Machine Vision Homework #1

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Homework Assignment

- 2025/03/10 – Homework 1 assigned, due 03/24
- 2025/03/31 – Homework 2 assigned, due 04/14
- 2025/04/14 – Homework 3 assigned, due 04/28
- 2025/04/28 – Homework 4 assigned, due 05/12

OpenCV

- OpenCV (Open Source Computer Vision Library) is a popular and widely used open-source library that provides tools for real-time computer vision applications.
- Supports a wide range of image and video processing tasks, from basic operations like reading and manipulating images to advanced techniques like object detection and facial recognition.
- It has C++, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS

- How to install :
- https://docs.opencv.org/master/df/d65/tutorial_table_of_content_introduction.html
- With C++ : https://opencv.org/releases/ (download)
- With Python : **pip install opencv-python**

OpenCV (in Python)

- **Import Library:**

```
import numpy as np
import cv2
```

- **Read an image:**

```
img = cv2.imread('image.jpg’)
```

- **Check image size:**

```
height, width, channels = img.shape
```

- **Show image:**

```
cv2.imshow('My Image', img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

- **Write image:**

```
cv2.imwrite('output.jpg', img)
```

Question 1

Give **three** image (img1.jpg, img2.jpg, img3.jpg) for testing as follow:

1. Image Quantization(binary, gray, index-color)

   1-1. Convert the color image to the grayscale image

   Formula: $(0.3 * R) + (0.59 * G) + (0.11 * B)$.

   1-2. Convert the grayscale image to the binary image

   Choose a appropriate threshold by yourself.

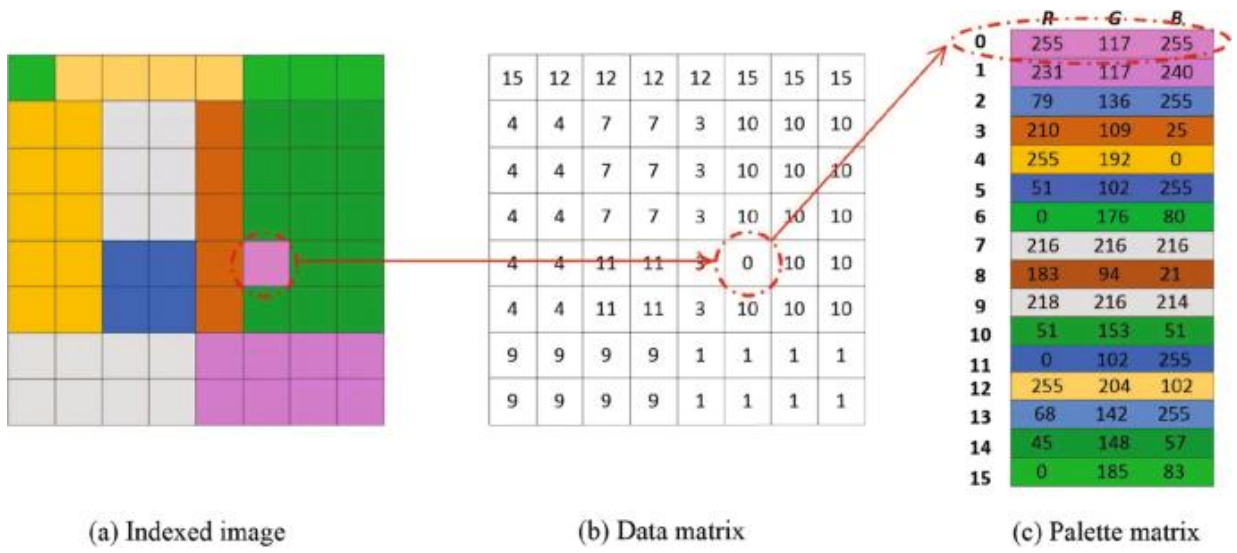
   (For example: Threshold = 128)

   1-3. Convert the color image to the index-color image

   Define your own color map of 32 type colors.

