INTRODUCTION TO DIGITAL IMAGE PROCESSING

ASSIGNMENT 4

Due date: Thursday, November 15, 2018 by 5 pm
Total marks: 5
Late penalty: 0.5 marks per day overdue. Late assignments will not be accepted after 5 pm of Monday, November 19, 2018, and a mark of zero will be given.

All assignments will be done in **groups** of 3-4, and the same final mark for the assignment will be assigned to all group members. Instructions for forming a group in OWL are given in Appendix A, but we prefer that you keep the same group as in previous assignments.

Instructions for submitting answers are given with each question below. Note that I allow you to keep resubmitting until the deadline. Only the last submission is available to the TAs for marking. I recommend that all group members should agree to a submission before uploading it.

CONVENTIONS

Fixed-point font (`Courier`) is used to denote MATLAB commands, variables and filenames.

OBJECTIVES

1. To use an implementation of the background removal function discussed in class.
2. To automate the background removal function discussed in class.

All code and answers requested below must be submitted using OWL. To provide answers via OWL:

1. **One group member should log into OWL and select "ECE 4445A 001 FW18".**
2. **From the left-hand side, select "Assignments".**
3. **From the page that comes up, select "Assignment 4".**
4. **You will now reach the submission page for Assignment 4. Follow the instructions below for each part to submit answers.**

PROBLEMS

1. **(a) [0.1 marks]** A MATLAB function implementing the background removal code that is based on our discussion in class is on the course OWL site in the folder **Lectures**. It is called `level.m`. Apply this function to the image '`rice.png`' that is available as part of the MATLAB image processing toolbox. Display the levelled image (i.e., image with background removed). Once you generate the display, you should save the display by selecting "File" in the figure window and then "Save As…". In the dialog box that comes up, select "TIFF image (*.tif)" as the output type and for "File name", enter "1a_#" without quotes where # is your group number. This will save the figure in the file called "1a_#.tif". **When you are on the submission page in OWL for Assignment 4, scroll to the bottom and attach your image.**

(b) [0.2 marks] What did you estimate the coefficients a_i, i = 0, 1,…,5, to be? Would you expect these to be identical to what other groups found? Explain your answer. **Write your answer in the text box on the submission page for Assignment 4 taking care to label this as part 1(b).**

(c) [0.2 marks] Using the '`plot`' command, plot a vertical profile through column 50 of the original unlevelled image as a dashed curve.[1] On the **same** axis, plot a vertical profile through column 50 of the levelled image as a solid curve. You may need to use the help facility in MATLAB to learn more about the `plot` command, including how to specify line types (dashed or solid) and how to plot on the same axis. Once you generate the plot, you should save the display by selecting "File" in the figure window and then "Save As…". In the dialog box that comes up, select "TIFF image (*.tif)" as the output type and for "File name", enter "1c_#" without quotes where # is your group number. This will save the figure in the file called "1c_#.tif". **Attach the image in OWL.**

(d) [0.2 marks] Based on the plot you made in Question 1(c), explain whether or not the function `level` is working correctly. **Write your answer in the text box on the submission page for Assignment 4 taking care to label this as part 1(d).**

2. In the `level` function, the user is asked to interactively select points in the background of the image to be levelled. In order to find background pixels *automatically*, one can break the image up into M x N non-overlapping blocks as discussed in class and find the minimum value and its coordinates in each block. The minimum value in each block and its coordinates can be used as background pixels. Modify the `level` function so that background pixels are found automatically, and no user interaction is required. You will have to select appropriate values of M and N, and these can be hardwired into your code. The modified function should display the original (unlevelled) image with selected points superimposed. This new automated levelling function should have the header:

```
function [im2, a] = autolevel_#(fname)
```

where # is your group number. For instance, if you are part of group 1, your function name would be `autolevel_1`. If you are part of group 50, your filename would be `autolevel_50`.

HINTS:

(i) To find the minimum value in a sub-matrix extracted from an image, you can apply the MATLAB function `min` twice. Part of the exercise is for you to figure this out.

(ii) To plot points on top of a displayed image, you should use the `hold` function as follows:

```
imshow(im)
hold on
plot(x, y, 'y+')
```

(a) [4 marks] Save the function in a file called `autolevel_#.m` where as before # is your group number. **NOTE: Use the exact filename and function name as specified above. All letters are in lowercase. Your function should be commented.**

Attach the M-file in OWL. Also, cut and paste this code into the text box and label it as 2(a).

(b) [0.1 marks] Display original image and the points automatically selected by your function. Once you generate the display, you should save the display by selecting "File" in the figure window and then "Save As…". In the dialog box that comes up, select "TIFF image (*.tif)" as the output type and for "File name", enter "2b_#" without quotes where # is your group number. This will save the figure in the file called "2b_#.tif". **Attach the M-file in OWL.**

---

[1] A vertical profile through column 50 refers to a plot of gray levels in column 50 versus the row number. You can plot a vertical profile through column 50 of image `im` with a dashed black line using the command:

```
>> plot(1:size(im,1), im(:,50), 'k--')
```

(c) [0.2 marks] In your automatic levelling function, what values of M and N did you use? Explain your rationale for using the particular values of M and N. **Write your answer in the text box on the submission page for Assignment 4 taking care to label this as part 2(c).**

In the text box on the assignment submission page, enter the name and student number of each group member.

MATLAB RESOURCES

All MATLAB guides can be found at:

http://www.mathworks.com/access/helpdesk/help/helpdesk.shtml

For information on the image processing toolbox, select the link labelled "Image Processing Toolbox".

APPENDIX A

Step 1: Log into OWL and click on Site Info. Click on the section near the bottom labelled Groups you can join**.** There should be a list of 50 potential groups to join. These are called "Assignment Group 1", "Assignment Group 2", …, "Assignment Group 50".

Step 2: Once a student joins a group you will see his/her name under **Members**. If you see your partner's name in a group, join that group by hitting the "Join" button. If you don't see your partner's name, join **any** empty group; when your partner goes to join a group they will see your name and join yours. If you joined the wrong group, you can leave or un-join the group.