
One of the key areas of modern technologies is digital healthcare. Part of digital healthcare are new ways of medical diagnosis using advanced visualization techniques and workflows. With continuously increasing computational power of modern computers, it comes an increased demand for advanced processing and visualization of medical datasets.

In this presented scientific work author is introducing a set of techniques and algorithms, which in combination with modern GPGPU architectures are creating a complete workflow used for interactive segmentation and data visualization of volumetric images. Some selected algorithms were studied in more general context, to allow their future usage for processing of different types of datasets.

The presented thesis contains 132 pages, introduction, conclusion, 7 chapters, biography and two attachments. An URL link to errata and additional information is also provided at the last page of the thesis. In the first chapter author is introducing the background of GPU architecture and CUDA framework. Important part of the chapter is a description of a new library for image processing CUGIP.

The second chapter is devoted to description of a parallel implementation of two non-trivial preprocessing algorithms. The two algorithms are: denoising in the form of a non-local means algorithm and coherence enhancing diffusion algorithm.

The third chapter describes a new type of transfer function, which is an important component of 3D volume rendering methods. Together with a color mapping, it helps to highlight objects of interests inside the voxel image.

The fourth chapter is starting with an overview of classical cellular automata theory which expands into new cellular automata extensions. The chapter also describe several computational problems, that could be solved using cellular automata. Towards the end of the chapter, author is presenting a novel solution for a watershed transformation using extended cellular automata. Several speed comparisons are presented in form of tables at the end of the chapter as well.

In the fifth chapter author is focusing on design and implementation of the fast (parallelized) min-cut algorithm, which is suitable for 3D segmentation. The implementation of presented algorithm is a modification of several already published algorithms from the past. The novelty here represents the parallelization, which with several small modifications increase speed of the algorithm and an implementation suitable for CUDA devices.

Chapter sixth is presenting a statistical model, which describes a foreground and background intensity distribution in relation to the position in space. It is very much suitable for initialization of segmentation algorithms and thus replacing some of the manual pre-processing work required.

In the seventh chapter author address combination and a usage of already presented methods and algorithms in a single interactive workflow, which could be suitable for wide range of segmentation tasks and final visualization of segmented regions of interests. In Conclusion author summarizes results and benefits
of the developed interactive segmentation workflow. At the end he offers possible extensions of his work.

I must note, that the core chapters, describing the novel algorithms are written in a very technically oriented style. In some cases, it could be quite difficult to understand the content, especially for non-technical trained readers, such medical doctors. As the results of this work should help doctors to provide better diagnosis, maybe a short plain English layout after each chapter would be useful.

There are several questions or notes that I would like to raise at this point. I believe, that answering these questions and address the notes will improve already very well written piece of scientific work.

1. As claimed in the thesis, the work and results described above should help doctors to provide better diagnosis. Could you please walk us through how and where the results were communicated with the medical personnel and whether there is a scope to use it in clinical praxis.
2. What is author’s opinion about the HW used in hospitals in comparisons to proposed algorithms HW requirements? What are the challenges to bring the developed software package into real clinical praxis?
3. What are the most suitable areas of healthcare research or other type of volumetric medical datasets, where the proposed algorithms and workflow pipeline could be successfully used?
4. What do you think is there a scope for fully automated diagnostic workflow of volumetric medical datasets without human intervention in the near future?
5. How was the CUPID library tested? Are there any statistical data for a test phase of the CUPID library (# of downloads, some comparisons, forum with discussions, etc)?
6. What was the reason to choose particularly the two pre-processing algorithms described in chapter 2 and not something else? (denoising in the form of a non-local means algorithm and coherence enhancing diffusion algorithm)

After reading the text and seeing the results described in the thesis I can confirm that this thesis is an excellent mixture of great computer science and computer vision research. It required a multidisciplinary effort of computer scientists, clinicians and engineers. Author in his work evidently shows wide knowledge from all described fields. He is presenting a clear ability to work as an independent researcher, which he seconds by publishing of several international conference publications where he is the first author. He is ideally trained to work on challenging scientific problems and he would be an extremely welcome addition to any research team.

I do not have any other specific comments concerning the presented thesis and few issues raised in the text above could be taken as initial points for the discussion. Finally, I can confirm that the goal and all the aims described in this thesis have been successfully fulfilled and therefore I can strongly recommend that this thesis can be taken as the doctoral thesis of Jan Kolomazník.

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