On admission to the examination room, you should acquaint yourself with the instructions below. You must listen carefully to all instructions given by the invigilators. You may read the question paper, but must not write anything until the invigilator informs you that you may start the examination.

You will be given five minutes at the end of the examination to complete the front of any answer books used.

May/June 2014 **SE3IA11 2013/4 A 001 & SE3IA11 2012/13 A 201**

2 Answer Books
Only CASIO fx-83ES or -83MS calculators permitted
Treasury tag

UNIVERSITY OF READING

IMAGE ANALYSIS (SE3IA11)

Two Hours

Answer any **THREE** out of FOUR Questions

Answer Question(s) from Section A and
Section B in separate Answer Books.

EACH Question is 20 marks

Section A

1. (a) Explain the basic approach to spatial filtering. Comment on its significance to image analysis and how it may be achieved efficiently in practice.

(4 marks)

(b) For each set of spatial filters given below, explain the circumstances under which they would be applied and the operation which is being computed (i.e. describe how it achieves the desired result).

(i) $\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$

(ii) $\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$

(iii) $\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$

(6 marks)

(c) An image codec is software that enables compression and decompression of images. You are tasked to design a new codec dedicated to compressing the depth images acquired from a consumer depth sensing device. Explain how you would design a codec for this purpose.

(10 marks)

2. (a) Define the term 'symbolic image feature' and explain why symbolic image features are important in image analysis.

(4 marks)

(b) Choosing ONE named symbolic feature, explain the process of extracting it from an image. Describe the factors which influence the quality of the result.

(6 marks)

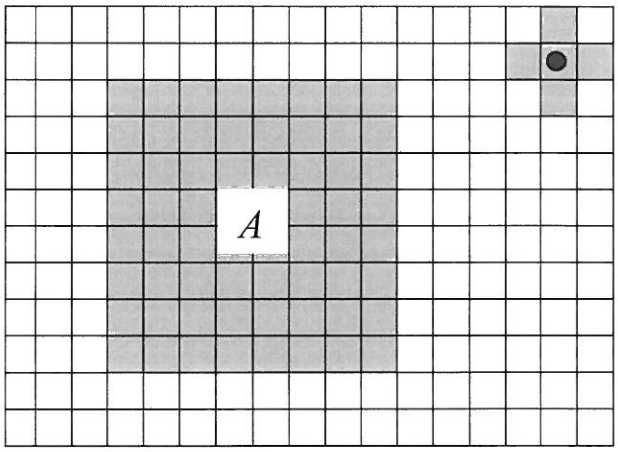
(c) Content-based image search is the process of automatically retrieving desired images from a database on the basis of semantic labelling of image features. Law enforcement would like to use such a process for their investigative work, for example, identifying the same vehicle across a wide geographic area using images captured from a CCTV (multiple) camera network.

Explain, with an appropriate set of methods from image analysis, how you might enable efficient search of a set of CCTV images in the database to identify the same vehicle. Include in your answer the application of THREE different image features.

(10 marks)

Section B

3. (a) Define the erosion operation as a basic morphological processing technique. Sketch the operation result of Object A eroded by Structural Element B based on the information given in *Figure Q3-1*.



Structuring element B

Figure Q3-1. Object A and structuring element B

(5 marks)

(b) Region growing and region splitting techniques can be used in image segmentation.

(i) Explain the key steps in a region growing algorithm.

(ii) Present the quad-tree region splitting algorithm. You may use a diagram to support your answer.

(7 marks)

(c) An image, with 8 digits presented, is given in *Figure Q3-2*. Design an algorithm which can automatically isolate the 8 digits. Present your algorithm step by step and detail how complicating factors are dealt with. (Hint: take noise and uneven illumination into account). State any assumptions you make in your answer.

Figure Q3-2. Image with 8 digits

(8 marks)

4. (a) Relationships of image pixels can be defined by the distance between them, or neighbours of a pixel. For a pixel P(x,y), define its four diagonal neighbours N_D(P) by giving the coordinates of these pixels; for two pixels $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$, present the equation to calculate the Euclidean, D_4, and D_8 distance between them.

You may use a diagram to support your answer.

(5 marks)

(b) Image colour information can be used for image segmentation. A remote sensed RGB image contains forestry with a burnt area. Design an algorithm which can identify the burnt area.

State any assumptions you make in your answer.

(7 marks)

(c) A Grey Level Co-occurrence Matrix (GLCM) provides rich features to describe image properties. Calculate the symmetrical GLCM of the image patch shown in *Figure Q4* with displacement vector of (1, 90°), and briefly explain how to read the GLCM for image properties.

2	4	3	5
0	4	1	0
3	5	1	0
2	2	1	0

Figure Q4

(8 marks)

(End of Question Paper)