Logo

Description automatically generated**MOD002643 Image Processing**

Coursework Brief for Trimester 1, 2025-26

**Leaf Morphometric Analysis**

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| --- | --- | --- |
| **Task** | **Description** | **Marks Available** |
| **A**. Complete the three MATLAB Training Certificates. | An all-or-nothing mark awarded only if all three Mathworks training certificates are 100% completed. You are required to supply hyperlinks to your certificates bearing your full name (the same name you are known by at ARU). PDFs are not accepted (see next page). Each certificate takes ~2 hours. | 15 |
| **B**. Complete 11 self-test quizzes with a mark of 12 or higher. | An all-or-nothing mark awarded only if all 11 weekly self-test quizzes are completed with a mark of 12 or higher. Your tutor will verify completion on Canvas, so you only need to tick to signify completion (see next page). | 15 |
| **C**. Threshold to isolate objects of interest. | Photograph a flat leaf collected from the backs or commons around Cambridge city placed on a blank sheet of paper. Also place a copper coin in the image. Use multiband thresholding to segment the two objects as neatly as possible. Show: (i) the input image, (ii) binary masks for each object, and (ii) the entry-wise product between the input image and the *union* of the masks. | 5 |
| **D**. Use morphological and/or non-linear filters to clean binary masks. | Convert FNs to TPs and FPs to TNs using morphological operators and/or non-linear filters. Try to close any interior holes and remove fragments of noise. Again, show your results as binary masks and entry-wise product images. The cleaned binary masks should be solid and show a single selected object only. | 5 |
| **E.** Show RGB histograms of segmented objects. | Use custom plots with lines for the R, G and B channels, limited to the range 0..255, to display normalised histograms for each *individual object* (leaf, coin). Use masks from Task D for pixel selection (i.e., ignorenon-selected pixels). | 5 |
| **F**. Annotate object boundaries. | Using the non-linear range filter, linear edge detection filter, or morphological gradient operator applied to the masks produced in Task D masks, trace the boundary around the two objects. Use your boundary to annotate the objects in the original image with a coloured border. | 5 |
| **G**. Calculate object centroid and medoid and add GLI. | Determine the centroid and medoid of each object using the masks produced in Task D. Display the centroid and medoid for each object using a different marker for each. Add the boundaries from Task F. Calculate and add annotation for the Green Leaf Index (GLI) of the leaf object using an average of all pixels belonging to the leaf in the formula. | 5 |
| **H**. Morphometric analysis | Since we can determine the size of the coin in mm, calculate: (i) the length in mm of the leaf along its longest/shortest dimension (drawing orthogonal annotation lines), and (ii) the area of the leaf in mm2, and (iii) the length of the perimeter from Task F. Add this information as annotations to the image. | 5 |
| **I.** Multi-leaf analysis | Adapt the workflow from C..H to analyse/annotate images containing multiple leaves simultaneously. Produce 25 test input images each containing 4-5 leaves. More marks if these are different species/have different appearance. Also include code to: (i) count of the number of leaves present, (ii) crop out each leaf, (iii) rank leaves on criteria such as size and GLI. Also consider adding damage metrics, such as percent leaf area loss (e.g., from insect or disease). | 40 |
| **TOTAL** | | **100** |

**NOTES**: (**1**) The pass mark is 40%, so as a minimum complete A..F. Do not just complete A..D as it is unlikely that you will score full-marks for programming tasks as your answer is unlikely to be objectively perfect. (**2**) You must upload your work in this this template as a Word document (DOCX). See Appendix A for more detailed presentation guidelines.

**A. Training Certificates (0 or 15 Marks)**

MATLAB Onramp Certificate Hyperlink:

http://

Image Processing Onramp Certificate Hyperlink:

http://

Computer Vision Onramp Certificate Hyperlink:

http://

**B. Quizzes 1..11 (0 or 15 Marks)**

Tick boxes to confirm completion with a mark of 12/15 or higher.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|  |  |  |  |  |  |  |  |  |  |  |  |

1. **Threshold to isolate objects of interest** **(0..5 Marks)**

Source Code in Editable Plain Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Input and Output Images:

|  |  |
| --- | --- |
| < insert here > | < insert here > |
| **Input:** Input Image (Original Photograph) | **Output 1:** Binary Mask for Leaf |
| < insert here > | < insert here > |
| **Output 2:** Binary Mask for Coin | **Output 3:** Entry-wise Product (Union) |

Any Comments on Effectiveness of Process/Threshold Values Adopted (50 words max):

1. **Use morphological and/or non-linear filters to clean binary masks (0..5 Marks)**