Index-color Image

- Use an algorithm or your own approach to define a color map for each image.
- Change each pixel to its corresponding indexed color.



15	12	12	12	12	15	15	15
4	4	7	7	3	10	10	10
4	4	7	7	3	10	10	10
4	4	7	7	3	10	10	10
4	4	11	11	3	0	10	10
4	4	11	11	3	10	10	10
9	9	9	9	1	1	1	1
9	9	9	9	1	1	1	1

	R	G	B
0	255	117	255
1	231	117	240
2	79	136	255
3	210	109	25
4	255	192	0
5	51	102	255
6	0	176	80
7	216	216	216
8	183	94	21
9	218	216	214
10	51	153	51
11	0	102	255
12	255	204	102
13	68	142	255
14	45	148	57
15	0	185	83

(a) Indexed image (b) Data matrix (c) Palette matrix

Index-color Image example

Input

Output

Question 2

Give **three** image (img1.jpg, img2.jpg, img3.jpg) for testing as follow:

2. Resizing Image

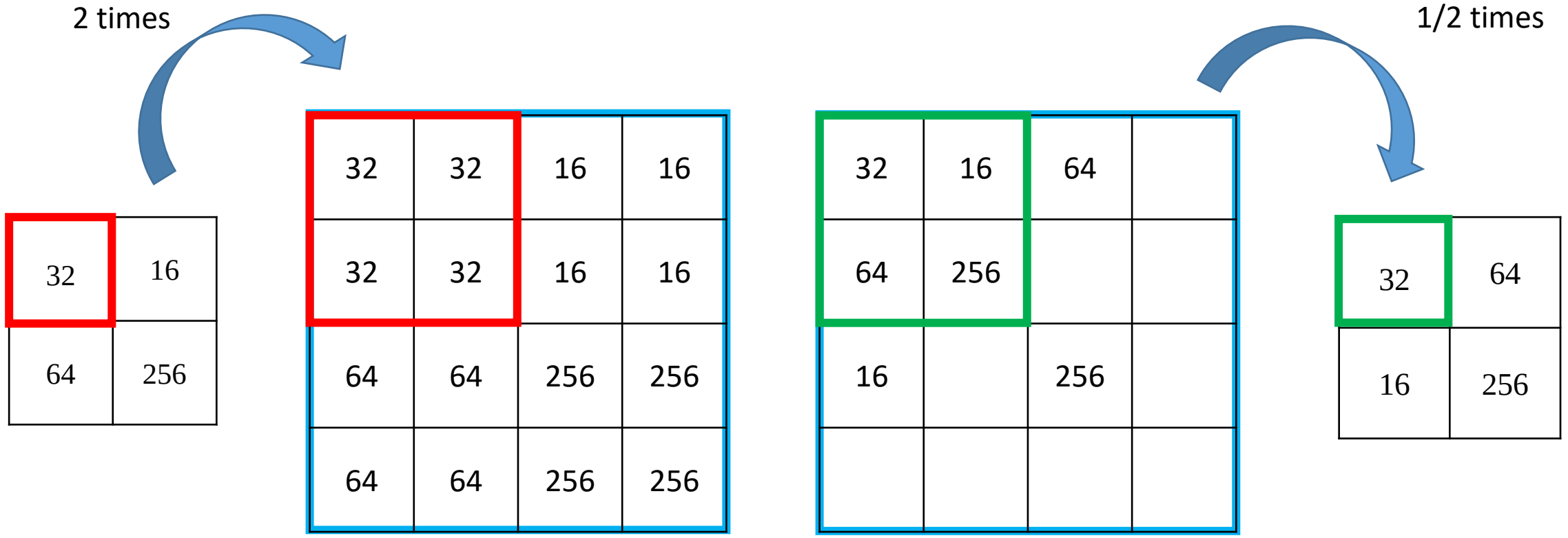
   2-1. Resizing image to 1/2 and 2 times without interpolation.

   2-2. Resizing image to 1/2 and 2 times with interpolation (round)

   - You can use Bilinear interpolation or Bicubic interpolation etc.

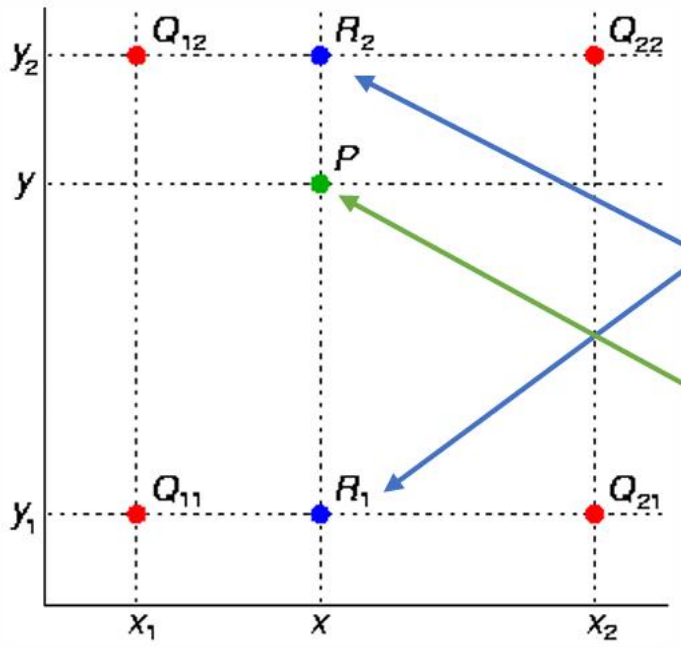
Resizing Image

- Resizing image to 1/2 and 2 times without interpolation



Resizing Image

- Resizing image to 1/2 and 2 times with interpolation (round)
  - You can use Bilinear interpolation or Bicubic interpolation etc.



$$f(x, y_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}),$$

$$f(x, y_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}).$$

$$f(x, y) \approx \frac{y_2 - y}{y_2 - y_1} f(x, y_1) + \frac{y - y_1}{y_2 - y_1} f(x, y_2)$$

Bicubic interpolation

$$F(i+v, j+u) = A * B * C$$

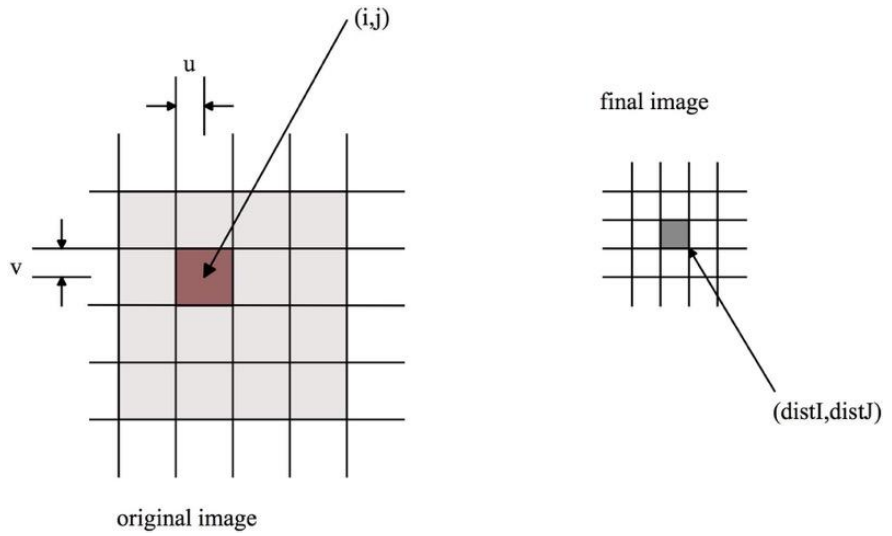
$$A = \begin{pmatrix} S(1+v) & S(v) & S(1-v) & S(2-v) \end{pmatrix}$$

$$B = \begin{pmatrix} f(i-1,j-1) & f(i-1,j) & f(i-1,j+1) & f(i-1,j+2) \\ f(i,j-1) & f(i,j) & f(i,j+1) & f(i,j+2) \\ f(i+1,j-1) & f(i+1,j) & f(i+1,j+1) & f(i+1,j+2) \\ f(i+2,j-1) & f(i+2,j) & f(i+2,j+1) & f(i+2,j+2) \end{pmatrix}$$

