Universal Uncalibrated Photometric Stereo with Sparse Views

Overview

Photometric stereo aims to recover the surface normals of an object with a set of images from the same viewpoint but with different lighting conditions. The emerging deep-learning approaches [2, 4, 5] can tackle the object's complex geometries and challenging materials. Current researches consider spare views but point lighting [1], general lighting but Lambertian objects[3], or directional lights with multiple stages [6]. These settings are too challenging to obtain in real life.

In this project, we will investigate the universal uncalibrated photometric stereo with spare views. This idea could be an extension of the work of Mo et al. [1], whose lighting condition is point lighting. We want to generalize it to a more real-world setting. This project has two challenges: 1) The current solution requires ambient lighting and assumes it is not dominated. Though the method can tackle 80% ambient lighting empirically, it is unclear when there is no point lighting at all. 2) the diffuse map of the current approach is flawed because of the self-shadow problem.

Goals

This project aims to extend the sparse view uncalibrated photometric stereo to general lighting conditions. It will be better to even overcome the self-shadow problem. There could be two possible directions: 1) based on the work of Mo. et al [1]. 2) Considering the Gaussian Splatting method.

Tasks

1 Getting familiar with the related literature and implementation details of the baseline (~ 50h);

This step should have two outcomes. We should understand all the important concepts in photometric stereo problems and get an overview of current works. Additionally, one baseline should be determined, and it should be the backbone of the following tasks.

2 Implementing the baseline and generating synthetic dataset (~ 60h);

We should first have some synthetic datasets in different lighting conditions. The aim is to reproduce the result from the baseline to ensure no problems are introduced from our side. Then, we directly apply the baseline to general lighting to get a feeling for the performance, etc.

3 Figuring out some ideas to tackle the general lighting conditions and perform experiments (~ 120h);

This is the main part of the whole course. The idea should be plausible, and we should conduct experiments to verify them. Ideally, we should be able to have some ideas around the mid-term.

4 Experiments on real-world dataset, e.g. diligent, or ideally, we can capture our own dataset(~ 50h);

It might happen that we will fail in step 3). In that case, we should investigate the reason of the failures in this step.

5 Writing a project report and preparing the presentations (~ 60h).

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References

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[6] Wenqi Yang et al. *PS-NeRF: Neural Inverse Rendering for Multi-view Photometric Stereo*. 2022. arXiv: 2207.11406 [cs.CV].