Crack detection in inspection by a fusion of computer vision and machine learning methods

DNV GL, Høvik and Trondheim,
in cooperation with Prof. Rudolf Mester, IDI

Background

DNV GL has actively researched how to apply computer vision and machine learning techniques to automation of our remote inspection services.

Currently, we are running an NFR project, Autonomous Drone-based Surveys of Ships in Operation (ADRASSO), which aims to develop computer-vision-based framework to automate the DNV GL ship survey process. The application scenario is that an autonomous drone equipped with RGB cameras flies within a ship tank and inspects the condition of the tank by taking videos. The videos taken by the drone might be processed either on-board of the drone for real-time (defects detection) display and navigation guidance of drone flight path, or offline at the DNV GL office premise using a highly reliable and robust defect detection model.

To develop such a computer-vision-based pipeline, we have investigated several state-of-the-art object recognition models including object classification (image-level), object detection (bounding box + localization), and semantic segmentation (pixel-level) to detect the existence of a particular type of detects, i.e., cracks, in static images. Both object detection and semantic segmentation models have achieved very good results on our static ship survey images. However, we still face the challenges:

- The number of false positives ('false alarms' is to be kept as low as possible
- To achieve a very low false negatives rate (missed cracks) is very critical for the whole application.

Since the ultimate goal of the ADRASSO project is to analyse videos to reliably detect actual cracks while not generating too many false positives, we can utilize the temporal-spatial correlation of videos to combat the weakness of the object detection model.

This setting defines the environment for several research topics that can be addressed individually, or in a cooperative manner by several students.

(2) Convolutional neural network based object tracking

CNN-based object tracking is another area of our interest. The annual Visual Object Tracking (VOT) challenge is a good reference to follow the state-of-the-art results.

Our unique challenge is that the cracks often have irregular shapes such as very thin lines and follow arbitrary directions. The object detection models which output horizontal bounding boxes may not yield satisfied detection results. The object detection model which outputs oriented bounding boxes might provide better detection results (i.e., tightly bound the actual cracks).

Since VOT 2015, rotated bounding box annotations are used by the VOT committee to provide highly accurate ground truth values for comparing results. That means the winners of VOT should have developed the corresponding models/solutions to output rotated bounding boxes.

The first research question is to investigate whether existing VOT models/solutions can be used to detect cracks in DNV GL ship survey images?

However, the CNN based object tracking models require a large amount of training data to achieve a good performance level. We have labelled around 1500 images with cracks for training the object detection and semantic segmentation models by 2019. We do have around 1.4 M static ship survey images which are not categorized yet. Since we have spent a lot of effort on identifying the suitable crack images for our application, we speculate that there are not more than 2% of 1.4 M images are suitable for our application. In addition, we have a few videos taken on the ships under survey. But they may not contain too many cracks. In order to prepare sufficient training video sequences, we may need to explore how to use synthetic data to train a CNN-based object tracking model.

Therefore, the second research question is to investigate the suitable approach for generating synthetic video sequences for training a CNN-based object tracking model.

Contact person: Prof. Rudolf Mester, IDI, Rudolf.Mester@ntnu.no