Software Methodologies COMP2231

2018/2019

Image processing assignment

Submit your work on **DUO** before **14 December 2018, 14:00**. For any questions, contact the setter of the assignment Dr Ioannis Ivrissimtzis: ioannis.ivrissimtzis@durham.ac.uk

What to submit

Submit a zip file with your report and your code.

Your **report**, covering part A (bilateral filter) and part B (joint bilateral filter) of the assignment, should be a single pdf file, no more than 4 pages long (in 11 font size), including a list of references at the end of the main document. It can have one appendix, which will not count towards the 4 page limit, showing the images of the main report in higher resolution.

Your **code** should be an OpenCV with Python implementation of the **joint bilateral filter**, as required in part B2 of the assignment. You do not have to submit any code for the bilateral filter in part A2 of the assignment.

Part A - Bilateral filter

In this part of the assignment you should demonstrate your understanding of the bilateral filter.

1. In part A of your report, describe the bilateral filter and discuss its main properties.

2. Apply the bilateral filter on the test images test 1 and test 2 and fine tune the filter's parameters.

3. Present and discuss the filtered test images from part A2, illustrating the main properties of the bilateral filter.

test 1

test 2

For filtering the test images you can use the OpenCV function ***bilateralFilter***.

Alternatively, you may want to implement the bilateral filter yourself and then extent your implementation to the joint bilateral filter required in part B2.

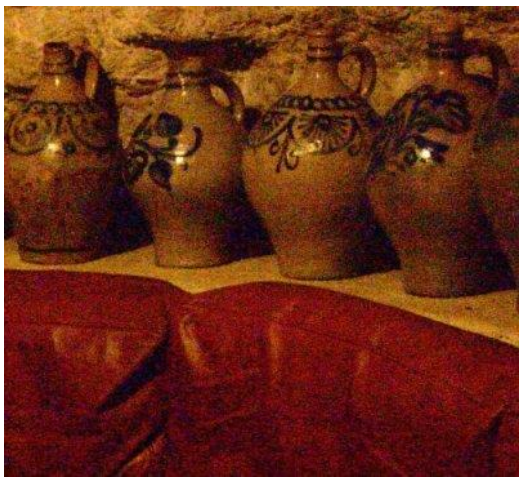
Part B - Joint bilateral filter

The *joint bilateral filter* is an extension of the bilateral filter, first introduced in [1] and [2]. The input of the joint bilateral filter is a pair of images, typically a no-flash and a flash image captured in quick succession by a digital camera. Then, a bilateral filter is applied to the first image, using non-spatial masks computed from the second image.

1. In part B of your report, describe the joint bilateral filter, discuss its main properties and some of its applications.

2. Implement the joint bilateral filter in Open CV in Python.

3. Fine tune the parameters of the joint bilateral filter on the pair of test images test 3a and test 3b. Present and discuss the results, illustrating the main properties of the joint bilateral filter.



test 3a (no-flash)

test 3b (flash)

[1] G. Petschnigg, R. Szeliski, M. Agrawala, M. Cohen, H. Hoppe and K. Toyama. "*Digital photography with flash and no-flash image pairs*." In ACM Trans. on Graphics, vol. **23**, no. 3, pp. 664-672, 2004.

[2] E. Eisemann and F. Durand. "*Flash photography enhancement via intrinsic relighting*." In ACM Trans. on Graphics, vol. **23**, no. 3, pp. 673-678, 2004.

All test images can be downloaded from DUO

Marking scheme

A1	Describe the bilateral filter and discuss its properties.	20%
A2	Apply the bilateral filter on the test images and fine tune the filter's parameters.	5%
A3	Fine tune the filter's parameters on the test images and discuss the results.	15%
B1	Describe the joint bilateral filter and discuss its properties and applications.	30%
B2	Implement the joint bilateral filter.	20%
B3	Fine tune the filter's parameters on the test pair of images and discuss the results.	10%

A1: I will be looking for evidence of understanding bilateral filters; depth and clarity in the discussion of their properties; evidence of independent reading beyond the material covered in the lecture. Few marks will be awarded for writing skills: the formatting of the report, grammar and syntax and the maturity of the technical writing style.

A2: Marks will be awarded for being able to read and write images and for the correct use of the OpenCV function ***bilateralFilter***, or your implementation of an equivalent function.

A3: I will be looking for evidence of understanding the influence of the parameters on the output, supported by references to the literature. The filtered images and your discussion should provide a good illustration of the properties of the bilateral filter discussed in A1.

B1: I will be looking for evidence of understanding how the joint bilateral filter works and what its main properties are; evidence of an effective search of the literature leading to an interesting choice of applications to discuss; clarity in explaining how the filter is used in those applications. Few marks will be awarded for writing skills: the formatting of the report, grammar and syntax and the maturity of the technical writing style.

B2: Marks will be awarded for the correctness of the implementation. Few marks will be awarded for code efficiency and for a clear documentation with inline comments.

B3: I will be looking for evidence of understanding the influence of parameters on the output. The output images and the discussion should provide a clear illustration of the properties discussed in B1.