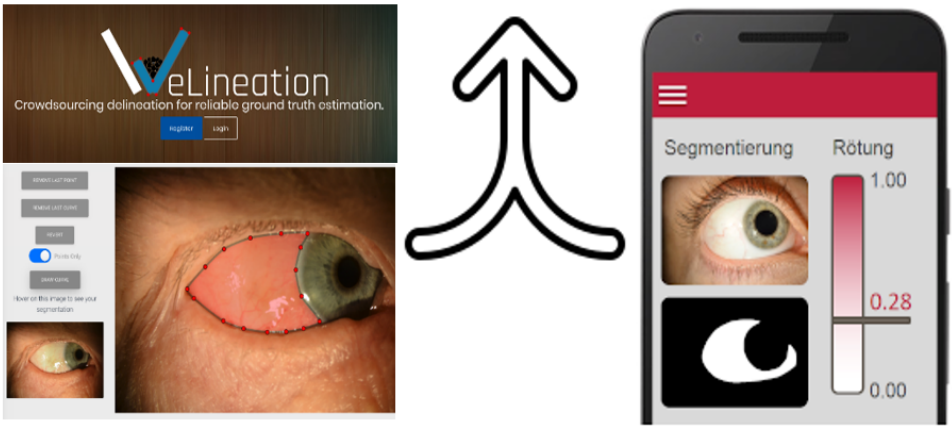

Enhancing the *WeLineation* platform and the *SmartRed* app by federated machine learning

Introduction

Since red eyes indicate not only fatigue or allergies, but also eye diseases (e.g. inflammation), monitoring of the eye redness is an important medical method. To calculate the eye redness, a segmentation of the eye's sclera is required.

The PLRI hosts the *WeLineation* research platform [1][2] which is a website for acquiring ground truth annotations for image segmentation. In the last summer, a group of students developed *SmartRed* [3] which is an Android app for acquiring images of the human eye with the smartphone camera. A pre-trained machine learning model is applied to the image for segmentation and redness measurement.

At the moment there is no connection between both systems. Therefore, a logical next step is to integrate *SmartRed* into the *WeLineation* platform, such that the acquired images are transmitted to the *WeLineation* platform. However, images of the human eye are sensible data which might reduce the willingness of some users to actually submit their images to the research platform.

Tasks

Hence, the aim of this thesis is i) to interconnect the *WeLineation* platform with the *SmartRed* app and ii) to add a paid crowdsourcing feature for users of the app gaining financial rewards for acquiring eye images and sending them (e.g. 1€ / image). Furthermore, an iii) interactive annotation editor shall be added to the SmartRed app that allows to create or modify annotation masks. Building upon these preliminary studies, the final aim is iv) the development of a *federated machine learning methodology* for users that do not agree to send their raw images.

The idea is to follow the key principles of federated learning: Images of the eye are acquired with the *SmartRed* app, the initial pre-trained model makes an initial "best guess" regarding the segmentation mask, the user corrects the segmentation, and using these ground truth annotations, local training on the smartphone is performed. Subsequently, the local models are aggregated on the WeLineation platform to acquire a consensus model which is then provided to all *SmartRed* users.

- Literature review
- Programming
- Data analysis
- Data acquisition
- Hardware set-up
- Theory & maths

Literature

[1] https://www.welineation.plri.de
[2] Goel S, Sharma Y, Jauer ML, Deserno TM. WeLineation: crowdsourcing delineations for reliable ground truth estimation. In: Proceedings SPIE 11318, Medical Imaging 2020: Imaging Informatics for Healthcare, Research, and Applications; 2020
[3] https://www.youtube.com/watch?v=UP8oakEIXSk

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