CS3570 Introduction to Multimedia Technology

Homework #1

Due: 11:59pm, 3/25/2025

1. Image Resampling (30%)

Implement an image resampling function to downsample an image to **1/8th** of its original width and height, then upsample it back to its original size. You will apply this to two different images, cat.png (easier) and logo.png (harder), and compare the results.

(You should not use any built-in function for interpolation.)

(a) Implement **Nearest-neighbor (NN) interpolation** to perform both downsampling and upsampling. Apply this to both cat.png and logo.png, then display the final restored images. (10%)

(b) Implement **Bilinear interpolation** to perform both downsampling and upsampling. Apply this to both cat.png and logo.png, then display the final restored images. (10%)

(c) Compare results from the first and second method. Discuss the differences in image quality and artifacts observed. (10%)

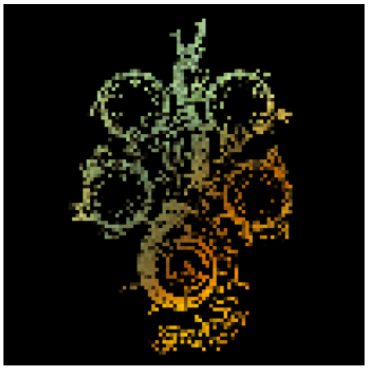
Original Cat Image

Nearest-Neighbor Upsampling Cat

Bilinear Upsampling Cat

Original Logo Image

Nearest-Neighbor Upsampling Logo



Bilinear Upsampling Logo

2. Photo Enhancement (30%)

You are required to enhance the image "scene_dark.jpg" by following these steps.

(a) Convert the image from RGB color space to YIQ and display the histogram of the Y channel. (10%)

(b) Apply **Gamma Transform** to the Y channel using an appropriate gamma value. (5%)
(c) Convert the modified image back from YIQ to RGB, and display the enhanced image along with the histogram of the Y channel. (5%)
(d) Compare the original and enhanced images along with their histograms. Discuss your observations regarding the differences and improvements. (10%)

3. Color Quantization and Dithering (40%)

Implement the following steps to reduce the number of colors in an image using median-cut color quantization and error diffusion dithering.

(a) Implement median-cut color quantization to reduce the color depth of the input image to **5-bit (32 colors)**. Display the output images for both cases. (15%)
(b) Apply **error diffusion dithering** to the quantized images to reduce color banding artifacts. Display the dithered output images. (15%)
(c) Visually analyze the results before and after dithering. Compare the images in terms of color accuracy, smoothness, and introduced artifacts. Discuss how dithering affects perceptual quality and whether it improves or degrades the image. Use observations from the images themselves rather than numerical metrics. (10%)

Reminder

- You are NOT ALLOWED to use any function that directly generates the result for each step, except for those provided by us.
- Your code must display and output your results to enable us to verify its correctness.
- Please follow the instructions in the Jupyter Notebook and complete the parts marked as "TODO."
- If you encounter any problems or have questions, please post them on eeclass.

- Rename your Jupyter Notebook file to Homework_01_xxxxxxxxx_ooo.ipynb, where xxxxxxxxx is your ID and ooo is your name. Ensure you upload it to eeclass before the deadline.
- Homework should be submitted before the announced due time. Scores of late homework will be reduced by 20% per day.