Correspondence Matching for the LUMIS2 Camera System

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Abstract

The LUMIS2 is an underwater camera system consisting of a projector and four cameras housed behind a thick translucent material and operate at different frequencies of light. Visualizing and classifying the produced images can be enhanced if correspondences are established between all the perspectives and the projector. However, the system's unique configuration poses special challenges.

1 Qualifications

1.1 Courses

CSE 152: Computer Vision (A+), CSE 166: Image Processing (A+), CSE252a: Computer Vision I (A), CSE150: Intro to Artificial Intelligence (A), CSE103: Statistics (A)

Project Courses: Compilers (A+)

2 Milestones

2.1 Step 1: implement a correspondence matching algorithm in C for calibrated images (deadline: April 17th)

For the first three weeks of the quarter, LUMIS will not be accessible. However, I can write correspondence code for a calibrated above-water camera system.[1]

Also, during this time I should be dissecting the OpenCV camera calibration subroutines to understand how calibration works at a deeper level.

2.2 Step 2: measure the error that the LUMIS system has with the single viewpoint assumption (deadline: April 24th)

The amount of error will inform what approach to use later on. Right now I expect (and hope) that the radial distortion captures enough that I only need slight modifications. For my purposes, cropping the periphery is not an option because the overlap of the four cameras will be around the corners of the images.

2.3 Step 3: refine the model for refraction (deadline: May 25th)

Experiment with a single-view point model that does a better job of capturing the distortions in water and see if it improves results.[2,3,4,5]

2.4 Step 4: put it all together (deadline: June 3rd)

Integrate my best results with the LUMIS GUI. OpenCVs existing libraries for finding homographies given corresponding points should make this relatively easy. I'll have to make some aesthetic decisions about how to best overlay.

3 Questions to be resolved

How can we refine existing single viewpoint models for underwater systems so that we can use traditional epipolar geometries? Are such methods worth the trouble?

4 Existing software

The bouguet calibration toolbox will be useful for the first stage when I want to use rectified images to implement multi-camera correspondence matching.

I plan to end the project with a modified version of OpenCVs calibration subroutines.

5 Data sets

For the initial steps of the project, I only need a multi-camera stereo system, which I already have set up. For the underwater system, I should have datasets by mid-April.

6 References

[1] M. Okutomi, T. Kanade, "A Multiple-Baseline Stereo," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 15, no. 4, pp. 353-363, Apr. 1993

[2] Richard Hartley, Sing Bing Kang, "Parameter-Free Radial Distortion Correction with Center of Distortion Estimation," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 29, no. 8, pp. 1309-1321, June 2007

[3] Tardiff, J.P., Sturm, P. & Sébastien, R. "Self-calibration of a General Radially Symmetric Distortion Model," Computer Vision – ECCV 2006, vol. 3954, pp. 186-199, 2006

[4] Tali Treibitz, Yoav Y. Schechner, Clayton Kunz & Hanumant Singh. "Flat Refractive Geometry," oral in CVPR (2008)

[5] Gili Telem & Sagi Filin, "Photogrammetric modeling of underwater environments," ISPRS Journal of Photogrammetry and Remote Sensing, vol. 65, no 5, pp. 433-444, September 2010