Obstacle detection in sonar images using deep learning techniques

Introduction to Fleet Cleaner

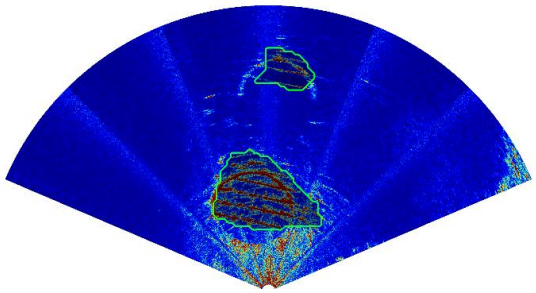
FIGURE 1: THE FLEET CLEANER ROBOT

Fleet Cleaner develops and deploys cleaning robots for ship's hull. We are an innovative techno startup based in Delft and have recently entered into the commercial phase. With our unique robot we offer the most complete solution for ship hull cleaning on the market. The robot is able remove all the fouling from the ship's hull, both above and under water, during loading and unloading in port; thereby reducing fuel costs and down-time.

Research objectives

As the robot usually operates is in turbid waters, camera vision is of irregular and poor quality. Therefore, for navigational purposes the robot relies heavily on an acoustics camera called a *forward looking sonar (FLS)*. This device gathers visual information of objects and fouled areas on the ship's hull in the form of a sonar image (see Fig 2.). The image is interpreted by the combined efforts of an operator and computer vision algorithms. From the operator's point of view, automated obstacle detection on FLS images would greatly facilitate the ease of operation. Furthermore, it provides the means towards developing an autonomously operated robot.

FIGURE 2: DETECTION OF BOW THRUSTER WITH A FLS



In a previous study, algorithms were developed for the detection of operation critical objects, like the waterline, the bilge, bow thrusters and sea chests (see Fig. 2). Currently, these algorithms rely on handcrafted rules and features. However, it is well-known that learning rules and features directly from the data, by making use of deep learning algorithms, may result in a better performance.

For computer vision applications, deep convolutional neural networks (CNN) gained a lot of momentum due to their empirical succes on camera images [1], but also sonar imagery [2]. Since CNNs learn directly from the data, they are able to uncover more useful clues for discriminating between objects and background, when compared to engineered rules and features. *Therefore, this MSc. thesis project focuses on the development of a FLS-based object detection framework that uses CNNs, or other deep learning approaches.* The algorithms should be able to:

- Outperform the detection accuracy of the rule/feature-based algorithms that are currently in use.
- Detect objects while using a limited amount of training data.
- Detect all objects on a ship's hull.

Arguably, detecting passable and non-passable regions in the image is sufficient for save navigations, hence identifying the obstacle type (some obstacle vs. bow thruster) may be less of a concern.

This assignment is a cooperation between Fleet Cleaner and the Aircraft Noise and Climate Effects section of the Aerospace Faculty at the TU Delft. We are looking for a talented and enthusiastic MSc student, preferably with a background in computer / sonar vision, machine learning, deep learning, or related engineering fields. We offer:

- 9-12 months thesis assignment at Fleet Cleaner (in the Delft office)
- Actual implementation and testing of your research in a real-world application
- Working in a innovative company with a young, dynamic, and multidisciplinary team

Interested? Contact prof. dr. D.G. Simons at d.g.simons@tudelft.nl (thesis advisor) or contact ir. D. Borota at d.borota@fleetcleaner.com (company / daily supervisor)

[1] K. He, G. G. (2017). Mask R-CNN. arXiv prepint arXiv

[2] Valdenegro-Toro, M. (2016). Objectness scoring and detection proposals in forward-looking sonar images with convolutional neural networks. *IARP Workshop on Artificial Neural Networks in Pattern Recognition,* 209-219.

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