Master Thesis Review
(supervisor's review)

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Thesis Title: **Segmentation of Bones in 3D CT Images**
Supervisor: Prof. Jiří Matas,
Co-supervisor : Dr. Rémi Blanc
Opponent: RNDr. Jan Horáček
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I supervised Marcel Krcah's thesis in the Medical Image Analysis Group of the Computer Vision Laboratory, ETH Zürich, in 2010. The proposed subject was related to automatic segmentation of bones from 3D Computed Tomography (CT) images, without relying on any prior on the shape of the bone.

While image segmentation is a long-studied domain, with an extensive literature, the lack of comprehensive databases of segmented images poses problems in terms of evaluation and comparison of methods, particularly in the medical domain. Having acquired a large database of CT images of the femur with manual expert segmentations, the Computer Vision Laboratory was interested in identifying an efficient automatic segmentation method, which could then be used as a starting point to facilitate the learning of statistical shape models. This constituted the subject for Marcel Krcah's thesis.

Given this context, Marcel started with a review of the main techniques of the field, and quickly gained a good understanding of various concepts related to image segmentation. He demonstrated his ability to grasp theoretical concepts as well as practical implementation aspects. He proved to be very autonomous in his research, and took initiatives in investigating and implementing several methods from the literature.

The retained segmentation method, based on recent results in graph optimization theory, was particularly studied. Though the graph-cut approach was already known to be promising, Marcel investigated advanced image filtering techniques, and was able to design specific cost functions that are particularly relevant for the problem of bone segmentation on CT. He managed to automate the otherwise manual initialization of the method, leading to a fully automatic approach, and to significantly improve the segmentation results.

Confronted with the challenge of performing large scale evaluation and comparison studies, he proved to be an organized and skilled developer, able to tackle with computationally intensive problems and optimizing his programs for run speed. He designed a rigorous, systematic experiment in the aim of identifying the most interesting method and optimizing it.

Marcel's thesis perfectly fulfilled the assigned objectives, developing a fast, efficient and fully automatic segmentation method. His programs are used on a broad basis in the laboratory, and within a Swiss national research network (NCCR Co-Me) which our laboratory is part of. Marcel presented his work at the annual research networking meeting.

The quality of his work has also been acknowledged by the medical image analysis community, with a publication accepted and presented (oral session) at the IEEE International Symposium on Biomedical Imaging (2011), one of the prime conferences in the field.

Though he can still improve his presentation skills, he displayed excellent capabilities both for scientific research or software engineering. I particularly appreciated his scientific skills as well as his autonomy. It has been a pleasure to work with Marcel during his thesis, and I highly recommend him.

Dr. Rémi Blanc
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Prague, 25/08/2011