



A segmentation and registration toolbox for multi-modality microscopic images

Project Management and Software Development
for Medical Applications



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.



General Info

Project Title: A segmentation and registration toolbox for multi-modality microscopic images

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Project Abstract

The proposed project aims to develop a segmentation and registration toolbox for pathologists to process and analyse their multi-modality microscopic images. As the key image processing algorithms involved in the toolbox have already been developed in the Chair [1], the major tasks for this project are to implement these algorithms in C++ and to design a user interface with additional interactive image processing and visualisation tools.

Background and Motivation

Recent advances in technological solutions for automated high-speed and high-resolution whole slide imaging have opened the way to digital pathology [2]. Instead of traditionally viewing a specimen under several microscopic fields, digital pathology enables one to view and analyse the entire specimen using a computer. Moreover, the development of multi-modality microscopes allows simultaneous or consecutive image acquisition on a single specimen [3]. The substantial increase of microscopic data amount, however, becomes a great challenge for manual image processing and data managing. As a consequence, computerised image processing and multi-modality data fusion methods play increasingly more important roles in helping pathologists to analyse and quantify their microscopic images [4].

Recently, we have proposed a novel deformable image registration method to align an immunohistological fluorescence image and a HE stained histological image based on a dual registration-learning method [1]. The developed image registration technique allows pathologists to spatially compare image data acquired from the two different modalities (as shown in Figure 1), hence the advantages of using each modality can be maximized. In addition to image registration, automatic segmentation methods have been developed in [1] to segment fluorescence and HE images into distinct functional regions, which have the potential to replace/partially replace manual segmentation. Therefore, using this work as a base, we would like to develop a segmentation and registration toolbox with a graphical user interface (GUI) for pathologists to process and analyse their microscopic images.

Student's Tasks Description

1. Literature review including general overview on microscopic image processing and specific technical documents relevant to the individual task.
2. Code up the segmentation and registration algorithms proposed in [1] using C++ and ITK packet (major functions in [1] are already included in the ITK). The original matlab code is also provided as a reference. This is a good training to improve the student's C++ programming skills.
3. Develop the toolbox with a GUI using MeVisLab, including the following functions:

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- a) Automatic image segmentation and registration tools using the C++ profile developed in Task 2;
 - b) Interactive manual segmentation tool (in case the automatic segmentation results are not satisfying) and image visualisation tools, using MeVisLab build-in functions / CAMP pre-developed functions;
 - c) Parameter quantifications, which are defined in conjunction with the clinical partner;
 - d) As MeVisLab modules are intended for use on the C++ level, this is again good C++ programming practice.
4. As the project is intended for two students, the first student's task primarily focuses on the implementation of the automatic image segmentation and registration algorithms, whilst the second student's task is the design of interactive segmentation and visualisation tools. Finally both students work together for parameter quantifications and GUI improvements, which will be a good teamwork experience.

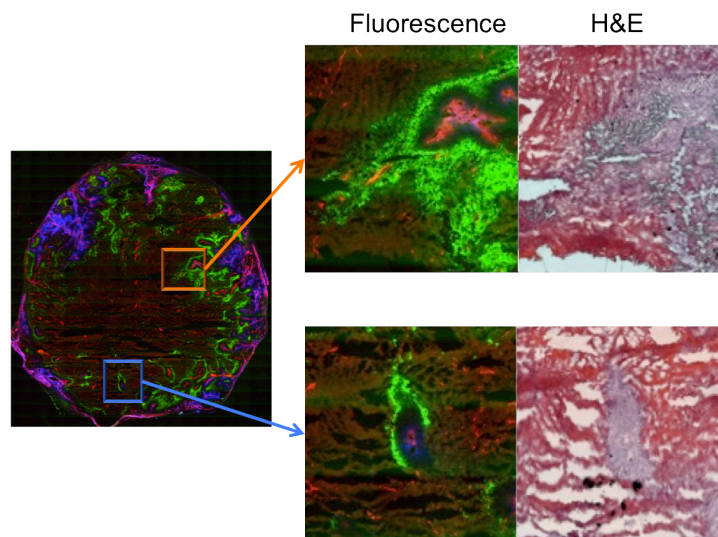


Figure 1: Example of a pair of co-aligned fluorescence image and HE stained histological image. Excellent registration between the two types of images was approved by expert pathologists after making detailed examinations at different locations.

Technical Prerequisites

1. Strong mathematical and numerical background
2. Experience in C++ and Matlab programming
3. Good English writing and oral-communication skills

Administrative Info

Working Time: $75 \times 2 = 150$ hours

Project Location: Home or CAMP

Required Equipment: No

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Timeline and Milestones

By Mid May: literature review & initial practice of programming

By Mid June: Student 1 completes C++ implementation of the automatic segmentation and registration algorithms, student 2 completes simple GUI with the interactive segmentation tool and the visualisation tool

By Mid July: Student 1 and 2 work together to complete parameter quantifications and to improve the GUI.

References

- [1] Peng, T., Eslami, A., Bayer, C., Shi, K., Navab, N.: A dual registration-learning methodology: application for the deformable registration of fluorescence and histological images. *Submitted to MICCAI 2013*.
- [2] Al-Janabi S, Huisman A, Van Diest PJ. Digital pathology: current status and future perspectives. *Histopathology* 61:1365–2559, 2012.
- [3] Pitkeathly, W.T., Poulter, N.S., Claridge, E., Rappoport, J.Z.: Auto-Align – Multi- modality fluorescence microscopy image co-registration. *Traffic* 13: 204-17, 2012.
- [4] Lezoray, O, Gurcan, M., Can, A., Olivo-Martin, J.: Special issue on whole slide microscopic image processing, editor. *Computerized Medical Imaging and Graphics* 35: 493-5, 2011.

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