Concordia University

Department of Computer Science & Software Engineering

COMP 478/6771 Image Processing

Project Due date: December 5, 2023

Instructions:
This take-home course project has two parts. It is strictly forbidden to copy from each other and online sources. ***A zero mark will be given to submissions with either identical writing/explanations or identical programming codes. If the codes submitted are highly similar to any online sources, a zero mark will also be given.*** *A written report must be submitted in PDF format via Moodle. The programming codes should be submitted along with the report.*

Undergraduate and graduate students can team up with another student as a group of ***TWO (a team must not mix both undergrad and grad students)****. Students MUST submit a report (****MAXIMUM*** *11 pages, including the paper review in Part I) and codes that produced the results presented. Put all the files in a zip folder. Please name the folder with your student ID and initials, such as "JD-2023432" for Joe Dominque with ID 2023432. If you are submitting as a team, name the folder as "AB-999999-JD-2023432".*

On the cover page (not part of the 11 pages), please specify the tasks and contributions of each team member if it is done in a team of two.

Presentation standards:
US letter size paper (8.5x11 inches), 2.54cm margin all around, single space, Times New Roman, 12 size fonts. Please include a cover page with the course number and name, and your name(s) and student ID(s). Provide the page number for each page, and your name and ID on top right corner of each page.

Part I.
Select one paper from the provided reading list. Read the paper and provide a brief review of the paper with **maximum** of <u>one page in length</u>. More specifically do the following:

- Summarize the motivation and contributions of the paper;
- Summarize the main approaches of the paper. If needed, a flow-chart can be used to clarify the processing steps;
- Provide critiques on the presentation of the results and method evaluation in the paper
- A reference section should be provided to list the paper(s) you have reviewed. In the review, you should refer to the referenced article (s) using the IEEE citation style (https://pitt.libguides.com/citationhelp/ieee).

For graduate students only: select another more recent research paper that is on the same topic and compare the approaches between the papers, and provide thoughts on why the results are better

in one paper than the other. As only one page is allowed, summarize the methods, contributions, and results of both papers concisely (the motivations should be the same for both).

Evaluation criteria:

- Organization (2 points): The review must have all required components.
- Clarity/Readability (3 points):
  - The instructor should be able to understand the main ideas of the summarized articles by reading only the review. The languages used should be easy to understand.
- Choice of Detail (3 points):
  - Because the page is limited, it is not possible to cover all the details in each article. Students must therefore decide which details to include and which to leave out. Students will be penalized for including details that are not central to the main ideas of the article(s).
  - The report should be written at a level appropriate for the instructor, as only he will read the paper. The student should not re-explain concepts covered in class, nor explain standard methods that are used (but not introduced) by the authors.
- Correctness (2 points): No false information is presented in the review.

Part II.

Re-implement the main algorithm of the selected paper, and provide the following items:

- Demonstrate the success of re-implementation (the software does what it is supposed to do);
- Validate the algorithm using images provided from the instructor or from your own, with similar validation approaches that were conducted in the research paper. This can potentially include testing the algorithms at different parameter settings and/or comparison with other baseline method(s)*;
- Provide a reflection on the pros and cons of the implemented method, and what are the main difficulties in the reimplementation process for you or your team.

*Note that you are not required to re-implement the comparison methods, and are allowed to use the equivalent functions in MATLAB. If you need, you are welcome to use OpenCV or any other software packages or libraries as long as you implement the algorithms instead of using readily available functions.

Evaluation criteria:

- Organization (2 points): The re-implementation must have all required components.
- Clarity of presentation (4 points)
  - The steps for presenting the results and validation are clear and concise.
  - The figures and charts are well presented with figure/table numbers and legends.
- Successful reimplementation (4 points): The algorithm does what it is supposed to do.
- Algorithm validation (6 points)
  - The parameter testing is appropriate and sufficient.
  - Comparison with baseline method(s) comes with sufficient discussions.
- Reflection on re-implementation (4 points)

- The pros and cons of the methods are clearly stated and well-reasoned.
- The discussion of the methods use the knowledge points talked about in class
- Self-reflectance on re-implementation difficulty is well elaborated.

List of candidate papers

These papers built the foundations of many algorithms in image processing that we use today. All of them use the basic concepts in image filtering in spatial domains. For some papers, bonus points will be given on top of the full mark.

Non-local means image denoising
A. Buades, B. Coll and J. -. Morel, "A non-local algorithm for image denoising," *2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05)*, San Diego, CA, USA, 2005, pp. 60-65 vol. 2, doi: 10.1109/CVPR.2005.38.

High-dynamic range tone mapping
Raanan Fattal, Dani Lischinski, and Michael Werman. 2002. Gradient domain high dynamic range compression. ACM Trans. Graph. 21, 3 (July 2002), 249–256. https://doi.org/10.1145/566654.566573

Blood vessel filtering and extraction*
Zhang, B., Zhang, L., Zhang, L., & Karray, F. (2010). Retinal vessel extraction by matched filter with first-order derivative of Gaussian. *Computers in biology and medicine*, *40*(4), 438–445. https://doi.org/10.1016/j.compbiomed.2010.02.008

*Useful dataset:
- RITE dataset: https://medicine.uiowa.edu/eye/rite-dataset
- Drive dataset: https://www.kaggle.com/datasets/andrewmvd/drive-digital-retinal-images-for-vessel-extraction

SIFT features – bonus points = 2 points
Lowe, D.G. Distinctive Image Features from Scale-Invariant keypoints. *International Journal of Computer Vision* **60,** 91–110 (2004).