



Habilitation thesis reviewer's report

Masaryk University	
Faculty	Faculty of Informatics
Field of study	Informatics
Applicant	RNDr. David Svoboda, Ph.D.
Unit	Faculty of Informatics
Habilitation thesis (title)	Virtual Cell Imaging (methods and techniques)
Reviewer	Prof Robert F. Murphy, Ph.D.
Unit	Carnegie Mellon University, USA

Reviewer's report (extent of text up to the reviewer)

Dr. Svoboda's work is divided into four areas of research. The work in the first of these, cell pattern recognition, followed very extensive work by other groups over the prior 15 years and was at most a modest contribution to the field. The work on the second, optimization of convolution, provided no theoretical results and only practical implementations and has had minimal impact (it has been cited only a handful of times by other authors). The work in the third area, texture features, was largely in the context of synthetic image evaluation and thus overlaps with the fourth area. The work done in that area, cell image simulation, provides the strongest support for the contemplated habilitation.

There are two main tasks required to generate simulated cell images. The first is to generate a realistic geometry for the simulated cell itself. Given this, the second task is to produce an image of how that simulated cell would have been observed through an imaging system (i.e., a digital microscope). Dr. Svoboda's work has primarily addressed the second task.

Dr. Svoboda accurately points out in Chapter 1 that using real images to assess quality of segmentation and tracking algorithms is difficult due to nondeterministic expert evaluations. However, for synthetic data the same problem applies in a different way – the evaluation of whether the simulations are accurate is nondeterministic since as presented it involves somewhat arbitrary choice of metrics (e.g., texture features) for comparing simulated and real images. Thus it would appear necessary to pay at least equal attention to improving the accuracy of the cell or tissue models being used to generate simulated images as to improving the model of image formation and acquisition. This is especially true since the properties of optical and electronic systems used in digital microscopy are far better understood than the organization of cells. Thus while the candidate has done significant work on simulating the former properties, the conceptual and practical impact has been limited. Perhaps the largest impact has been from the use of simulated movies from his work in the cell tracking challenge. The results indicated that segmentation accuracies from various algorithms were similar between real and synthetic images, an encouraging result. However, cells in the simulated movies were easier to track than real cells, indicating a need for improvement in the motion model.

In summary, Dr. Svoboda has been reasonably productive but publications have mainly been modest contributions presented or published in minor venues. Of the papers included in the



habilitation thesis (spanning a period of 13 years), there have been 12 short proceedings papers from minor conferences, 2 papers in minor journals, 4 papers in medium impact journals and 1 short proceedings paper in a medium impact conference. Only one paper was published in a highly competitive venue, a benchmarks paper in Bioinformatics with many authors from different institutions based on the cell tracking competition. Much of the work has been incremental and infrequently cited, with only one paper from his group garnering more than 50 citations.

As I am not completely familiar with the standards for acceptance of a habilitation thesis at your university, I considered how Dr. Svoboda's record would be viewed here. In my opinion, the record presented is unlikely to result in the awarding of tenure at a top university in the United States. However, it would likely be sufficient for tenure at a lower ranked university. From discussions with European colleagues, my sense is that the requirements for completion of the habilitation in terms of impact are somewhat less than those for tenure in the U.S. With this in mind and in consideration of the body of work contributed by the candidate, I conclude that the thesis meets the requirements for a successful habilitation.

Reviewer's questions for the habilitation thesis defence (number of questions up to the reviewer) ...

Conclusion

The habilitation thesis submitted by David Svoboda entitled "Virtual Cell Imaging (methods and techniques)" *meets* the requirements applicable to habilitation theses in the field of Informatics.

In Pittsburgh on August 30, 2017

