Computer Vision and Imaging [06 30213]
Computer Vision and Imaging (Dubai) [06 32578]
Assessed Assignment

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1. Instructions

You are to work individually for this assessment, and produce one report. The report must be no more than THREE pages long including all graphs and tables. The report should be submitted via CANVAS (See Canvas for deadline).

Your assignment involves some implementation and some experimentation, plus the write up. All images to be processed are provided.

Your code/script should also be submitted as supplementary data (5 extra Pages max): Remember to follow good practice with structure, use of functions and adding of comments to your code.

Any text beyond the stated 3 pages will not be marked. There will be 5% penalty per day (or part of), for late submissions.

Your submitted assignment should:

- Be a maximum of 3 pages (A4)
- Have minimum margins (top/bottom/sides) of 2 cm
- Use Arial (narrow) font of 11
- Contain your student ID, and module code in the header

2. The assignment:

Task 1. Laplacian of Gaussian [10 Marks]

- Write a function to create a mask that implements the Laplacian of Gaussian filter. This is the second derivative of the Gaussian noise function. We covered this operator in detail in the lectures and you can read more about it in the Chapter on Edge Detection in textbook by Jain or other related text within the resources section of canvas: https://canvas.bham.ac.uk/courses/72993/modules/items/3498608
- Show the results of applying your filter to the 'Shakey' image, outlining the steps taken, and discussing your findings. Discuss the use and method of any noise removal technique used.

Task 2: Cell Detection: Background

- Serological testing for anti-nuclear antibodies (ANAs) plays an integral role in diagnosing a plethora of autoimmune diseases. ANAs are detected by indirect immunofluoresence (IIF) on HEp-2 cells, a human epithelial cell line originally derived from a larynx carcinoma. In brief, patient serum (containing ANAs) is incubated on HEp-2 cells and detected with a commercially produced fluorescein conjugated anti-human secondary antibody. When viewed under a fluorescent microscope, the distinct patterns - a result of the ANAs targeting the nuclear components of HEp-2 cells - can then be associated with a specific disease.
- A semi-quantitative evaluation of fluorescent intensity can be obtained by conducting serial dilutions of the serum sample to endpoint (the final antibody titre where positive staining is still visible). However, this methodology is still reliant on subjective interpretation and therefore prone to both high inter- and intra-laboratory variance. As such, standardization of ANA testing by IIF remains a significant issue.
- You will find THREE images of fluorescing cells provided, together with manually detected edges ('Ground Truth'). You need to devise, carry out and test the efficacy of the various edge detectors we have seen. These are:
    1. Roberts,
    2. Sobel,
    3. first order Gaussian,
    4. Laplacian,
    5. Laplacian of Gaussian.

Task 2: Edge Detection [15 Marks]

- Apply the above edge detectors to the THREE sets of images provided. Show the results, outlining the steps taken and discuss your findings. Discuss the use and method of any noise removal technique used.

Task 3: Advanced Edge Detection [15 Marks]

- Implement any other edge detector algorithm to the THREE sets of images provided. Show the results, outlining the steps taken and discuss your findings. Discuss why the use of the proposed algorithm is better/worse than those in Task 2.

Task 4: Result evaluation [10 Marks]

To test the accuracy of an edge detector you will need to threshold the results to produce a binary image. You will then need to measure the edge points you have detected, against those in a labelled ('Ground Truth') image.

- How can you measure how accurate an edge detector is? To do this you will need to do what is called ROC (Receiver Operator Characteristic Analysis). ROC analysis allows you to produce two numbers telling you how sensitive and specific each edge detector is (See lecture 1, Week 5 by Ales Leonardis). As part of this you will have to implement a routine that compares your edge image to the labeled edge image, and calculates the matches, the non-matches and the type of each. Discuss your findings.

Write an experimental report of THREE pages detailing the experiments you have carried out. Make sure that you include the Aim, Method, Results and Conclusions. You should be able to draw a limited conclusion about which detector or detectors are best for the images you have chosen from the database.

Notes

- Remember, credit will be given where there is detail and reasoning. If you use any edge detection filters NOT used in class, you need to outline its implementation.
- Although I have made quite detailed suggestions about how to analyse each technique you are free to do your own investigations and report them. You will obtain significant credit for doing this if your investigations are interesting and well reported. You will also gain considerable credit for extending the techniques in other ways.