EQ2425 – Analysis and Search of Visual Data

Project #1: Image Features and Matching

due Monday, September 16, 2019, 11:59 pm

Please email your reports in PDF format to the course assistant assigned to this project with the subject line "EQ2425 - Project". Your email should also include relevant Matlab source code(not including public libraries).

1 Prerequisite

In this project, you need the open source library VLFeat for SIFT feature extraction. Please download the toolbox and add it to your Matlab using the instructions from the following link: http://www.vlfeat.org/install-matlab.html

2 Image Features

2.1 Introduction

Local image features can be viewed as a combination of a robust interest point detector with a feature descriptor. To test the robustness of keypoint detectors and descriptors, we need to modify the original images in several ways and evaluate the repeatability measure. The repeatability measure is defined as the number of matching features between the original image and the modified images, divided by the number of detected features in the original image.

To compute repeatability, first, predict the positions $[x', y']$ where the keypoints should ideally appear in the modified images. Keypoints that are not present within a certain neighborhood in both images, decrease the repeatability measure. Therefore, search for a nearby keypoint which is detected in the modified image with coordinate $[x_0, y_0]$, satisfying $|x_0 - x'| \leq 2$ and $|y_0 - y'| \leq 2$. If such a $[x_0, y_0]$ is found, increment "number of feature matches" by 1.

2.2 Robustness of Keypoint Detector

(a) Apply SIFT and SURF keypoint detectors on the image "obj1_5.JPG ". Adjust peak and edge thresholds of the SIFT keypoint detector, and the strongest feature threshold of the SURF such that a few hundred SIFT and SURF keypoints are detected, respectively. Submit images showing the detected SIFT keypoints (vl_feat function: vl_plotframe) and SURF keypoints, superimposed on the original image for each detector separately, and report the thresholds you have chosen respectively. Describe which objects or regions in the image seem to generate large numbers of SIFT and SURF keypoints.

(b) Plot repeatability versus rotation angle in increments of 15 degrees, from 0 degrees to 360 degrees for the two keypoint detectors. Comment on the robustness of the two keypoint detectors against rotation.

(c) Plot repeatability versus scaling factor with the scaling factors $(m^0, m^1, m^2, \cdots, m^8$, where $m = 1.2)$ (MATLAB function: imresize) for the two keypoint detectors. Comment on the robustness of the two keypoint detectors against scale changes.

3 Image Feature Matching

(a) Extract a few hundred SIFT features from the test images (vl_feat: vl_sift). Show the feature keypoints superimposed on top of obj1_5.JPG and obj1_t5.JPG.

In the following, you will implement three feature matching algorithms. For each algorithm, plot side-by-side views of the query image obj1_5.JPG and the database image obj1_t5.JPG with matched feature points connected by lines. Visually examine the matched features and comment on the performance of the three matching algorithms.

(b) Implement the "fixed threshold" matching algorithm. Adjust the distance threshold until you obtain a satisfying result. Plot the best result and one suboptimal result which uses a different distance threshold.

(c) Implement the "nearest neighbor" matching algorithm.

(d) Implement the "nearest neighbor distance ratio" matching algorithm. Adjust the ratio threshold until you obtain a satisfying result. Plot the best result and one suboptimal result which uses a different ratio threshold.

(e) Extract a few hundred SURF features from the test images. Use the "nearest neighbor distance ratio" matching algorithm. Again, plot side-by-side views with matched feature points connected by lines. Compare your result to (d).