COMP9517

Lab 2, T1, 2021

The lab files should be submitted online.

Instructions for submission will be posted closer to the deadline.

Deadline for submission is Week 4, Monday March 8th, 16:59:59 AEST

Objectives: This lab presents a revision of important concepts from week 3 lectures about feature representation. Most questions require you to use OpenCV, an open source software package that is widely used in this field.

NOTE if you are using OpenCV: We will be exploring the SIFT (Scale Invariant Feature Transform) algorithm, which is only available in OpenCV's non-free module (OpenCV has both free and non-free modules). This algorithm has been patented by the creator but is free to use for academic and research purposes. The non-free modules can be found in the opencv_contrib package. You will need to install this package as shown below and then you can use the SIFT module.

Also note that not all versions of python3 are compatible with the following libraries. The suggested versions is python 3.7.0. Feel free to look at virtualenv and virtualenvwrapper to set up your environment to have a python 3.7 installation.

Installation:

```
Initialize and activate virtual environment (optional):

$ python3 -m venv env
$ source venv/bin/activate

Install correct version of OpenCV and contrib module:

$ pip install opencv-python==3.4.2.17
$ pip install opencv-contrib-python==3.4.2.17
```

Materials: The sample images to be used in all the questions of this lab are available in WebCMS3. You are required to use OpenCV 3+ with Python 3.

Submission: **Your jupyter notebook is required to be submitted.** Submission instruction will be posted prior to the lab session.

The sample image “syd_house.jpg” is to be used for Task 1, 2 and 3.

1 **SIFT** (Scale Invariant Feature Transform)

SIFT is a well-known algorithm in computer vision to detect and describe local features in images. Its applications include object recognition, robotic mapping and navigation, image stitching, 3D modelling, video tracking and others.

A SIFT feature is a salient keypoint that corresponds to an image region and has an associated descriptor. SIFT computation is commonly divided into two steps:

- Detection
- Description

At the end of the detection step, and for each feature detected, the SIFT algorithm establishes:

- keypoint spatial coordinates (x, y)
- keypoint scale
- keypoint dominant orientation

After the detection step, the description step computes a distinctive fingerprint of 128 dimensions for each feature. The description obtained is designed to be invariant to scale and rotation. Moreover, the algorithm offers decent robustness to noise, illumination gradients and affine transformations.

1. **Lab Tasks**

Task 1: Compute SIFT features:

- Extract SIFT features with default parameters and show the keypoints on the image.
- Reduce the number of keypoints extracted so that the visualisation of keypoints is easier. Show these keypoints on the image. (Hint: vary the parameter “contrastThreshold” or “nfeatures” so that the number of keypoints becomes about 1⁄4 of all default keypoints).
- Submit this image as the results image for task 1.

Task 2: Rotate the image and compute the SIFT features again:

- Rotate the image anti-clockwise by 255 degrees
- Extract SIFT features and show the keypoints on the rotated image, using the same parameter settings as Task 1 (for reduced number of keypoints)
- Inspect the keypoints visually: Do the keypoints look roughly the same as those extracted on the original image? What does this observation imply? These questions for task 2 will not be assessed, but are designed to get you to think about what the SIFT algorithm is doing.

Task 3: Test rotational invariance of SIFT features:

- Rotate the sample image in increments of 60 degrees, from 0 to 120 degrees.
- For each rotated image, compute SIFT features and draw keypoints on the image.
- For each rotated image, match its SIFT descriptors with those from the original image based on the nearest neighbour distance ratio method.
- Draw the matches between the two images.

Submit 4 images, including 1 from Task 1, and 3 from Task 3 showing the keypoint matches with different rotation degrees (0 degrees, 60 degrees and 120 degrees) in a zip file for marking.

NOTE: Refer to https://docs.opencv.org/3.4.3/da/df5/tutorial_py_sift_intro.html for an example of computing SIFT features and showing the keypoints. And refer to https://docs.opencv.org/trunk/dc/dc3/tutorial_py_matcher.html for an example of feature matching. The attached template.py file can be used as a template for the lab tasks.

REFERENCES

D. G. Lowe, "Distinctive image features from scale-invariant keypoints," Int. J. Comput. Vis., vol. 60, no. 2, pp. 91–110, 2004