Project Proposal 2

3D Scene Reconstruction Using Passive Stereo Sensors

1 Abstract

The improvement of 3D reconstruction techniques has opened a wide range of applications from scanning and motion estimation to environment mapping. However, typical hardware used in 3D reconstruction is either expensive or, as in the case of active stereo sensors like the Kinect, sensitive to sunlight or the presence of other active stereo sensors. For this reason, passive stereo camera sensors offer an alternative low cost solution, without the interference problems faced by the Kinect. In addition, passive stereo camera reconstruction allows the generation of a depth map from a single position. This is in contrast to a mono camera setup, which requires several pictures for depth map generation. For this project we are implementing a 3D passive stereo reconstruction pipeline consisting of three phases with five modules as shown in figure 1.

The first module in the reconstruction pipeline obtains the necessary hardware parameters using a stereo camera calibrator application integrated into MATLAB based on [1] and [2]. The second module deals with image rectification in order to parallelize epipolar lines and change the underlying search problem from the 2D domain into line search. Our approach will be based on the methods implemented by [3]. Module 3 performs pixel matching by locating projections of real-world points into both images. The technique applied here follows extended block matching implementation from [4] in combination with sub-pixel estimation from [5]. In addition, we will tweak the extended block matching technique by changing the similarity score to a normalized cross correlation as outlined in [6]. Module 4 takes care of mesh formation by applying a triangulation technique using the disparity map generated in module 3. The last module takes care of texture mapping through ray-casting using the RGB values from the 2D images.

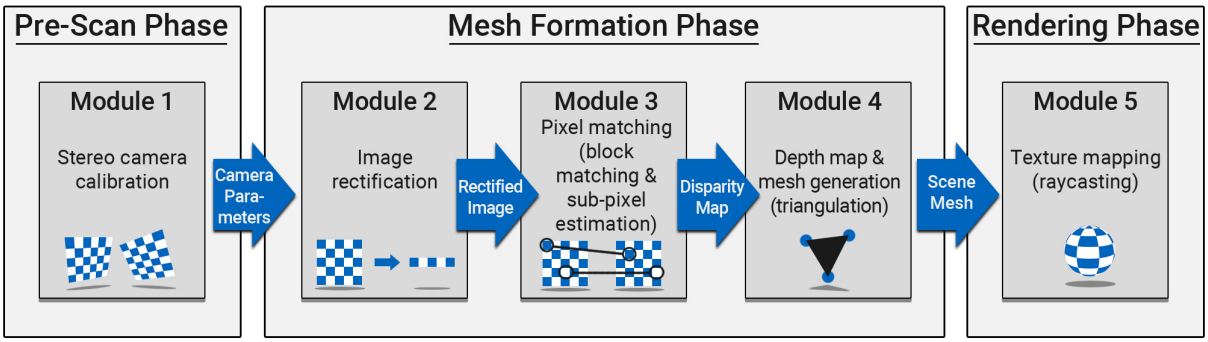

Figure 1: Overview of stereo reconstruction pipeline. Shown are the three pipeline phases and the five core modules.

2 Hardware Requirements

Project will use following hardware with the purpose of obtaining stereo images:

1. Passive stereo camera without automatic focus (or any automatically changing intrinsic) for RGB-D reconstruction.

3 Team

The project team consists of four group members from various academic backgrounds:

1. Gorbachev, Gleb - Master Robotics, Cognition, Intelligence - Mtr-Nr. 03709785
2. Hernandez, Ivan - Master Robotics, Cognition, Intelligence - Mtr. Nr. 03712543
3. Rohregger, Alex - Master Robotics, Cognition, Intelligence - Mtr.-Nr. 03716431
4. Yagubbayli, Farid - Master Informatics - Mtr.-Nr. 03708842

4 Project Timeline

The implementation of the stereo reconstruction pipeline will take around 6 weeks. Each module will take around one week to complete as shown in figure 2.

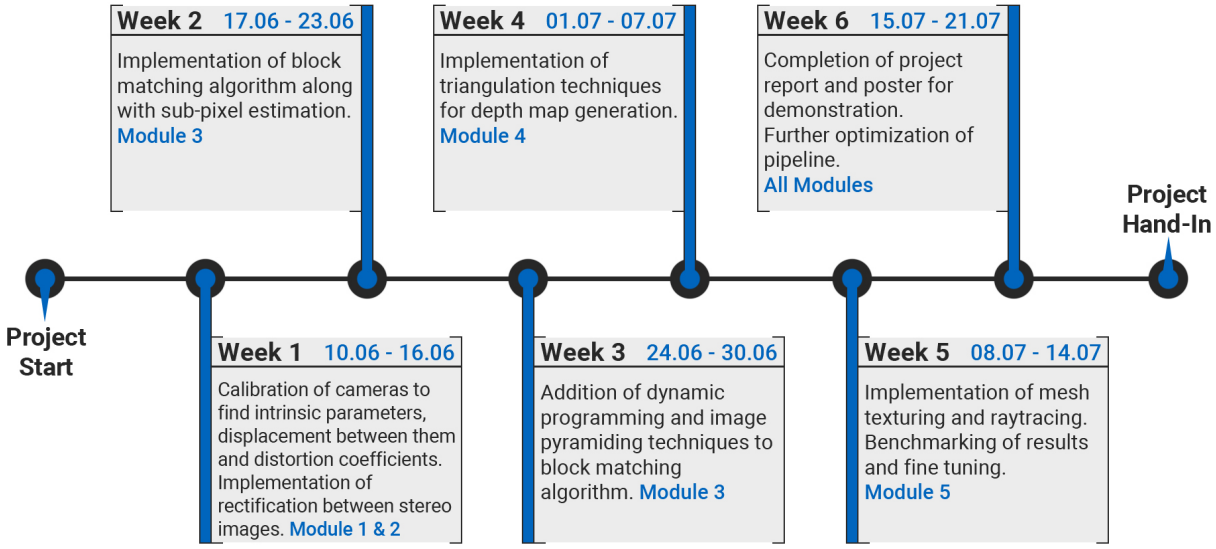

Figure 2: Project timeline broken down into weekly milestones.

References

[1] Z. Zhang, "A flexible new technique for camera calibration," *IEEE Transactions on pattern analysis and machine intelligence*, vol. 22, 2000.

[2] J. Heikkila, O. Silven, *et al.*, "A four-step camera calibration procedure with implicit image correction," in *cvpr*, vol. 97, p. 1106, Citeseer, 1997.

[3] Xi Liu, Dahai Li, Xiaoyong Liu, and Qionghua Wang, "A method of stereo images rectification and its application in stereo vision measurement," in *2010 Second IITA International Conference on Geoscience and Remote Sensing*, vol. 1, pp. 169–172, Aug 2010.

[4] K. R. Reddy, P. V. Raja, M. S. Rao, and S. C. R. Reddy, "3d reconstruction based on block matching and image pyramiding," 2014.

[5] D. G. Bailey, "Sub-pixel estimation of local extrema," in *Proceeding of Image and Vision Computing New Zealand*, pp. 414–419, 2003.

[6] D. Bradley, T. Boubekeur, and W. Heidrich, "Accurate multi-view reconstruction using robust binocular stereo and surface meshing," in *2008 IEEE Conference on Computer Vision and Pattern Recognition*, pp. 1–8, June 2008.