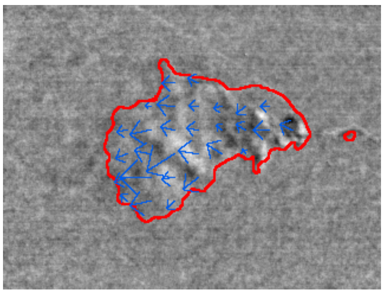
Mess- und Regelungstechnik
Univ.-Prof. Dr.-Ing Andreas Kroll

B.Sc. Thesis:

Optical Flow Computation in Gas Images with Deep Learning Techniques

Juan Camilo Dueñas

Fugitive emissions in industrial facilities can be visualized by optical gas imaging cameras. These capture infrared radiation from the gas and its surroundings without the need of an external infrared source and generate a gas image. The need of new methods for quantifying gas emissions in the industry has motivated the use of such cameras and gas images for estimating gas velocities. This quantity is of special interest, since it is required for the quantification of the emission flow rate. At the Department of Measurement and Control (MRT) of the University of Kassel, classical optical flow methods have been implemented and tested for segmentation and motion estimation of gas structures in differential gas images (see Figure). However, several aspects such as low uncertainty or low computational time have to be still improved.



Optical flow of gas structures in differential image and segmentation result.

The use of machine learning techniques, namely deep learning techniques such as CNNs (convolutional neural networks), for solving computer vision problems in the visual range (e.g. image semantic segmentation, optical flow, visual SLAM (simultaneous localization and mapping)) has shown being competitive with classical image processing methods and, for image classification and semantic segmentation problems, to outperform them in terms of accuracy and computational time. In this work, state of the art supervised, semi-supervised and unsupervised deep learning techniques for optical flow computation in visual images have to be selected and tested on gas images. The selected methods have to be adapted for the optical flow problem in gas images. For that, differences between visual and gas images that have an influence on the learning process for optical flow have to be identified. Synthetic gas images with optical flow information as well as real gas images are available at MRT for the training of the selected networks. Additionally, the adapted methods have to be tested and evaluated for computing optical flow in gas images under laboratory and field conditions and their performance has to be compared with the performance of classical optical flow methods. Different test scenarios with reference gas velocity information have to be also conceived.

The following tasks have to be addressed in this work:

- Familiarization with the topic of optical flow and deep learning techniques
- Literature research, selection of at least 3 deep learning techniques for computing optical flow and test on gas images
- Adaptation and implementation of a selected deep learning technique for analyzing gas images based on visual Vs. IR comparison
- Test of the implemented methods under laboratory and real conditions with reference velocity data and qualitative comparison with classical optical flow methods
- Documentation and presentation of the results

Supervisor: M. Sc. J. Rangel, Dr.-Ing. R. Schmoll, Prof. Dr.-Ing. A. Kroll
Start: 01.09.2019
End: 31.03.2020