

GROUP PROJECT—JPEG Implementation

CS 443/543, Spring 2021

We did not start Chapter 9 yet (JPEG algorithm will be covered by Monday lecture (4/19)).

Important Dates:

Report and Source code: midnight on 5/1/2021

You may implement this project individually or as a group having up to 4-5 members (undergrad). **However, graduate students who registered for CS543 should work on this project alone.**

Project Description

The goal of this project is to implement the lossy compression part of the JPEG algorithm. Implement and apply the following simplified JPEG algorithm for two images in Project_Code_Images.zip. All of the following techniques are covered by Chapter 8 & 9.

Step I: Compression

1. Convert RGB components to YCbCr components (you can use Matlab function `rgb2ycbcr()` or HW2.).
2. Perform chroma subsampling 4:2:0 on color components (you can use HW2).
3. Apply 2D DCT transform (for one block size: $N = M = 8$) on Y, Cb, and Cr components (refer to `dctbasis.m` in Project_Code_Images.zip)
4. Apply quantization using quantization tables (Table 9.1 and Table 9.2 of the Chap9 slide) for Luminance and Chrominance components respectively. (i.e., remove AC components—check Chap. 9 slide or textbook.)

Step II: Decompression

1. Dequantize the DCT coefficients.
2. Implement and apply the 2D IDCT to the dequantized DCT coefficients.
3. Convert YCbCr components to RGB model (Use your HW2 or `ycbcr2rgb()`).

Step III: Outputs

- Save the outputs in .png

Step IV: Error Computation

1. Compute the pixel-wise error (difference) between the original frame and output frame and display the error using `imagesc()` or (any other way you can do with your language)
2. Compute the Peak Signal-to-Noise Ratio (I is the original frame and I' is the output frame).

$$MSE = \frac{1}{MN} \sum_{y=1}^M \sum_{x=1}^N [I(x, y) - I'(x, y)]^2$$

$$PSNR = 20 * \log_{10} \frac{255}{\sqrt{MSE}}$$

Step V: **Group Report**

- Show and output values of the first 8x8 block of the input and output pictures for each stage at both Step I and II; you have to show how the values of the 8x8 block are changed according to different stages.
- Include input (two different input pictures from Project_Code_Images.zip) and output pictures for each stage at both Step I and II. So, you need to generate your intermediate results at each stage.
- Discuss your observations of the results at each stage at Step I and II; discuss comparisons between the original image and your final output image.
- Show and discuss how the output images look different
- Create a table including all error values (Step IV) for two images. Discuss the results.
- Lastly, your report cover (the first page) should also include a) Names of group members and b) responsibilities/ contributions of group members.

Submission

You should submit the following materials for the grading. The user should be provided an option of inputting images to your program. Include everything in a zip file and the filename of the zip file should include last names of all team members.

- Source code
- A group report
- All output files in png (for each of the two images (tulip and alu), generate two output images.)
 output_tulip_8x8.png
 output_alu_8x8.png

Group Project Policy: Typically, all members of a team receive the same project scores, except for clear occasions. Report any team problems to the instructor early, so something can be done to remedy the situation before it is too late.

1. You are responsible for choosing group members.
2. Each group must choose a leader. The leader is responsible for the management of the group.
3. Each group needs to maintain how many times they met, group members who attended the meeting, dates of the meetings, and problems solved. If a group member misses a meeting, s/he should let me know as soon as possible if s/he has any excuse.
4. All group members should contribute the assignment effectively. Normally, all group members will get the same grade for their assignment. However, if there are complaints about some members, not all group members get the same grade.