60006 Computer Vision (Term 2) Relevant Questions in Exams Before 2018 (2010-2018)

Note: If you find any typos or incorrect answers and explainations, please email me at xz1919@ic.ac.uk with the title <course_number>-<course_name>-<year>-past-paper-enquiries or directly message me through Whatsapp. If you need explaination or reviews on the provided questions, please contact me as well. :)

This course before 2018 was a totally different course compared to the version after 2018. However, there are still relevant parts that can help to prepare the exams, so I've collected all questions that are relevant to the exams from 2018 onwards.

Notice that before 2020 (inclusive) the course number is C315/C316, before 2013 (inclusive) the course number is C418

Year 2018

Q1b. This question is about Hough transform

i) A system is designed to extract parabolic curve segments from a monochrome shaded image. The curve is defined by the equation $y = ax^2 + bx + c$. Explain how the Hough transform could be used to find these curve segments.

ii) Discuss how to limit the voting space to 2D to solve the above problem. What are the main advantages of using low dimensional voting spaces?

Q4a. Explain the term optical flow and the usual assumptions in using it for motion analysis in an image sequence.

Year 2017

Q1c. The features detected in the images will end up in a database used for object recognition.

i) What are the two main challenges in object recognition? Provide two examples of each challenge.

ii) List the 4 main steps for k-means clustering used in bag-of-features.

Q2. Image sequence processing

a. i) In the context of image sequence processing, what is feature and describe why local features are desired for tracking?

ii) What are feature descriptors and why are they used over the original features?

b. i) What is meant by the following when measuring tracking errors? TP, RN, FP, TN

ii) How are precision and recall defined?

c. Describe the steps of the Harris corner detector, providing the necessary equations in matrix form

d. Consider the following images extracted from a longer image sequence of a hot air balloon festival. Propose a suitable framework to track the balloons in this sequence, taking into consideration: What features you will use and how you will extract them. How you would distinguish between ballons and clouds. A possible way to deal with a balloon disappearing from a few frames due to it being blocked by another. This problem is known as occlusion.

Q3. Edge Detection and Hough transform

a. i) Identify a set of convolutional filters that can be used to extract edges from an image. Explain how you can combine the results from this set of filters to generate an edge magnitude and gradient.

ii) With a sketch, clearly illustrate the difference between edge direction and edge gradient.

(question b is not relevant)

c. In a jar lid factory, a vision system takes photos of the lids for quality control. These lids are expected to be perfectly round. Outline how you can use the Hough Transform to extract the lids that are perfect circles and also those that are not perfect circles (more elliptical). Show your steps with a flowchart. You can assume there will a maximum of 8 lids in each image.

d. Describe in detail an alternative method of extracting circular objects from the images. List the advantages and disadvantages of your method over the Hough Transform.

Q4. Image segmentation and analysis

a. The student would like their vision system to first identify which pieces of sushi are largest. An example of an image from the camera is below; you can clearly see the plates and the sushi pieces on them.

i) Outline a method to segment the sushi pieces from the scene.

ii) Propose three shape discriminants that could be used to determine the size of the pieces of sushi.

Year 2016

Q1c. The second step required is to extract the pairs of wings of each dragonfly from the scene.

i) Using a flowchart, describe the steps required to use the Hough transform to extract each pair of wings together as an ellipse

ii) Describe an alternative approach to extract the wings from the dragonflies, taking into account the noise in the image

Q3a. i) Provide a sketch of the pinhole camera model, labeling the object point, the image point, the image plane, the focal distance and the centre of projection.

ii) If you have calibration matrix K shown in the paper, what are the internal parameters of the camera that are represented by each variable in the matrix?

iii) What are the benefits of using homogeneous coordinates in projective geometry?

Year 2015

Q2. The Hough transform

(question a and b are not relevant)

c. The Hough transform will be used to extract circles in the image below. The image is size 256x256 and the circles have maximum diameter of 100

Indicate in pseudocode how you would implement the following two cases. Describe the advantages and disadvantages of each implementation. You can assume that a Sobel filter has already been applied to the image and that each pixel has an edge gradient magnitude and direction.

i) Using a three dimensional histogram array to extract x_c, y_c, and r. x_c and y_c are the center of a circle and r is the radius.

ii) Using a two dimentional histogram array to extract the centers first and then finding the radii.

Q3. Image sequence processing

a. i) Describe why local features are good for object tracking in image sequences.

ii) Why are corner features more suitable for tracking than edge features?

b. With reference to feature tracking in image sequences, explain what is meant by: brightness constancy, temporal persistence and spatial coherence

c. Explain why feature descriptors are required for feature matching and clearly outline the steps for calulating the SIFT descriptor for a feature.

d. The two images in the paper are taken of the same scene at different times of the day. Propose a method for matching the buildings in this scene, clearly outlining your steps and your reasons for choosing them.

Q4c. Explain what is meant by the aperture problem and describe one potential way to overcome it.

Year 2014

Q2. a. The Hough transform can be used to extract straight lines from an image. Describe two parameter spaces that can be used and indicate their advantages and disadvantages in the transform.

c. There is a fast-food chain by the name of WackyBurger with a suspiciously familiar logo. The logo can be modeled as a pair of parabolas (a parabola can be written as $y = a(x - x_c)^2 + y_c$). Describe how you would use th Hough transform to identify the WachyBurger logo in an image of a street scene. Assuming that the image would be first divided into windows of size 128x128, suggest suitable bounds on the histogram array for the parameters a, x_c and y_c

Year 2013

Q1c. Explain the general concept and main steps involved in generalized Hough transform

Q2. a. Explain what is optical flow and the assumptions that need to be made for it to be useful for determining object motion.

b. What is the aperture problem encountered in optical flow? Explain mathematically the reason behind this problem.

Year 2012

Q1d. A system is designed to extract curve segments from a monochrome shaded image. The curve is defined by $y = ax^3 + bx^2 + cx + d$. Explain how the Hough transform could be used to find these curve segments.

Year 2011

Q1. The Hough transform

A Hough transform is to be used to extract circles from an image. The image has a resolution of 256by 256 and each of the circles has a radius of less than 64 pixels. Using a pseudo code of your choice, indicate how the implementation could be carried out in the following three cases:

a) Using a three-dimensional histogram array for xc, yc and r, with x., y. specifying the centre and r the radius of the circle.

b) Determining the centres with a two dimensional histogram first, using gradient information as well as position, and then finding the radii.

c) Determining the centres with a two dimensional histogram first, using position information only, and then finding the radii.

d) Comment on the advantages and disadvantages of the three methods used in parts a, b and c.

Year 2010

Q4d. By expanding the intensity function $I(x + dx, y + dy, t + dt)$, show that the change in intensity at a pixel is related to the velocity of the object seen from that pixel by the equation of optical contraint. Clarify the assumptions that need to be made about the illumination if this is to be made into an algorithm for determining object motion.