$$C = \begin{pmatrix} S(1+u) \\ S(u) \\ S(1-u) \\ S(2-u) \end{pmatrix}$$

Equivalent to

$$F(i+v, j+u) = \sum_{row=-1}^{2} \sum_{col=-1}^{2} f(i+row, j+col)\, S(row-v)\, S(col-u)$$



- **Formula :**

$$S(x) = \begin{cases} 1-(a+3)x^2+(a+2)|x|^3, & 0 \le |x| \le 1 \\ -4a+8a|x|-5ax^2+a|x|^3, & 1 < |x| \le 2 \end{cases}$$

When a takes different values, it can be used to approximate different spline functions (common values: -0.5, -0.75).

Rules

- **Rules in using C/C++ OpenCV Lib**
  - Use OpenCV-2.x version
  - Allow use:
    1. Read, save, show image (cvLoadImage, cvShowImage, …)
    2. Define image (Mat)
    3. Get image size (cvSize, cvGetSize)
  - Not Allow use:
    1. Cannot use the function of Lib to do the main part of homework.
       Ep: cvtColor(image, gray, CV_RGB2GRAY); // convert RGB to Gray

Rules

- **Rules in using Python OpenCV Lib**
  - Allow use:
    1. Read, save, show image (cv2.imread, cv2.imshow, cv2.imwrite…)
    2. Define image (np.zeros)
    3. Get image size
  - Not Allow use:
    1. Cannot use the function of Lib to do the main part of homework.
       For example: cv2.cvtColor(image, cv2. COLOR_BGR2GRAY);
       // convert RGB to Gray

Grade

- **Program (80%)**
  - Q1-1 (10%)
  - Q1-2 (10%)
  - Q1-3 (20%)
  - Q2-1 (15%)
  - Q2-2 (25%)
- **Report (20%)** **(Please write the report in English.)**
  - Student ID, Name
  - Explain your program and method for each question
  - Put the result images (21 output images, 3 input images)
  - Please explain and discuss the results you obtained, and share your thoughts on the homework.

Folder Structure

- Folder Structure
  - There are 21 images in the results folder.
  - Write all questions in one program

Python

