference between the following image and the average, and made images based on threshold values by color, to determine which channels would see the most difference. Because light changes can create differences above the standard deviation if the light patterns were consistent in the previous images, I chose to create a threshold of 32 for each RGB difference from 0-255.
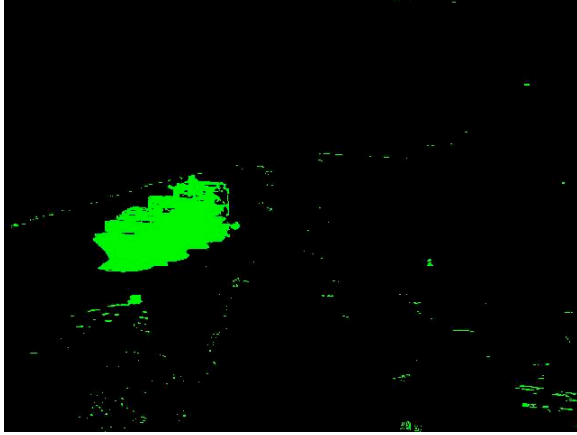
Once I get a threshold image (as above), I use it to go through and mark regions by looking for colored pixels and then iterating through and marking adjacent colored pixels. For regions above 50 pixels in size, I add them to a list that tracks the number of pixels in the region, and the min/max x/y coordinates of the region. I then make versions of the image which highlight the regions it thinks boats are in by coloring them red, and also take counts of the number of regions it thinks are boats.

Results

Currently, I have a good success rate at finding large boats, but not as much success finding the smallest boats. In the following picture we can see a number of different regions the program identified and did not:

In the picture, you can see that the large boat and one of the small boats has been marked. However, one small boat was not marked, and there are a few blocks marked underneath the bridge and one towards the bottom of the image. For this image, it counted 5 boats: two correctly identified, one unidentified, 3 misidentified, and numerous small regions which were not mis-marked.

In the above image, both boats were properly identified and no extraneous regions were misidentified.

Discussion

The current problems in my program are related to mistakenly marked regions, particularly due to light changes. I can solve some of these problems by creating a mask that will ignore the parts of the image that are not the river. Another way may be through looking at the region dimensions—a long thin mark is less likely to be a boat than a more square one, so I may be able to exclude some not-boat regions that way. One more way I may be able to minimize the number of incorrectly marked regions is by being more careful as to whether or not the image parts are brighter or darker than the average. If they are brighter, it is more

likely to be the cause of a sudden bright period of time, where otherwise it is more likely to be a boat.

For my final exploration, I would like to try to increase the total accuracy of the program. I believe I can significantly decrease the number of things marked incorrectly as boats. I would also like to provide a report of the number of boats it guessed in the image.

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[1] Panama Canal Webcam.
http://www.pancanal.com/eng/photo/camera-java.html
[2] Scott, William R. *The Americans in Panama*.
http://www.czbrats.com/AmPan/index.htm
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