**Lab 08**

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| Student ID: | B08611010 |
| Total Score: |  |

**Note:**

Most of the explanations in this lab is mandatory, However, giving reasonable explanations to your answer or programs will earn you partial credits when your answer is incorrect.

1. **Multiple Choice (10 points)**

|  |  |  |  |
| --- | --- | --- | --- |
| # | Answer | Explanation (Optional) | Score |
| 1 | d |  |  |

1. **Filters and Convolution (25 points, 5 points each question)**

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| # | Description | Score |
| a | This filter extracts horizontal edges in an image. |  |
| b | This filter extracts slanted edges in an image. |  |
| c | This is the Laplacian filter times negative one. It extracts the edges in an image and can be used for edge enhancement. |  |
| d | This is the Sobel x filter. It extracts vertical edges in an image. |  |
| e |  |  |

1. **Denoising a Picture (20 points)**

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| # | Description | Score |
| - | Be sure to show all your experiment result (e.g., image processing steps and output images) here.  First, I checked the result for each filter and applying them several times.  Applying **total variation filter** twice seems to do best in denoising while still maintaining enough detail of the focus in the image.  Next, I tried finding the best edge extraction (using Laplacian filter) for image sharpening:    Laplacian filter seemed to work better on **grayscale images**, so I tried converted the denoised images to grayscale first, applied Laplacian filter, and converted them back to rgb. Although the results looked pretty similar to each other, the last one (bottom right) worked best for sharpening after trying.  Here’s the final result: |  |

1. **Image Enhancement (15 points)**

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| # | Description | Score |
| - | Paste your result from (a) to (g) here.  (a)  (b)    (c)    (d) have to set vmax to one to look like the image in the example    (e)    (f)    (g) gamma=0.5 |  |

1. **Fingerprint Analysis (30 points)**

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| # | Description | Score |
| - | Paste your result here and briefly describe your image processing procedure and approach. How do you think your results are?  First, I binarized the image using Souvola threshold and did some preprocessing to the image (in the order of left to right, top to bottom in the figure below). Then, I skeletonized the image.    Then, I performed minutiae extraction of the processed fingerprint image. This was done by implementing a function called “sections”, which gets the surrounding 8 pixels of a given pixel and calculate how many “sections” have the total 9 pixels (the given one and the surrounding eight) been divided into. This can be better illustrated with some graphic examples:    We define connected (not including diagonally) white pixels (ones) as a single “section”. We can see that the left image of nine pixels has one section, the image in the middle has two, and the right image has three sections.  A certain type of fingerprint minutiae can be determined by the number of sections in the 9-pixel window. For example, a pixel is a ridge ending if it has only one section in the surrounding nine-pixel window, a continuing ridge point if it has two sections, and a bifurcation point if it has three.  Using this algorithm, I successfully extracted the features in the center part of the skeletonized image, and here’s the result:    Then, I continued to combine the extraction result with the original image, and here’s what I got:    The result appeared to be accurate on the skeletonized image, but not so much on the original image. This is due to unsuccessful pre-processing of the image. I was unable to smoothen the edges of the fingerprint ridges, which led to many unwanted skeleton “branches” to appear and be extracted as minutiae.  In conclusion, I tried many ways to enhance/clean the original image, and this is what I’ve got so far. I believe the feature extraction algorithm works well, it’s just the preprocessing part that needs more time and efforts. |  |

1. **Properties of Convolution (30 points)**

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| # | Description | Score |
| 1 |  |  |
| 2 |  |  |