3D Reconstruction Underwater from Stereo Images

Student: Thanh Dao - Supervisor: Xavier Llado, Joaquim Salvi

Abstract

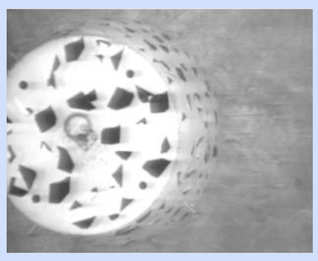
Reconstructing the 3D model of objects from stereo image in underwater condition is a challenging task due to attenuation of light and unknown structure. This master thesis attempts to address this problem by first applying some image enhancing techniques to remove the effect of illumination and reduce the noise. The corresponding SIFT features are then detected and matched between the images. From the matched points, epipolar geometry is computed to remove outliers and recover the transformation between cameras. Finally, the surface reconstruction is performed by linear triangulation. The result of the process is a set of 3D points with robust features that can be used for applications like robot mapping or 3D SLAM.

Image Enhancement

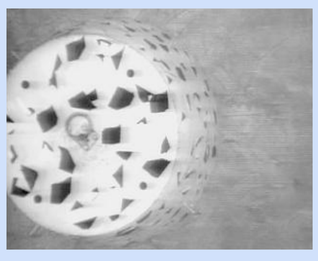
Problems of image underwater:

- Low contrast and blur, due to light attenuation and scattering

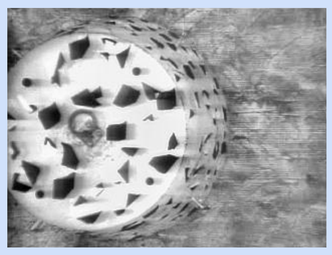
Enhance the quality of images by of filtering



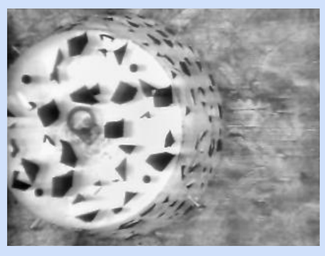
Original image



Homomorphic filter



Histogram Equalization



Noise Removal

Image Processing

Feature detecting and matching using SIFT descriptors

- SIFT descriptors invariant to scale, rotation, illumination change, affine transformation

Epipolar geometry

- Reduce the search for correspondence & remove false matches
- Fundamental matrix estimation by least square method and robust method (RANSAC)

Surface reconstruction

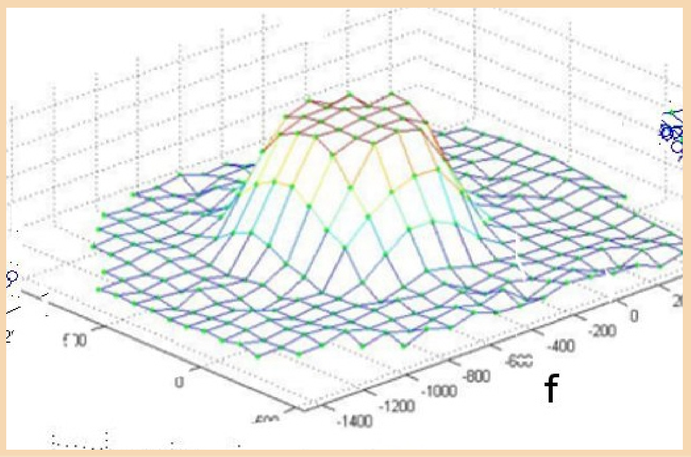
3D triangulation: intersection of two optical rays through camera centers and correspondence points is the position of 3d point.

- Camera calibration: To find the position of 2 cameras and its parameters. Using tool box.
- Position estimation: The rays do not intersect due to noise and computation error. Estimate by the closest middle point between two lines

Experiments and Results

Object: a truncated cone put on 3 DOF plotter with predefined trajectory. The cone is underwater in a tank 4x3x3m3. 17 gray scale images of size 320x240 are used

	Real cone	Model cone
Height	480 mm	483 mm
Top diameter	480 mm	477 mm
Base diameter	970 mm	979 mm



Conclusion

With the aim of developing a complete system that performs 3D reconstruction for large scale under water scene using efficient and advanced techniques of in the field of computer vision, this work has successfully implemented an algorithm that: given a set of underwater images, it can return a 3D reconstruction of the scene in form of 3D cloud point for surface modeling. It also have achieved the goal of finding a set of 3D points with robust features (SIFT) which can be utilized for other purposes such as mapping or Visual SLAM.

Master science in Vision and Robotics (Vibot)

HERIOT WATT UNIVERSITY

UNIVERSITÉ DE BOURGOGNE

UdG Universitat de Girona