3D-Model Reconstruction Using Photogrammetry Technique

Muhamad Nuh, Muhammad Reza Aditya, Novian Gilang Bujana, Nova Eka Diana, Nurmaya and Ummi Azizah Rachmawati
muhamadnuh54@gmail.com, Rezaditya28@gmail.com, noviangilang@gmail.com, nova.diana@yarsi.ac.id
1Informatics Department, Faculty of Information Technology, Universitas YARSI, Indonesia

Abstract

Recently, many areas such as for entertainment, automotive industry, archeology, architecture, and game, have used 3D models to enhance the content qualities of their product. Many companies have offered various products, such as the 3D scanner, Xbox One Kinect Sensor, and XYZ Handheld 3D Scanner Pro, to capture the shape of real objects and turn them into realistic 3D models. Those are still extremely expensive for the users to buy especially for educators or researchers with minimum funds. This research used photogrammetry technique to create a 3D model of an object. Photogrammetry or usually called as a 3D scan from photographies is a process to reconstruct a 3D object from 2D captured still-images using computer vision and computational geometry algorithms. The photogrammetry consisted of four steps to reconstruct 3D models: captured various photos of the same object, images features extraction, and pairwise matching, sparse reconstruction, and dense reconstruction. The authors captured different images of the same object for every ten degrees of angle and from the top view direction. This study used the SIFT algorithm to find the critical interest point and descriptor of an image and use it to match with other images. The next step is sparse reconstruction using multicore bundle adjustment algorithm to reconstruct the point cloud of key point descriptors for generating a 3D object. Finally, the authors used the Yasutaka Furukawa's CMVS/PMVS (Clustering Views for Multi-view Stereo) method for performing dense reconstruction to put textures between point cloud to smooth the generate 3D object.

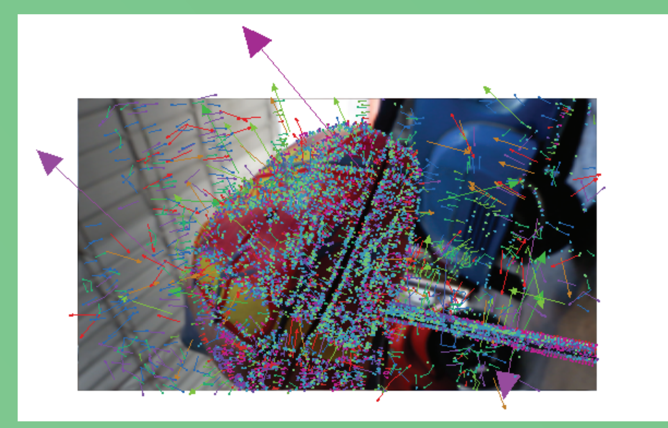
Methodology

Photogrammetry 3D Modeling

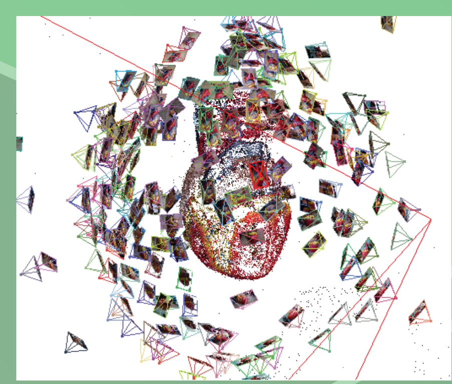
- Image Collection from various angles
- Features Extraction (SIFT Keypoints Descriptor)
- Image Matching (RANSAC)
- Sparse Reconstruction (8-Point Fundamental Matrix & Bundle-Adjustment Algorithm)
- 3D Dense Reconstruction (Yasutaka Furukawa's CMVS/PMVS)

Result & Discussion

1. Captured images from different angle and top-view with a focal length of 16 mm using lens 16-50mm.



2. Pairwise matched using SIFT Keypoint Descriptor and RANSAC matching algorithm.

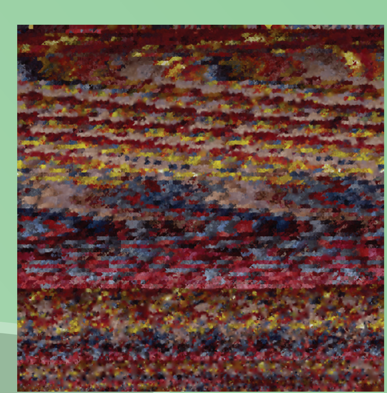


3. 3D Sparse Recontruction based on Structure for Motion (SfM) of 2D Pairwise Matches.

4. 3D Dense Reconstruction using Yasutaka Furukawa's CMVS algorithm.

5. surface reconstruction (Screen Poisson Surface Reconstruction). set reconstruction depth 10, minimum number of samples 2, and interpolation weight 4.

6. Parametrization trivial triangle-by-triangle the texture dimension 4096 pixel.



7. Texture Extraction (vertext attributes to texture). the resolution of texture 4096 pixel with format picture PNG.

Dataset & running time	
Number of images	212 (Dimension of 2000px)
Feature extraction	95.083 minutes
Sparse Reconstruction	3.416 minutes
Dense Reconstruction	95.467 minutes
Screened poisson surface	2.27 minutes
trivial triangle by triangle	142 msec
Vertex attributes to texture	9699 msec

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Reference

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