Reconstruction of Light Field from focal stack

Background

Light field [1] has become important for a number of applications from re-focusing to rendering of scenes in VR headsets. Light field is a format describing the light from any position in any direction of a scene. There are different ways to capture light field. One common way is to register multiple pictures in parallel. Lately an interest of indirect capture of light field in the form of a stack of differently focused images (focal stack) has been proposed, whereby the light field is reconstructed by solving an inverse problem [2-4]. Certain reconstruction methods consist of trainable priors [5].

The quality of the reconstructed light field depends on a number of parameters. The quality of the original data, both resolution of image data as well meta data (e.g. focus position, etc.) reflects the quality of the reconstructed light field. The position of the light field sub-aperture images is limited to the actual lens aperture of the capturing device (camera), and it is expected that disocclusion errors appears the farther outside of this aperture data is reconstructed.

Problem Description

The thesis work implies testing the limitations of different algorithms for light field reconstruction from focal stack, and propose possible improvements to existing algorithms.

Milestones and Extensions

Firstly, a dataset consisting of ground truth focal stack and light field shall be constructed, from either existing light field data, or data captured with cameras in a lab, or both. Secondly, the work implies employing existing algorithms on the dataset and examine their ability to reconstruct light field. Thirdly, improvements and extensions to existing trainable algorithms shall be proposed and investigated.

Tools, qualifications, and outcomes

Code will be written in existing frameworks, e.g. C++, Python, Matlab, also using PyTorch and TensorFlow, as deep learning framework. GPU workstations for training the models are available in our lab.

The work will be carried out in the Realistic3D group at MIUN with Mårten Sjöström as examiner/contact-person.

Relevant Articles and Resources

[1] M. Levoy, P. Hanrahan, Light field rendering, in: Proceedings of the 23rd annual conference on Computer graphics and interactive techniques, 1996, pp. 31-42. doi:10.1145/237170.237199.

[2] A. Mousnier, E. Vural, C. Guillemot, Partial light field tomographic reconstruction from a fixed-camera focal stack, arXiv preprint arXiv:1503.01903.

[3] J. R. Alonso, A. Fernandez, J. A. Ferrari, Reconstruction of perspective shifts and refocusing of a three-dimensional scene from a multi-focus image stack, Applied optics 55 (9) (2016) 2380{2386. doi:10.1364/AO.55.002380.

[4] Gao, S. , Qu, G. , Sjöström, M. & Liu, Y. (2022). A TV regularisation sparse light field reconstruction model based on guided-filtering. Signal processing. Image communication,

[5] Shan Gao, Mårten Sjöström, Gangrong Qu, ” Light Field reconstruction from Focal stack using ADMM with learned prior”, in manuscript.