```
113598041_hw1/
├── test_img/
│   ├── img1.jpg
│   ├── img2.jpg
│   └── img3.jpg
├── result_img/
│   ├── img1_q1-1.jpg
│   ├── img1_q1-2.jpg
│   ├── img1_q1-3.jpg
│   ├── img1_q2-1_half.jpg
│   ├── img1_q2-1_double.jpg
│   ├── img1_q2-2_half.jpg
│   ├── img1_q2-2_double.jpg
│   ├── ……..
│   └── img3_q2-2_double.jpg
├── 113598041 _hw1.py
├── 113598041 _hw1.pdf
└── Readme.txt (Optional)
```

C/C++

```
113598041_hw1/
├── project_hw1/
│   ├── test_img/
│   │   ├── img1.jpg
│   │   ├── img2.jpg
│   │   └── img3.jpg
│   ├── result_img/
│   │   ├── img1_q1-1.jpg
│   │   ├── img1_q1-2.jpg
│   │   ├── img1_q1-3.jpg
│   │   ├── img1_q2-1_half.jpg
│   │   ├── img1_q2-1_double.jpg
│   │   ├── img1_q2-2_half.jpg
│   │   ├── img1_q2-2_double.jpg
│   │   ├── ……..
│   │   └── img3_q2-2_double.jpg
│   ├── include/
│   │   └── func.h
│   ├── func.cpp
│   └── main.cpp
├── 113598041_hw1.pdf
└── Readme.txt (Optional)
```

Homework #1

- Please compress your files (program and report)
  - **StudentID_hw1(For example: 113598041_hw1.zip)**
- Please submit to iStudy, in Homework 1 Assignment.
- Deadline: **2025/03/24 23:59:59**
- For each hour late, 10% of the total score will be deducted.
- Don’t share your code and your report with other students. Do it by yourself.