

ME 5411 Robot Vision and AI

CA – AY24/25 Semester 1

Computing Project

You will be assigned to a random group of 2-3 students to work on the computing project. The software must be developed using MATLAB. You are encouraged to rely on your **own implementations** for the different steps of this project. You will be rewarded doing so. Otherwise, you are allowed to use MATLAB's Imaging Toolbox and any other toolboxes related to Machine Learning.

Do not use ChatGPT or any AI program to generate code!

In your report, you should include the following:

1. an **introduction** to the tasks,
2. a description of your **algorithms and flow charts**,
3. **screen captures** of every stage of the image processing, and
4. a discussion and conclusion including an **explanation** on why you choose the method(s) employed in your project, which investigation you performed, and what **lessons** you learned.

You should upload your report and software online to CA-Project under Assignments at NUS Canvas by 18 November 2024, 23:59 Singapore time.

This is a group project. Please submit only one set of report and software. All members of the group will receive the same score. **Name your submission as Group XX.zip**. Please indicate the **names and IDs** of all group members on the cover page of your report.

Figure 1 shows a BMP image of a label on a microchip. This image is available in a file with the name: **charact2.jpg**

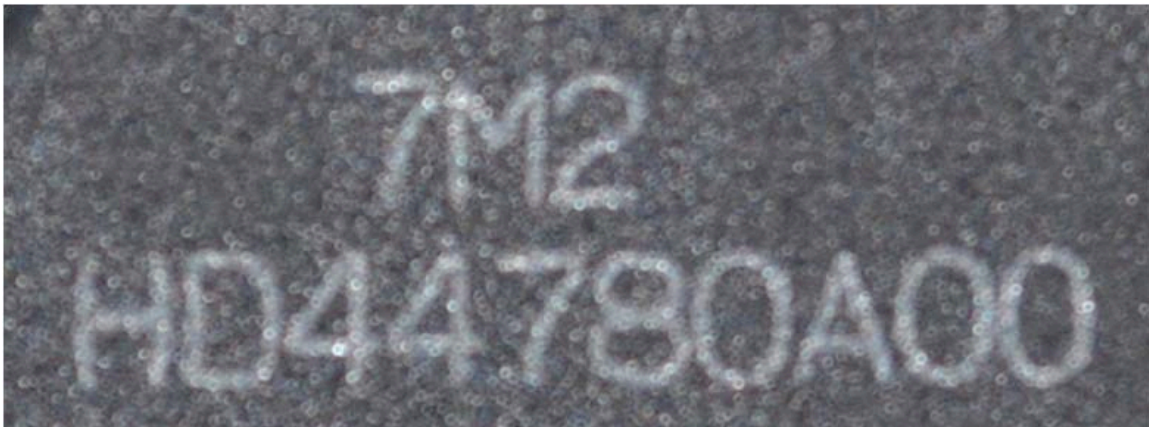


Figure 1: Image 1

Perform the following tasks in sequence:

1. Display the original image on screen. Experiment with **contrast enhancement** of the image. Comment on the results.
2. Implement and apply a 5x5 **averaging filter** to the image. Experiment with **filters of different sizes**. Compare and comment on the results of the respective **image smoothing methods**.
3. Implement and apply a high-pass filter on the image in the frequency domain. Compare and comment on the results and the resultant image in the spatial domain.
4. Create a sub-image that includes the middle line – HD44780A00.
5. Convert the sub-image into a binary image.
6. Determine the outline(s) of characters in the image.
7. Segment the image to separate and label the different characters as clearly as possible.
8. A dataset contained in the file *p_dataset_26.zip* is provided on CANVAS. Divide this dataset into two portions: (a) a 75% portion that will be used as the training set, and (b) the remaining 25% portion as the validation (testing) set. Use these two sub-datasets to complete the following three tasks:

Task 1: Design a CNN to classify each character in Image 1 (see Figure 1).

Task 2: Design a classification system, using a **non-CNN-based** method (or a combination of such methods) selected from those methods that have been covered in Part 2 of this course, to classify each character in Image 1.

Task 3: Report the results obtained from Task 1 and Task 2, and compare the effectiveness and efficiency of the two approaches (i.e., one uses a CNN, the other does not) used in Task 1 and Task 2. Provide your own explanation on any differences in the results between these two approaches.

Note: Do not use the characters in Image 1 as training data for your classifier.

9. In carrying out Step 8, also experiment with pre-processing of the data (e.g., padding/resizing the input images) as well as with hyperparameter tuning. In your report, discuss your findings and how sensitive your approach is to these changes.