UNIVERSITY OF
LINCOLN

Lincoln School of Computer Science

Assessment Item Briefing Document

Title: CMP9135M Computer Vision Assignment	**Indicative Weighting: 100%**

Learning Outcomes:

On successful completion of this assessment item a student will have demonstrated competence in the following areas:

• [LO1] Critically evaluate and apply the theories, algorithms, techniques and methodologies involved in computer vision.

• [LO2] Design and implement solutions to a range of computer vision applications and problems, and evaluate their effectiveness.

Requirements:

This assessment comprises three assessed tasks, as detailed in the following page.

1. Image segmentation and evaluation. Weight: 40% of this component
2. Feature calculation. Weight: 30% of this component
3. Object tracking. Weight: 30% of this component

Deliverable:

Your submission should include a zip file with all the source code and a concise report that describes your work on the above tasks. Please note that, in the report, you also need to include the main source code in the appendix.

Useful Information

This assessment is an individual piece of work. Your work must be presented according to the Lincoln School of Computer Science guidelines for the presentation of assessed written work.

Please make sure you have a clear understanding of the grading principles for this component as detailed in the accompanying Criterion Reference Grid.

If you are unsure about any aspect of this assessment component, please seek the advice of a member of the delivery team.

Note: The maximum page limit of the report for this assessment is 8 pages (excluding the appendix).

Submission Instructions

The deadline for submission of this work is included in the School Submission dates on Blackboard.

You must make an electronic submission of your work in pdf format together with a zip file containing all source code files by using the assessment link on Blackboard for this component. Each student is then required to demonstrate their solution to the module instructors, as per the schedule indicated on Blackboard. You must attend the lectures for further details, guidance and clarifications regarding these instructions.

DO NOT include this briefing document with your submission.

Task 1: Image Segmentation and Evaluation

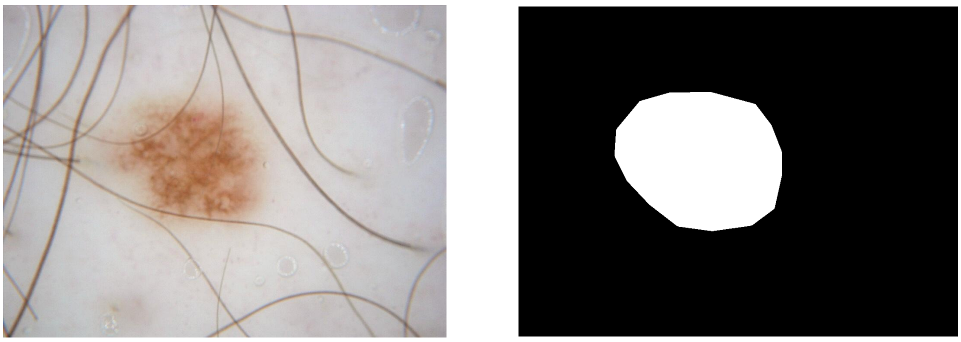
Download and unzip the file 'skin lesion dataset.zip' from Blackboard. You should obtain a set of 120 images. Among those images, there are 60 skin lesion colour images and 60 corresponding binary masks (ground-truth segmentation).

Task 1: Object segmentation. For each skin lesion image, please use image processing techniques to automatically segment lesion object. Examples of the lesion image (Fig.1(a) and the segmented lesion (Fig.1(b)) are shown in Figure 1. Please note that you are encouraged to develop one model with same parameter settings for all the images.

Task 2: Segmentation evaluation. For each skin lesion image, calculate the Dice Similarity Score (DS) which is defined in Equation 1; where *M* is the segmented lesion mask obtained from Task 1, and *S* is the corresponding ground-truth mask provided.

$$\mathrm{DS} = \frac{2|M \cap S|}{|M|+|S|} \tag{1}$$

The calculated DS shall be between 0 and 1. For example, DS is 1 if your segmentation matches perfectly with the ground-truth mask, whist DS is 0 if there is no overlap between your segmentation and ground-truth mask.



(a) Skin lesion image (b) Segmented object (lesion)

Fig.1 Skin lesion segmentation

Your report should include: 1) For three skin images (ISIC_0000019, ISIC_0000095 and ISIC_0000214), you are required to put the original images, final segmented lesion binary images, the calculated DS value for each of the three images and; 2) for all the 60 skin images, please provide a bar graph with x-axis representing the number of the image, and y-axis representing the corresponding DS. 3) Calculate the mean of the DS for all the 60 images, and 4) briefly describe the implementation steps.

Task 2: Feature Calculation

Download the Image (ImgPIA.jpeg) from Blackboard. This part of the assignment will deal with the area of Feature Extraction, in both the Frequency and Spatial domains.

Task 1: Read the image (ImgPIA.jpeg), and select the features for both radius and direction as described in the Spectral Approach session of the Feature Extraction lecture. For additional marks you can change the values of radius and angle, and present those values in a plot or table.

Task 2: Read the image (ImgPIA.jpeg), and select features from the image histogram (i.e. 1st order), and at least six (6) features from the co-occurance matrix (the original paper by Haralick has also made available to you). Please note that the co-occurance based features can be directional and as a function of distance between pixel co-ordinates. For additional marks you can change the bit-depth of the image (i.e. 8, 6, 4 bit), and recalculate the features presenting them as a plot or table.

For both tasks analysis and discussion of your findings is expected.

Task 3: Object Tracking

Download from Blackboard the data files 'x.csv' and 'y.csv', which contain the real coordinates [x,y] of a moving target, and the files 'a.csv' and 'b.csv', which contain their noisy version [a,b] provided by a generic video detector (e.g. frame-to-frame image segmentation of the target).

Implement a Kalman filter with a software application that accepts as input the noisy coordinates [a,b] and produces as output the estimated coordinates [x*,y*]. For this, you should use a Constant Velocity motion model F with constant time intervals $\Delta t = 0.1$ and a Cartesian observation model H. The covariance matrices Q and R of the respective noises are the following:

$$Q = \begin{bmatrix} 0.1 & 0 & 0 & 0 \\ 0 & 0.2 & 0 & 0 \\ 0 & 0 & 0.1 & 0 \\ 0 & 0 & 0 & 0.2 \end{bmatrix} \qquad R = \begin{bmatrix} 0.3 & 0 \\ 0 & 0.3 \end{bmatrix}$$

1) You should plot the estimated trajectory of coordinates [x*,y*], together with the real [x,y] and the noisy ones [a,b] for comparison.

2) You should also assess the quality of the tracking by calculating the mean and standard deviation of the absolute error and the Root Mean Squared error (i.e. compare both noisy and estimated coordinates to the ground truth).