

Master Thesis / Master Project

Understanding How Video Quality Affects Deep Learning-Based Object Detection: Case Study on Autonomous Obstacle Detection in Railways

Background: Due to the tremendous advances in Artificial Intelligence (AI), and Deep Learning (DL) in particular, vision-based object detection techniques using deep learning have been actively studied in recent years. It is known that the success of DL-based object detection highly depend on the amount and quality of data used for training the DL models. Commonly, DL models are trained and tested on high quality image datasets, yet in real-world applications the images can not be assumed to be of high quality due to different external disturbances during image acquisition. Because of this, it is of high importance to understand how the image quality affects DL-based object detection, and what is the image quality that is sufficiently good to be used in a vision-based object detection system using DL methods.

Within the H2020 project SMART2-Advanced integrated obstacle and track intrusion detection system for smart automation of rail transport [1], a multi-sensory on-board system for detection of objects, potential obstacles, on and near the rail tracks ahead of the train has been developed. Different camera types, 3 RGB cameras with different zooms, thermal and SWIR cameras, have been integrated into the SMART2 OD system. Multiple vision sensors complement each other in order to handle different illumination and environmental conditions. In general, cameras as visual sensors are able to provide very dense and detailed information about the environment, however in practice their performance depends highly on the ambient lighting and visibility conditions and can drastically degrade if such conditions are not optimal. As examples, the performance of RGB cameras degrade in dark environments and the performance of thermal cameras is influenced by environment temperature and for high temperatures the contrast of thermal camera images is poor.

The main goal of this student work is to investigate and implement different measures of image quality such as image contrast, brightness, image information content (entropy) [2].

For the purpose of Master Project: The quality of images from SMART2 dataset shall be measured using analysed measures of image quality. The relation between the image quality and the accuracy of the CenterNet-based object detection shall be established.

For the purpose of Master Thesis: In addition to the above tasks foreseen for Master Project, for this Master Thesis a Decision Support System (DSS) shall be developed for the prioritization of camera type based on camera image quality (illustration given in Fig. 1). Prioritization DSS is of high importance for real-time applications such as autonomous obstacle detection in railways as it will prevent unnecessary processing of data of poor quality for the object detection. Besides the calculated image quality, the DSS may consider additional input information such as environment weather condition and time of the day.

Contact: Danijela Ristic-Durrant, ristic@iat.uni-bremen.de; Marten Franke, franke@iat.uni-bremen.de

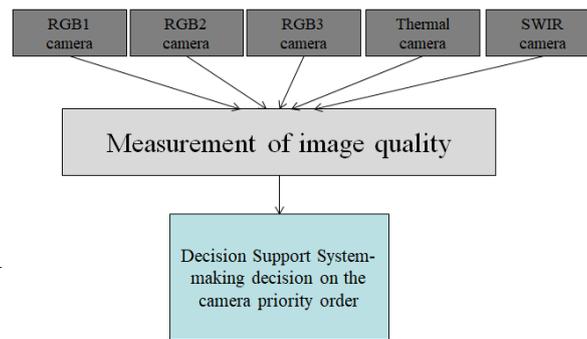


Fig. 1. Prioritization Decision Support System (DSS) in multi-sensory on-board SMART2 system for obstacle detection in railways

Requirements:

- Self-motivated, passionate about innovative applications comprising computer vision and machine learning.
- Understanding of machine learning and computer vision (sensor-based environment perception).
- Good programming skill in python.

References

- 1) <https://smart2rail-project.net/>
- 2) Samuel Dodge and Lina Karam, Understanding How Image Quality Affects Deep Neural Networks, arXiv:1604.04004v2 [cs.CV] 21 Apr 2016