

Doctoral thesis (hereinafter referred to as "thesis"), title of the thesis:

REAL-TIME LIGHT FIELD RENDERING ACCELERATION ON GPU

Name of the doctoral student (hereinafter referred to as "student"), name and surname:

Tomáš Chlubna

Name and institution of the reviewer (full name of the reviewer, full name and country of the institution):

Ing. David Sedláček, Ph.D.

**Czech Technical University in Prague
Faculty of Electrical Engineering
Department of Computer Graphics and Interaction**

Czech Republic

I. Thesis

Appropriateness and relevance

In his scientific career, the student is involved in the field of computer graphics, which falls under the technical disciplines addressed at FIT. From this area, he has chosen a topic that I do not consider to be in the current mainstream of the computer graphics field. Still, nevertheless, it is important to the field, has valuable connections to the field, and, most importantly, has implications for hardware and imaging devices, as well as with respect to possible future developments in XR devices.

A summary of the contributions of the thesis

The primary goal of this work is to improve the efficiency and quality of Light Field rendering using GPU acceleration methods. In the third chapter, the author defines the hypothesis that it is possible to improve the current methods for rendering the so-called all-focused image, to make its use more accessible without using additional depth information, and to reduce the hardware requirements for rendering and memory. To this end, he proposes a new method of input data compression by selecting a suitable keyframe scheme in H.265 format. Furthermore, he proposes the use of so-called focus maps instead of depth maps, and proposes an algorithm to compute focus maps without prior knowledge of the content. He optimizes the sampling steps of the implemented algorithms. He continuously demonstrates iterative process improvement on standard datasets and his own synthetic scenes through results. Finally, the author proposes improvements in the way the light field scene is captured, and the preparation of light field data from suitable video sequences in order to be used on a real 3D display.

The contribution of this work to the field of real-time light field rendering is significant.

Novelty and significance:

Most of the results presented have a direct impact on the methods used in Ligth Field Rendering and take the field further. It increases the quality of the final output by increasing sharpness, reducing artifacts, or increasing rendering performance by using GPU methods, optimizing compression, and simplifying the rendering process without the need for depth information. Selected parts of the work were experimentally verified with user testing on an actual 3D display, which I took as confirmation of possible future use in practice.

Evaluation of the formal aspects of the thesis:

The formal level of the work is excellent. I positively evaluate the large number of illustrative pictures and their unified appearance, which makes the work look compact and clear. Overall, the work is easy to read and explains everything necessary. An extensive section is devoted to related work; the author references more than 300 relevant publications. The scope of the work is adequate for a doctoral thesis. I am satisfied with the quality of the English language. I found a minimum of mistakes, typos, and incorrect references in the thesis, which indicates diligent preparation of the text.

I have a minor complaint about Chapter 2, which could be better structured.

Quality of publications

Most of the content of the thesis is supported by ten publications in academic forums (1 conference, 9 journals) with excellent or very good rank (conference CORE rank B, journals: Q1 / Q2). The author's publications review primarily lists the Scopus journal rankings, but the WoS also lists these journals with similar rankings. The journals are well chosen with respect to the topic of the papers. The student is the first author of eight articles with a minimum of 70% attribution. Six of these ten articles have citations totaling 26 in google scholar.

II. Student's overall achievements

Overall R&D activities evaluation:

I definitely think that the content of the thesis and the attached results, whether scientific (journal publications), teaching activity (supervised and reviewed student thesis), participation in scientific projects, and reviews for journals, testify to the student's scientific erudition and ability to work independently in the scientific field and in a future leadership role.

III. Conclusion

The student has demonstrated in his work that he is capable of independent scientific work. I had no significant comments on the thesis; most of my questions were clarified during the reading of the thesis. In my opinion, the thesis and the student's achievements until now meet the generally accepted requirements for the award of an academic Ph.D. degree (in accordance with Section 47 of Act No. 111/1998 Coll., on higher education institution).

In Prague 23.10.2024

Signature of the reviewer:

Q1: With respect to future developments, do you think that raster formats will continue to be used for storing light field data (e.g. a grid of 2D images) or is it more realistic to switch to another method with higher compression per scene such as the currently popular NeRF or Gaussian Splat?

Q2: Imagine a situation where you have a scene taken with a camera that has a so-called shift lens (with a shallow depth of field). The shift lens causes the plane of focus to not be parallel to the plane of the camera chip. Please try to guess whether your technique for rendering the new all-focused view will work in this case?