The University of Melbourne
School of Computing and Information Systems
COMP90086 Computer Vision, 2021 Semester 2

Assignment 1: Image formation and filtering

Due:	7pm, 20 Aug 2021
Submission:	Source code (in Jupyter Notebook) and written responses (as .pdf)
Marks:	The assignment will be marked out of 6 points, and will contribute 6% of your total mark.

1. Mapping between world and image coordinates [3 pt]

Figure 1: The full size version of this image (`Asst1_1_image.jpg`) has been provided with this assignment specification on Canvas.

Use the pinhole projection model shown in lecture to work out where the indicated points A and B are relative to the camera in `Asst1_1_image.jpg` (illustrated in Figure 1 above). Point A is located at the top of the coffee pot, which is 21.5 cm tall. Point B is located at the top of the mug, which is 9 cm tall. The camera was placed so that its aperture was exactly aligned with the surface of the table. You can assume the camera aperture is at (0, 0, 0), and that the camera is oriented along the z axis so the centre of the image corresponds to a point (0, 0, z) in the world, the vertical axis of the image is exactly aligned with the vertical (y) axis in the world, and the horizontal axis of the image is exactly aligned with the horizontal (x) axis in the world (so the table surface is the plane y=0). The imaging sensor in this camera is 14.8 mm high by 22.2 mm wide. The image was taken with a focal length of 32 mm.

What are the (x, y, z) coordinates of point A and point B in the world? Show your work and include a diagram to illustrate how you set up the problem in your written report. (Coding is optional

Figure 2: A photograph with hidden text

for this question, but if you do not submit code, you must provide the formulas used to compute your answer in your written report.)

2. Secret messages with bandpass filters [3 pt]

Use bandpass filters to hide a secret message in an image, as in Figure 2.

- Find or create a message image A, and a cover image B. These should be the same size (and it is strongly recommended that both be square – equal height and width – and grayscale).
- In the Fourier domain, apply a high pass filter to the message image A and a low pass filter to the cover image B. Add them in the Fourier domain.
- Convert back to the spatial domain to obtain a modified image B hiding the secret message A.

Done correctly, the secret message A will only be readable if you are quite close to the image. From a distance, the image will simply look like cover image B.

You will need to do some experimentation to find the best thresholds for the bandpass filters, as this will depend on the images A and B that you use. Note that you are *not* required to use the same threshold for both A and B, and you may get better results if you use two different thresholds.

Your written report should show your final image result, state the thresholds you used for the bandpass filters, and explain the experiments you used to choose these thresholds. Include figures to illustrate your experimental results and reasoning.

Submission

You should make two submissions on the LMS: your code and a short written report explaining your method and results. Please note that although coding is optional for question 1, both questions require a written response. The response to each question should be no more than 500 words.

Submission will be made via the Canvas LMS. Please submit your code and written report separately under the **Assignment 1: Code** and the **Assignment 1: Report** links on Canvas.

- Your **code** submission should include the Jupyter Notebook (please use the provided template) with your code and any image files we will need to run your code.
- Your written **report** should be a .pdf with your answers to each of the questions. The report should address the questions posed in this assignment and include any images, diagrams, or tables required by the question.

Evaluation

Your submission will be marked on the correctness of your code/method, including the quality and efficiency of your code. You should use built-in Python functions where appropriate and use descriptive variable names. Your written report should clearly explain your approach and any experimentation used to produce your results, and include all of the specific outputs required by the question (e.g., images, diagrams, tables, or responses to sub-questions).

Late submission

The submission mechanism will stay open for one week after the submission deadline. Late submissions will be penalised at 10% of the total possible mark per 24-hour period after the original deadline. Submissions will be closed 7 days (168 hours) after the published assignment deadline, and no further submissions will be accepted after this point.

Updates to the assignment specifications

If any changes or clarifications are made to the project specification, these will be posted on the LMS.

Academic misconduct

You are welcome — indeed encouraged — to collaborate with your peers in terms of the conceptualisation and framing of the problem. For example, we encourage you to discuss what the assignment specification is asking you to do, or what you would need to implement to be able to respond to a question.

However, sharing materials — for example, showing other students your code or colluding in writing responses to questions — or plagiarising existing code or material will be considered cheating. Your submission must be your own original, individual work. We will invoke University's Academic Misconduct policy (`http://academichonesty.unimelb.edu.au/policy.html`) where inappropriate levels of plagiarism or collusion are deemed to have taken place.