CSCE 643 Multi View Geometry CV Final Project Proposal

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I. Introduction of 3D Reconstruction

A. Definition

The essence of an image or a photo is a projection from 3D scene onto a 2D plane[1]. Naturally we can think of that the depths of things are lost in this process as the final image we get from the projection is in 2D, thereby a lot of information is lost during the projection. 3D reconstruction, the reverse process of obtaining 2D images from 3D scenes, is the creation of three-dimensional models from a set of images.

B. Motivation

The applications of 3D reconstruction are penetrated in our daily life. As 2-D imaging has problems of anatomy overlapping with each other and don't disclose the abnormalities, 3-D imaging can be used for both diagnostic and therapeutic purposes. The 3-D models we obtain from reconstruction can be used for operation planning, morphometric studies and has more reliability in orthopedics. Another recent tech trend is the development of 3-D printing, which also requires the model reconstruction to provide input to printers.

II. 3D Reconstruction from Uncalibrated Images

As we mentioned above, due to the lost of information, from a single 2D image, no depth can be computed without additional information. However, this problem becomes feasible when we have multiple images (hopefully focusing on certain region). The classic process is composed of two major steps:

- Match features across multiple images.
- Compute depth information using standard triangulation based on the above feature correspondence.

However, traditional approach like this requires careful calibration, which is a major drawback as it's error-sensitive. There are also other methods proposed but they either requires more than commonly known information or lead to certain drawbacks in results. Therefore, a relative 3D reconstruction approach using uncalibrated images is proposed in [2]. The major advantage of this new approach over other previous ones are two fold:

- It introduces the uncertain 3D information only at the latest stage of the perception process, and only if it is needed.
- It avoids the unstable calibration process, and therefore relies only on the accuracy of the measures in the image during the processing.

The basic idea of our approach for implementation is that it incorporate calibration and reconstruction in the same optimization process by an implementation of parameters estimation theory using Levenberg-Marquardt algorithm. Different from other earlier methods, our reference approach is formulated globally as a least squares estimation method that does not need to first estimate the epipolar geometry and it makes full use of redundancies in multiple images. Throughout this project, we will propose an implementation of the relative 3D reconstruction approach and evaluate the method using reasonable experiments to show its performance.

References

[1] Wikipedia, "3D reconstruction from multiple images," https://en.wikipedia.org/wiki/3D_reconstruction_from_multiple_images.
[2] R. Mohr, L. Quan, and F. Veillon, "Relative 3d reconstruction using multiple uncalibrated images," *The International Journal of Robotics Research*, vol. 14, no. 6, pp. 619–632, 1995.