

Image-Based LOCS III Score Estimation During Cataract Surgery

Franziska Katharina Rothen



Supervisors: Prof. Dr. Raphael Sznitman, Dr. Michael Steinlechner
Institutions: ARTORG Center for Biomedical Engineering Research
University of Bern
Ziemer Ophthalmic Systems AG
Examiners: Prof. Dr. Raphael Sznitman, Dr. Thomas Asshauer

Introduction

The lens opacities classification system III (LOCS III) is a well-established method to grade the severity of cataracts [1]. This form of evaluation is based on slit-lamp images and is not made to be adapted for other imaging modalities. Optical coherence tomography (OCT) is integrated within the Ziemer LDV Z8, a widespread femtosecond laser for cataract surgeries, therefore it would be beneficial to classify cataracts based on OCT scans of the eye. This study aimed to conduct a feasibility study on automatic LOCS III score estimation using OCT images.

Materials and Methods

A dataset of 1350 expert-labeled OCT images was gathered by the Dardenne Eye Hospital in Bonn. Depending on the approach, the LOCS III grades were grouped into two or three equally sized groups. Different neural networks were then trained and the performance of the respective deep learning system was compared to a predefined baseline.

Evaluation metrics included confusion matrices and gradient-weighted class activation maps (grad-CAMs) as well as performance measures such as accuracy, F1 score, and quadratic kappa score.

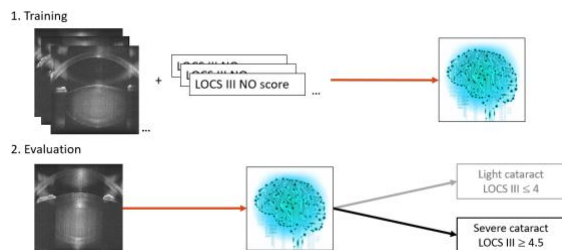


Fig. 1. Workflow of training and evaluation of a neural network. Here, the network output is a binary classification (discrimination between light and severe cataracts).

Results

The binary classifier yielded an accuracy and an F1 score of 84.38% each. Comparing different networks with different configurations, the best performance

for the three-class classifier resulted in an accuracy of 71.79% and a quadratic kappa score of 0.75.

Both these results show a significant improvement compared to the baseline (classification depending on the mean image intensity).

The grad-CAMs show an automatic detection of the region of interest.

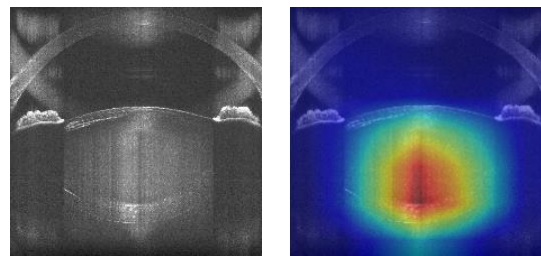


Fig. 2. Left: raw OCT image as reference. Right: combined grad-CAM of all images in the test set with an overlay of an OCT image.

Discussion

Using a balanced dataset and keeping the number of classes at a minimum by choosing a binary and tree-class classification, a first attempt at classifying cataracts yielded promising results. According to the findings, the LOCS III score estimation can be done on the raw OCT scans without needing any preprocessing such as lens extraction. For further investigation, more data regarding marginal LOCS III grades is desirable to improve the robustness and performance of the models.

References

[1] Leo T. Chylack et al. The Lens Opacities Classification System III. *Archives of Ophthalmology*, 111:831-836, 1993.

Acknowledgments

The project was supported by Ziemer Ophthalmic Systems AG and the Dardenne Eye Hospital in Bonn. Special thanks to Dr. Thomas Asshauer, Dr. Michael Steinlechner, and Prof. Dr. Raphael Sznitman for their support and expert input.