Source Code in Editable Plain Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Input and Output Images:

|  |  |
| --- | --- |
| < insert here > | < insert here > |
| **Input 1:** Original Binary Mark from Task C for Leaf | **Input 2:** Original Binary Mask from Task C for Coin |
| < insert here > | < insert here > |
| **Output 1:** Cleaned Binary Mask for Leaf | **Output 2:** Cleaned Binary Mask for Coin |

Any Comments on Effectiveness of Process/Methods Adopted (50 words max):

1. **Normalised RGB histograms of segmented objects. (0..5 Marks)**

Source Code in Editable Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Input and Output Images:

|  |  |
| --- | --- |
| < insert here > | < insert here > |
| **Input 1:** Entry-wise Product (Leaf Only) | **Input 2:** Entry-wise Product (Coin Only) |
| < insert here > | < insert here> |
| **Output 1:** Normalised RGB Histogram for Leaf | **Output 2:** Normalised RGB Histogram for Coin |

Any Comments on Effectiveness of Process/Methods Adopted (50 words max):

1. **Annotate object boundaries. (0..5 Marks)**

Source Code in Editable Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Output Images:

|  |  |
| --- | --- |
| < insert here > | < insert here > |
| **Output 1:** Boundary around Cleaned Leaf Binary Mask | **Output 2:** Boundary around Cleaned Coin Binary Mask |
| < insert here > |  |
| **Output 3:** Input Image with Overlaid Object Boundaries |

Any Comments on Effectiveness of Process (50 words max):

1. **Calculate object centroid, medoid and GLI (0..5 Marks)**

Source Code in Editable Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Output Images:

|  |
| --- |
| < insert image > |
| **Output 1:** Input Image with Overlaid Boundaries, Centroid and Medoid Markers, and GLI Value for Leaf |

Any Comments on Effectiveness of Process (50 words max):

1. **Morphometric analysis (0..5 Marks)**

Source Code in Editable Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Output Images:

|  |
| --- |
| < insert image > |
| **Output 1:** Input Image with Overlaid Major/Minor Axes (mm), Area (mm2), and Perimeter (mm). |

Any Comments on Effectiveness of Process (50 words max):

1. **Multi-leaf analysis (0..40 marks)**

Source Code in Editable Text in a Fixed Width Font (i.e., *not* a picture/screenshot):

clear all;

close all;

clc;

Input and Output Videos:

Add tables similar to those in Tasks C..H, reflecting each process that has been attempted for a *single* test image. Other test images can be included in your upload (as output1, output2, output3, etc).

Any Comments on Effectiveness of Process/Design Decisions (50 words max):

**Appendix A:** PresentationGuidelines

1. To expedite marking, your work must be submitted using this Word template ONLY.
2. You are to submit ONE DOCX file along with .m files containing your code for each task. You cannot upload a ZIP or RAR file since this would prevent your report being parsed by Turnitin, and would also mean that it cannot be annotated with feedback by the marker during the marking process.
3. Call your code files **TaskC.m** up to **TaskI.m** so that they can be easily found. It is fine to have additional files containing functions too, if you break your code up in this way.
4. In your source code, variable names should make sense (i.e., avoid single letter variable names, except where these correspond to mathematical convention, like **L**, **M**, **N**, **i** and **j**, or where variable names correspond exactly to the variables used in equations from the course notes). Variable names should *never* be verbs. Where it is appropriate for variables to contain several words, use lower camelCaps (first letter lower case, first letter of each subsequent word in upper case).
5. Code should be well commented (in MATLAB, a comment starts with the % symbol). Where the end keyword is used to terminate a loop or if statement, place % end if, % end while, or % end for, as appropriate, to highlight what the end corresponds to. You can also use the Live Editor in MATLAB to document your code if you prefer.
6. Break large programs into functions, where appropriate, such that each function is informatively named, starting with a verb, and performs one small, well-defined task.
7. Avoid using literals in programs; either use arguments to control settings (e.g., inputs to functions), or collect settings from the user at run-time, or declare named constants (by convention, in UPPER CASE).
8. Code should be properly indented, and ordinarily one line should contain only one command. Before submitting your work, highlight all code and click “smart indent” to do this automatically. Code in your report should be presented in a fixed width font like Courier New to preserve indentation.
9. Ensure code is concise, efficient, and that unnecessary work is not done. Check that your program does not perform calculations or declare variables that are not subsequently used.
10. It is acceptable to use built-in functions provided in MATLAB or its official toolboxes, if these are adequately explained in the corresponding text. If you use MATLAB code from a third-party source, this source should be acknowledged, and the underpinning theory precisely explained in the corresponding Comments boxes. Bear in mind that you are to implement the above tasks from first principles, so using a third-party functions that do more or less complete leaf analyses are not valid.