Homework Assignment 1
CFA Demosaicing

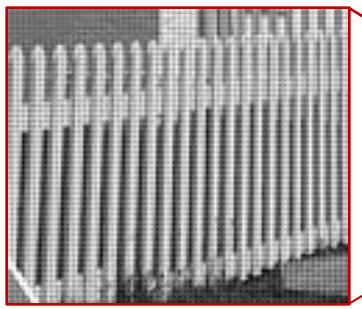
Digital Image Processing

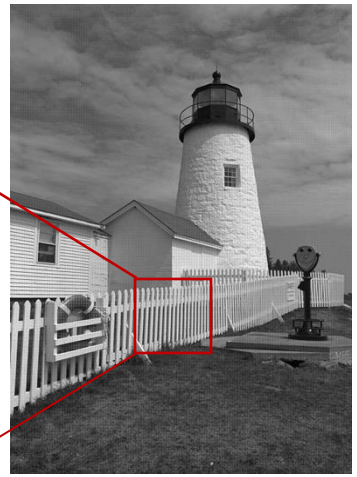
Deadline: 09:00 AM, 10/13/2025

Problem Statement

The purpose of this homework is to implement various methods for **image demosaicing**. Specifically, you are asked to reconstruct a full-color RGB image from the given **Bayer-pattern raw images** using 1) the simple interpolation technique (30 points) described in the lecture notes, 2) the edge-aware interpolation (30 points) also described in the lecture notes, and 3) an advanced interpolation technique (40 points) based on, for example, statistical properties of the images. For Part 3, you will need to do a literature survey and choose one technique that provides significant improvement over the first two techniques.

Sensor RGB layout





Lighthouse_raw.tiff

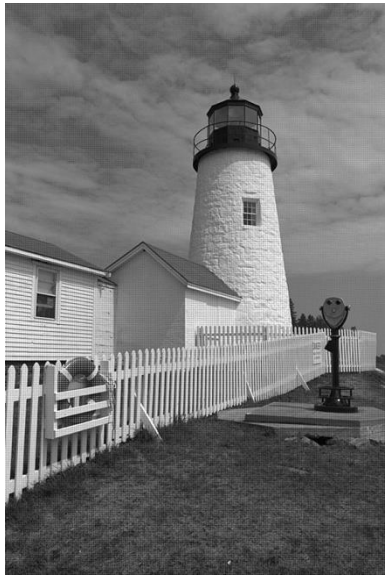
CFA Demosaicing

Ground truth

Grading Policy

- You should provide a detailed description of the techniques employed.
- You should provide a thorough discussion of the results you have obtained.
- You should analyze the strengths and weakness of the employed techniques.
- Your reconstructed color images should be tested against the ground-truth using **PSNR**. The score will be based on the quality and correctness of your results and analysis.
- Your computer code will be tested by TA using a sixth test image.
- Bonus points will be awarded for creative thinking.
- Total points: 100.

Test images



A

B

C

D

E

Relevant Papers

- H. -A. Chang and H. H. Chen, "Stochastic Color Interpolation for Digital Cameras," in *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 17, no. 8, pp. 964-973, Aug. 2007, doi: 10.1109/TCSVT.2007.897471.
- K. Hirakawa and P. J. Wolfe, "Spatio-Spectral Color Filter Array Design for Enhanced Image Fidelity," *2007 IEEE International Conference on Image Processing*, San Antonio, TX, USA, 2007, pp. II - 81-II - 84, doi: 10.1109/ICIP.2007.4379097.
- Xin Li, Bahadir Gunturk, Lei Zhang, "Image demosaicing: a systematic survey," Proc. SPIE 6822, Visual Communications and Image Processing 2008, 68221J (28 January 2008).

Software Package Allowed

- Python 3.8+
- Standard Python library
- Numpy
- Opencv-python
- Matplotlib

Assignment Requirements

- Only the Image IO of the Software Package is allowed, other image operations (interpolation, filtering, etc.) should be written by yourself.
- Set your directory structure as follows:

hw1_<student ID>/

- p1.py
- p2.py
- p3.py
- report.pdf
- images/
  - Images of program output

Assignment Submission Requirements

- Submit to NTU COOL
- Do NOT copy homework (code, report, results, etc.) from others