

Opponent's review of the doctoral thesis by

Msc. Ali Ghaznavi

„Cell segmentation from wide-field light microscopy images using CNNs“

The submitted dissertation of author Msc. Ali Ghaznavi deals with the very interesting and timely topic of developing machine learning methods for analysis, detection and segmentation, of microscopic images of living cells. From the perspective of wide-field microscopy techniques, this is a very complex topic, not only in terms of distinguishing cells from the background but especially to the intrinsic complexity of systems such as the human HeLa cells used in the work. Equally interesting is the fact that these images were taken using a unique microscope, which greatly enhances the quality of the images taken in terms of capturing a higher level of detail.

The dissertation is written in an abbreviated form with a standard structure, where the Introduction is followed by a description of the methodology and data collection. The last part is a commentary on the results obtained and a summary of the work presented. This section is followed by an appendix consisting of the publication outputs with a brief description of the author's contribution to each output. From the rich state of the art, individual contributions are selected and incorporated into the individual chapters of the introductory section. I very much appreciate the clear Introduction chapter, which includes traditional cell segmentation techniques, the overview of which introduces the reader to the whole subject of this work in a simple way. Chapters 1.4.2 and 1.4.3 would perhaps have deserved more diagrammatic examples in the form of figures to provide a better and more detailed understanding of the different approaches to image analysis. Figures 1.9-1.11 also suffer from not very good resolution, at least in the electronic form of the dissertation. An important chapter (Chapter 1.5 Our research objectives) is then a summary of the motivation and logical division of the work into separate projects. this chapter then includes a description of the actual technical equipment used to acquire the individual records. The following chapter then summarizes the methodology of data collection, data pre-preparation and methods of individual analyses.

Chapter 4 contains 2 published articles and 2 articles in "under review" status. The first two papers are directly related to cell segmentation (single and multi-class), the second two contain the methodological approach and the general principles used, which are described within this dissertation.

The thesis refers to a total of 103 sources that are correctly referenced in the spot-check. The citation references are in standard form.

Based on my study of this thesis, I have the following questions for discussion:

- 1) Are the proposed cell segmentation procedures applicable to image sources other than those acquired through a telecentric lens, for example, in terms of detecting pixels close to the cell membrane?
- 2) Can the minimum background-cell parameter difference for successful cell segmentation be quantified using artificial intelligence methods?
- 3) To what level of detail can one go with this method, in the case of, for example, contrast labeling of intracellular organelles? Can specific labeling be used for segmentation using deep machine learning?

To summarize my review, I would like to mention that the formal and graphic quality of the submitted dissertation is good. In conclusion, the doctoral thesis presented by Ali Ghaznavi represents a significant contribution to utilization of artificial intelligence in the field of cell segmentation. The thesis is written in a readable form, some results have already been published in scientific journals with an impact factor. The presented work proves that Ali Ghaznavi is capable of independent scientific activity at a high level in the given field, and therefore I recommend the committee to accept this work and that after a successful defense that Msc. Ali Ghaznavi receives a Ph.D.

In Brno

June 18th 2023

 doc. Ing. Filip Mravec, Ph.D.,

Opponent