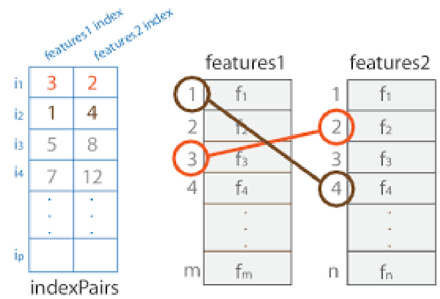
EE462, EE9SO25, EE9CS728

Machine Learning for Computer Vision

Coursework on image matching [50% mark]



Release on 19 Feb 2018, the report due on 30 April 2018

The course work requires Matlab or python programming. In all questions, you can use any existing toolbox/code, unless '*implement*' is specified. You can compare results of your implementation to a standard toolbox.

Submission instructions:

One joint report by each pair

Page limit: 3 (three) A4 pages per report with 10 font size (use the IEEE standard double column paper format, either in MS word or latex). List of references and appendix do not count for this page limit. Use report template from Blackboard.

At master level of this course, general principles for writing technical report are expected to be known and adhered to. Similarly, for practices in conducting experiments, some are as listed below:

a) Select relevant results that support the points you want to make rather than everything that matlab gives.

b) The important results should be in the report, not just in the appendix.

c) Use clear and tidy presentation style, consistent across the report e.g. figures, tables.

d) The experiments should be described such that there is no ambiguity in the settings, protocol and metrics used.

e) The main points are made clear, identifying the best and the worst-case results or other important observations.

f) Do not copy standard formulas from lecture notes, explain algorithms in detail, or copy figures from other sources. References to lecture slides or publications/webpages are enough in such cases, however short explanations of new terms or parameters referred to are needed.

Find and demonstrate the parameters that lead to optimal performance and validate it by presenting supporting results. Give insights, discussions, and reasons behind your answers. **Quality and completeness of discussions within the page limit** will be marked. Include formulas where appropriate, results presented in figures and their discussion.

Code required for the experiments can be taken from any public library if available, otherwise implemented if necessary. Source code, is not expected, however if needed it can go to appendices, which do not count for the page limit.

Submit the report in **pdf** through the Blackboard system. No hard copy is needed. Write your **full names, logins and CID numbers on the first page. Use both logins in the submitted filename e.g. login1_login2.pdf.** The latest submission before the deadline will be assessed.

If you have questions, please post it on **goo.gl/K61te5**

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Collect a sequence of pictures (we call it **FD**) of the same scene (e.g. an object in Science Museum). At least 3 pictures (many more recommended, at different distance and angle to the object) should be taken by changing the camera position by 20cm in horizontal direction (see stereo examples in the lecture notes). Another sequence (we call it **HG**) of 3 pictures should be taken by changing the zoom (e.g. factor 1.5) and slightly rotating the camera (e.g. 10-20 degree) but keeping exactly the same location of the camera. Try to find out the focal length of your camera, typically between 18-55mm (varies with zoom), otherwise assume a length.

Matlab implementation code may be included in Appendix.

You can use Boat and Tsukuba sequence as a data with ground truth for development before testing on your images.

http://www.robots.ox.ac.uk/~vgg/research/affine/det_eval_files/boat.tar.gz
http://vision.middlebury.edu/stereo/data/scenes2001/

Q1. Matching

Implement methods for finding correspondences and estimating transformations. In the report show different steps of processed image, briefly discuss the main operations and justify the parameter choice you made. Discuss the benefits and drawbacks of the method you implemented.

1) Manual
  a) Implement a manual method for getting coordinates of corresponding interest points in two images (clicking on corresponding points).

2) [10] Automatic
  a) Implement interest point detector (e.g. Harris) and a descriptor (simple colour and/or gradient orientation histogram).

b) Implement a method that performs nearest neighbour matching of descriptors.

3) [10] Transformation estimation

a) Implement a method for estimating a homography matrix given a set of corresponding point coordinates.

b) Similarly to Q1.3.a, implement a method for estimating a fundamental matrix.

c) Implement a method for projecting point coordinates from image B to A given Homography between the two images. Implement a method for calculating average distance in pixels between the original points in A and the ones projected from B. This average distance can be interpreted as homography accuracy **HA**.

d) Implement a method for calculating epipolar line given point coordinates and a Fundamental matrix between two images. Display that line on an image in Matlab. Implement a method calculating the average distance of points in image B to their epipolar lines of the corresponding points in image A. This average distance can be interpreted as fundamental matrix accuracy **FA**.

Q2. Image Geometry

1) **[15] Homography (use images HG)**

   a) Find interest points in one image by using method from Q1. Reduce the size of the image by a factor of 2 and run the detector again, then repeat for factor of 3. Compare the interest points obtained in these three cases using **HA** error.

   b) Using method from Q1 estimate homography from the manually established correspondences with Q1.1 and compare to the homography from the list of correspondences obtained automatically with Q1.2. Use function from Q1.3.c to visualise and validate your homographies. Analyse and compare geometric transformation parameters that can be derived from the two homographies.

   c) Estimate homography from different number of correspondences from Q1.2 starting from the minimum number up to the maximum number of available pairs. Report and discuss **HA**. Find and show the outliers and explain your approach to that.

2) **[15] Stereo Vision (use images FD)**

   a) Estimate fundamental matrix using list of correspondences from Q1.1 or Q1.2.a. Calculate and discuss the FA accuracy.

   b) Calculate the epipoles for images A and B. Show epipolar lines and epipoles on the images if possible. Calculate and present disparity map between images A and B.

   c) Calculate and display depth map.

   d) Change the focal length by 2mm, repeat Q2.2.c and compare. Add small random noise (e.g. Gaussian with max 2 pixel) to the disparity map, repeat Q2.2.c and compare.

   e) Present stereo rectified pair of your images.