Software Framework for 3D Optical Coherence Tomography Data Annotation and Visualization
Project Management and Software Development for Medical Applications

General Info
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Project Abstract
Precise and robust segmentation of retinal layers and surgical instruments could enable reproducible and targeted robotic vitreoretinal procedures.

This project proposal aims to implement a software framework that integrates a deep learning model to segment retinal layers and that allows for the interactive correction of the segmentation results.

Background and Motivation
Subretinal injection is a challenging ophthalmic procedure that requires to insert a micro needle into the retina and to position the tooltip into the potential subretinal space (a target area of approximately 20-30 μm) [1]. This procedure represents a more precise and efficient route of ocular drug delivery for gene and cell therapies, which have the potential to improve the treatment of many degenerative vitreoretinal diseases [2].

However, unprecise advancement of the needle potentially causes harm to important retinal cells. Additionally, the subretinal injection of fluid can damage the retinal pigment epithelium layer (RPE), which is the layer located immediately bellow the retinal layers. Extensive damage of this layer can induce a retinal detachment with loss of visual function [1].

Intraoperative Optical Coherence Tomography (iOCT) is an imaging modality that provides micron-scale resolution and cross-sectional visualization of anatomical structures and surgical instruments that are not visible from the microscopic view used during surgery. This imaging modality has shown the potential to assist surgeons and to improve the outcome of vitreoretinal surgeries.

In this context, the design and implementation of algorithms that enable precise and robust segmentation of retinal layers and surgical instruments could enable reproducible and targeted interventions.

Student’s Tasks Description
This project application requires the design and implementation of a python-based software framework to annotate and visualize a database of 3D iOCT scans. The student’s tasks include:

1. The import and visualization of data sets containing iOCT B-scans that correspond to volumetric data of the retinal anatomy.
2. The integration of a segmentation algorithm for the automatic segmentation of retinal layers from iOCT B-scans.
3. A Graphical User Interface (GUI) to interact with the initial segmentation estimates:
   a) Allow for the interactive correction of the segmentation maps (when necessary).
   b) Enable the generation and visualization of volumetric point clouds resulting from the combination of the segmentation maps that correspond to the volumetric data.
Technical Prerequisites

- Proficient knowledge of Python is a must.
- Previous experience working with Machine and Deep Learning algorithms is desired.
- Proficient knowledge of OpenCV and Qt is desired.

Additionally, it is desired that the student demonstrates basic knowledge using version control software and a high proficiency writing scientific and technical reports.

References


