COMPUTER VISION

Sea and Boat Detector and Tracker

Introduction

Automated analysis of traffic scenes mainly focuses on road scenes. However, similar methods can also be applied in a different scenario: boat traffic in the sea.

The goal of this project is to develop a system capable of: 1) detecting boats in the image, 2) segmenting the sea in an image, and 3) tracking the boats in a video. The number of tasks you should face is as follows:

- If you develop your project alone, you should develop only point 1;
- If you work in a group of two students, you should develop points 1 and 2;
- If you work in a group of three students, you should develop points 1, 2 and 3.

You should consider that the sea surface is not regular and it is moving (and could lead to white trails), and the appearance of a boat can change sensibly from model to model, and depending on the viewpoint.

Boat detection can be tackled in several different ways: the ultimate goal is to locate the boat in the image (e.g., drawing a rectangle around the boat). Consider that the boat can appear at any scale. In case a boat dataset is needed (if you plan to use machine learning) you can find two datasets at these links:

http://www.dis.uniroma1.it/~labrococo/MAR/classification.htm

https://www.kaggle.com/clorichel/boat-types-recognition/version/1

Regarding sea segmentation, you should highlight the pixels in the image corresponding to the sea region. You are free to choose the best method for visualizing the segmentation output. While developing the project, please bear in mind that:

- Images without sea and/or boats shall be correctly analyzed
- Boats can appear from any viewpoint
- The presence of a boat does not imply the presence of the sea, and vice-versa

Performance measurement

You should evaluate the performance of your approach considering:

- For boat detection, the Intersection over Union[1] (IoU) metric;
- For sea segmentation, pixel accuracy[2] for both classes (sea, non-sea);

[1] https://www.pyimagesearch.com/2016/11/07/intersection-over-union-iou-for-object-detection/
[2] https://towardsdatascience.com/metrics-to-evaluate-your-semantic-segmentation-model-6bcb99639aa2

- For boat tracking, a quantitative evaluation is beyond the scope of the project: you shall provide a video showing the results from a qualitative point of view.

The metrics mentioned above need to compare the output of your system against the ground truth, namely what is considered "the truth" for each output image. Collecting the ground truth is a time-consuming task that you need to perform – but you are free to share the output of the ground truth with other colleagues belonging to other groups. In other words, you are allowed to cooperate with everyone to share the ground truth collection.

The ground truth is usually stored in a set of (text) files, one file for each input image. The information representing the ground truth (e.g., the rectangle enclosing the ship/boat or the pixels belonging to the sea) is expressed in such text file based on a standard that you can define (and you should describe in the report). Such standard might be extremely simple, e.g.:

- For object detection: every object is found inside a rectangle defined by two opposite corners, whose coordinates are listed in a row, one object per raw;
- For segmentation: a black & white mask for discriminating sea vs non-sea.

You are free to define your own standard. If you agree with other groups to share the ground truth collection, be sure to share the standard. The organization of the ground truth collection is completely free; if you wish, you can use the dedicated section in the moodle forum.

Project delivery

The project must be developed in C++ with the OpenCV library. The only allowed exception is the usage of Python code for the deep learning part if you decide to exploit this family of techniques.

You need to deliver your project including:

- All the source code (both C++ and Python);
- CMake configuration files (the use of CMake is mandatory);
- A report (no page limit) presenting your approach and the performance measurement on a set of images detailed below.

If you work in group, you should **clearly identify** the contribution of each member in terms of ideas, implementation, tests and performance measurement. You can organize the work as you prefer: you are not forced to assign one specific step to each group member. Please also include **the number of working hours** per person in the report. This is needed for a monitoring on our side on the effort requested – the evaluation will not depend at all on the number of working hours, but on the quality of the result.

You should include in your report the results of the boat detection + sea segmentation (both output image and metrics values) for the following images:

Images belonging to the MAR dataset:

- https://drive.google.com/file/d/1kCgOFIP7meuUDh49BYxGyTYTg-kJQwys/view?usp=sharing

Images belonging to the Kaggle dataset:

- https://drive.google.com/file/d/1PToX_LH4JsjU2rSiD4vJQSV80cojxy5m/view?usp=sharing

The boat tracking system shall be tested on the following videos:

- http://www.diag.uniroma1.it//~labrococo/MAR/private-videos/20070928_1425_c04-C.m4v

- http://www.diag.uniroma1.it//~labrococo/MAR/private-videos/20120605_0803_H25-c2.m4v
- http://www.diag.uniroma1.it//~labrococo/MAR/private-videos/20120605_0803_H25-c1.m4v

And the output videos should be uploaded on a shared resources (e.g., Google drive provided by the University).

Feel free to add more test images, taken from the internet or acquired using your camera.