German Jordanian University
School of Applied Medical Sciences
Department of Biomedical Engineering

BM326: Medical Image Processing Lab

Course Catalog
1 Credit hour (3 hrs laboratory) Software experiments illustrating the concepts in image processing and analysis. Topics covered include basics of medical image processing: Grey-Level operations, image subtraction, averaging, manipulate histograms for image enhancement; including histogram equalization, and image filtering (in spatial domain). Moreover, it includes analysis of image quality (MTF, image noise, S/N-behavior), image segmentation, gradient operators, morphological filter, image enhancement, restoration; and reconstruction.

Lab Instructor	
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Evaluation		
Assessment Tool	**Weight**	**Expected Due Date**
Lab Reports	30%	Each report is due at the beginning of the next lab session
Quizzes	10%	At any time in any lab session
Midterm Exam	20%	Assigned at the beginning of each semester
Final Exam	40%	Assigned at the beginning of each semester
Total	100%	After completing the final exam

Topics Covered		
Week	**Experiment No**	**Topic**
1	----------	Lab Introduction
2	Experiment 1	Image Enhancement
3	Experiment 2	Image Segmentation
4	Experiment 3	Edge Detection
5	Experiment 4	Continuity Based Segmentation
6	Experiment 5	Morphological Operations
7	**Exam**	**Midterm Exam**
8	Experiment 6	Image Coloring
9	Experiment 7	Image Registration
10	Experiment 8	Image Reconstruction
11	Experiment 9	Image Deblurring
12	Experiment 10	DICOM Files
13	**Exam**	**Final Exam**

Objectives and Outcomes	
Objectives	**Outcomes**
1. Learn how to use MATLAB Image Processing Toolbox in digital image processing.	1.1. Learn the fundamental enhancement techniques. 1.2. Recognize the histogram and histogram equalization using MATLAB. 1.3. Design mean and median filters using MATLAB and use them to filter different medical images.
2. Understand the different approaches of image segmentation.	2.1. Apply Thresholding algorithm on different medical and non- medical images using MATLAB. 2.2. Use image histogram in pixel base image segmentation.
3. Understand the definition of Edges and learn the different methods of edge detection.	3.1. Use the MATLAB command "edge" to recognize the different gradient and Laplacian edge detectors. 3.2. Apply edge detection on different medical images using MATLAB, and learn the applications of edge detection.
4. Understand the continuity based image segmentation approach.	4.1. Apply neighborhood operations in segmentation tasks for the images that have the same intensity in different regions with different texture properties. 4.2. Design different non- linear operators to process the similarity and consistency in images using the MATLAB command "nlfilter".
5. Represent and perform the fundamental and compound operations of morphological image processing on binary and gray scale	5.1. Design different structuring elements using MATLAB for different morphological tasks include dilation, erosion, opening, closing, skeletonization, etc…). 5.2. Apply Morphological operations on different medical

images.	and non-medical images
6. Learn the colored digital images and their processing techniques.	6.1. Recognize the two major colored images systems (24-bit and 8- bit indexed colored images). 6.2. Apply histogram equalization for both 24- bit and 8-bit indexed images using MATLB. 6.3. Apply pseudo-color generation using MATLAB.
7. Understand the concept of image registration.	7.1. Recognize the three image registration solutions using MATLB. 7.2. Use Image Processing Toolbox and Computer Vision System Toolbox™ to register different medical and non-medical images.
8. Understand the concept of image reconstruction and its two major categories.	8.1. Recognize the parallel beam projection geometry and the fan beam projection geometry. 8.2 Use the MATLAB command "iradon" to reconstruct images acquired from parallel beam projections. 8.3. Use the MATLAB command "ifanbeam" to reconstruct images acquired from fanbeam projections.
9. Understand the theoretical model, and the practical implementation of image blurring-deblurring.	9.1. Define and model image blurring and image deblurring in both (time and frequency) domains. 9.2. Explore several schemes for eliminating or reducing blur afflicting the image of interest using MATLAB.

Lab Report Requirements	
Report section	**Description**
Introduction	This section should provide the context and motivation for the experiment, briefly explain relevant theory in sufficient detail, introduce any relevant laws, equations or theorems, and clearly state the aim or research question that the experiment is designed to address. You should try to write it in your own words, rather than paraphrasing the lab manual (but if you have to, be sure to include the appropriate references). It's always a good idea to read the entire experiment in the manual before you begin your introduction.
Procedure	This section must include a description of the procedure followed. It should not simply be a re-statement of the procedure section of this manual. You should interpret the procedure section and develop your own step-by step method.
Results	In this section, you present the main data collected during your experiment. Each key measurement needs to be reported appropriately. Data are often presented in graphs, figures or tables. These need to be labelled appropriately to clearly indicate what is shown. Tables should be labelled numerically above the table as Table 1, Table 2, etc. Everything else (graphs, images, diagrams etc.) is labelled numerically below the figure as Figure 1, Figure 2, etc.
Discussion	This section should demonstrate how will you understand what happened

	in the experiment. You should identify and comment on any trends you have observed, compare the experimental results with any predictions, identify how any sources of error might impact on the interpretation of your results, suggest explanations for unexpected results, and where appropriate, suggest how the experiment could have been improved.
Conclusion	This section should provide a message summing up what has been learned from the experiment such as: briefly restate the purpose of the experiment (the question it was seeking to answer), identify the main findings (answer to the research question), note the main limitations that are relevant to the interpretation of the results, summarize what the experiment has contributed to your understanding of the problem.
References	List all sources that you have referred to in the body of your report. These can include references to accepted literature values or equations you use in your calculations. You should use proper referencing techniques.
Appendix	It contains material that is too detailed to include in the main report, such as tables of raw data, software code or detailed calculations.
Formatting	Font type: Times New Roman. Font size: 12 for the main paragraphs and 14 bold for the titles. Justify the paragraphs. Numbering. Figures should be inserted in the center of the page and they should be labeled below the figure with font size 10. Tables should be inserted in the center of the page and they should be labeled above the table with font size 10.

Policy	
Attendance	Attendance will be checked at the beginning of each lab session. University regulations will be strictly followed for students exceeding the maximum number of absences (20%).
Reports	Each student must hand his\her own separate report. Laboratory reports are due to ***one week after*** the experiment was carried out and it will be collected at the beginning of each laboratory. If any report is not submitted to the TA by the deadline, it will be judged as "**LATE**".
Examinations	The midterm and the final exams are closed book tests. Students who are not able to attend an examination (medical or another emergency) must notify the instructor. Make up tests require a ***valid university*** excuse.
Student Conduct	It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Cheating will not be tolerated in at all. University regulations will be pursued and enforced on any cheating process.