

Integrated GUI Development for Parkinson's Disease Diagnosis based on 3D-Ultrasound

Project Management and Software Development
for Medical Applications

General Info

Project Title: Integrated GUI Development for Parkinson's Disease Diagnosis based on 3D-Ultrasound

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Project Abstract

Transcranial 3D ultrasound has the potential to be used as an early indicator for Parkinson's Disease. In this project, a graphical user interface (GUI) will be developed, which integrates several pre-developed methods for image segmentation and analysis, allowing the usage of these algorithms in clinical research.

Background and Motivation

Parkinson's disease (PD) is a neurodegenerative movement disorder caused by decay of dopaminergic cells in the substantia nigra (SN), which are basal ganglia residing within the midbrain area. In the past two decades, transcranial B-mode sonography (TCUS) has emerged as a viable tool in differential diagnosis of PD and recently has been shown to have promising potential as a screening technique for early detection of PD, even before onset of motor symptoms. In TCUS imaging, the degeneration of SN cells becomes visible as bright and hyper-echogenic speckle patches (SNE) in the midbrain.

In the past years, the LMU Department of Neurology at Klinikum Grosshadern, together with CAMP, have proposed the usage of 3D ultrasound imaging in order to make the application of the TCUS technique easier and more objective. Several methods for 3DUS segmentation and quantitative analysis have been proposed and published, forming the building blocks of a framework towards computer-aided diagnosis (CAD) of early Parkinson's Disease.

So far, the individual components are implemented in MATLAB mainly, the operation requires coding experience and is not useful for clinicians. In order to make the scientific tools more clinically applicable, an integrated user interface should be developed, unifying the individual modules and their GUIs into an integrated framework which facilitates the workflow of the overall CAD process.

Student's Tasks Description

In the beginning of the project, the exact workflow of the CAD pipeline will be defined together with the supervisor. The requirements for the GUI will be defined accordingly. Among others, the GUI steps will probably include:

- Load and visualize 3DUS data in a 3-slice viewer with a 3D visualization panel
- Initialize a midbrain segmentation algorithm by positioning the mean-shape of a statistical-shape-model (SSM)
- Execute SSM segmentation on a cropped volume and visualize the optimization

Please send the completed document to us (Ralf.stauder@tum.de) before the project proposal deadline, April 8th. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in the case of acceptance.



- Execute a Random-Decision-Forest classification algorithm of voxels within the midbrain ROI to detect SN voxels
- Thresholding of RDF output to obtain a binary segmentation of SN voxels
- 3D Visualization of voxelization output
- Statistical analysis of voxel data to obtain a computer-aided diagnosis

Please note that for all above steps, extensive *individual* implementations and GUIs already exists. The task will be to unify these steps in one coherent GUI. Evaluation will be performed by the supervisor and clinicians associated to the project.

The main learning experience will be the building of a GUI which can be applied in a clinical research setting, and thus understanding and meeting the user requirements. However, even though a re-implementation of algorithms will not be required, a detailed understanding of 3D segmentation algorithms using active surfaces and classification using Random-Decision-Forests will be part of the project as well.

Technical Prerequisites

The project can be executed either in MATLAB or C++. Since all algorithms are mainly implemented in MATLAB, this platform is the primary choice. Extensive experience with MATLAB programming and prior experience in MATLAB GUI programming (Guide etc.) are recommended.

However, given enough interest and prior experience, an implementation in a C++ based framework (most probably MITK, which is built on Qt/ITK/VTK components) can be attempted as well. This decision will be made early in the project.

Administrative Info

Working Time: 10-20 h/week

Project Location: Arbitrary work location, but weekly/bi-weekly meetings in Garching or at Klinikum Grosshadern

Required Equipment: The student should have a laptop equipped with at least 4GB, and a MATLAB license.

Timeline and Milestones

No special timelines or milestones are planned, other than the course requirements.

References

- [1] A. Plate, S.A. Ahmadi, O. Pauly, T. Klein, N. Navab, K. Boetzel, Three-dimensional sonographic examination of the midbrain for computer-aided diagnosis of movement disorders, *Ultrasound Med. Biol.* 38, 2041-2050 (2012)
- [2] O. Pauly, A. Ahmadi, A. Plate, K. Bötzel, N. Navab, Detection of Substantia Nigra Echogenicities in 3D Transcranial Ultrasound for Early Diagnosis of Parkinson Disease, In *Proc. MICCAI*, 2012
- [3] A. Ahmadi, M. Baust, A. Karamalis, A. Plate, K. Bötzel, T. Klein, N. Navab, Midbrain Segmentation in Transcranial 3D Ultrasound for Parkinson Diagnosis, In *Proc. MICCAI*, 2011