UNIVERSITY OF SOUTHAMPTON COMP6223W1

SEMESTER 1 EXAMINATION 2017 - 2018

COMPUTER VISION (MSC)

DURATION 120 MINS (2 Hours)

This paper contains 6 questions

Answer **THREE** questions. You are advised to spend no longer than 40 minutes per question.

An outline marking scheme is shown in brackets to the right of each question.

Each question is worth 33 marks. A maximum of 99 marks is available for the paper.

University approved calculators MAY be used.

A foreign language dictionary is permitted ONLY IF it is a paper version of a direct Word to Word translation dictionary AND it contains no notes, additions or annotations.

7 page examination paper.

Question 1.

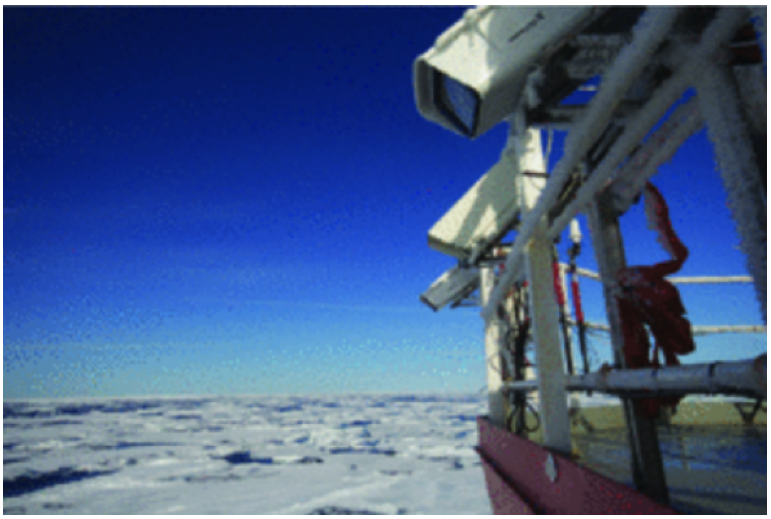


FIGURE 1: Arctic and imaging equipment [from: Sorensen S. et al. (2017) Deep Learning for Polar Bear Detection. In: Sharma P., Bianchi F. (eds) Image Analysis. SCIA 2017 LNCS, vol 10269. Springer]

(a) Figure 1 shows an image of a system used in the Arctic to observe polar bears. **Describe** the computer vision approaches (not including deep learning) which could be combined to achieve this task, describing how they might be tailored and deployed for this application, and the attributes they possess. (Note: bears do leave paw prints when crossing snow.)

[33 marks]

Question 2.

(a) **Describe** the principles and advantages (or otherwise) of the Gaussian smoothing operator and uniform (direct) averaging.

[12 marks]

(b) **Show** how an approximation to the Gaussian operator can be derived by using Pascal's triangle for 3×3 and 5×5 operators. Determine whether the 3×3 Gaussian operator can be made, by scaling, to be the same as the 3×3 approximation, stating any assumptions you have made.

[15 marks]

(c) **Describe** the changes in operation that the difference between the two operators might cause.

[6 marks]

TURN OVER

Question 3.

(a) **Describe** the difference in principle between first-order and second-order edge detection. **Describe** one approach for either operator.

[12 marks]

(b) **Describe** how zero-crossing detection can be achieved in second-order edge detection.

[15 marks]

(c) **Describe** whether thresholding could be applied to the output of second-order edge detection to avoid the complexity of (b).

[6 marks]

Question 4.

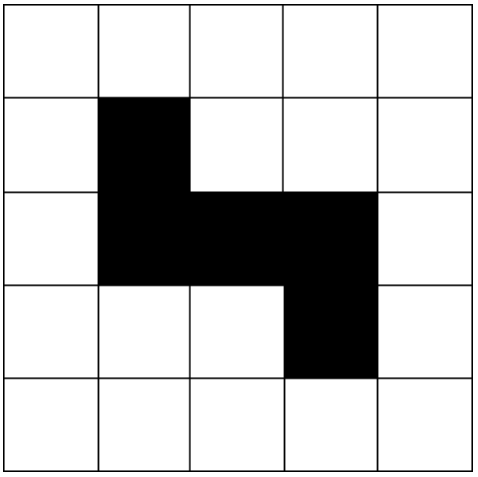
(a) **Describe** how you could segment a colour image by representing each pixel as a vector of its component colours and applying k-means clustering. **Ensure** your description includes details of all the steps, information on all parameters that will need to be chosen, and any other design choices you make.

[12 marks]

(b) **Describe** the main problems of the approach taken above, and suggest how they might be overcome.

[6 marks]

(c) Consider the connected component depicted by the solid black pixels below:



Ensuring you show all working, **compute** the central moments μ_{11}, μ_{20} and μ_{02}.

[11 marks]

(d) **Show** why the central moments μ_{01} and μ_{10} are not useful as descriptors.

[4 marks]

TURN OVER

Question 5.

Currently, Parking Enforcement Officers in Southampton have to manually type in the licence plate details of every car they record. Considerable time savings could be made if this information could be captured using a smart phone based system in which the Enforcement Officer takes a photograph of the car, and computer vision software is used to recognise the licence plate. You have been asked to design the system. The system should be designed to work at all times of day and under all weather conditions, and must be easily carried by the Enforcement Officers.

(a) **Describe** the features of current licence plate designs in both the UK and abroad that can help you develop a robust system.

[8 marks]

(b) **Discuss** features that you might incorporate into your design to help ensure robustness. You should think about both the hardware and software aspects. You can suggest additional hardware to augment the smart phone as long as the overall system can be easily carried by the Enforcement Officers.

[8 marks]

(c) Starting with an image captured by your mobile hardware, **describe** in detail the processing that your system will perform to recognise the individual characters within a licence plate.

[17 marks]

Question 6.

You have been asked to design a program that can stitch photos of the same rigid scene together to automatically create a panorama. **Describe** the steps your software will take to achieve this and **discuss** the reasons for your design choices. Be sure to **demonstrate** understanding of each part of your approach in detail, using pseudo-code and diagrams as necessary. You can assume that interest points detected in the photos given to your system are sufficiently far away from the camera to be considered to lie on a plane. [33 marks]

END OF PAPER