Project 4 - Color Image Compression Using Unsupervised Learning (Clustering) (Due 11/22)

Background

Many display devices allow only a limited number of colors to be simultaneously displayed. Therefore, *true* color images may need to be converted to *indexed* color images for the purpose of saving storage space or display in restricted display devices [1].

Data

The image given is a 120x120 full-color image (flowersm.ppm). This image can also be treated as a 120 x 120 x 3 matrix, representing a 3-dimensional feature space of 120 x 120 samples. For a 2x2 color image, the matrix would look like
R(0,0) G(0,0) B(0,0) R(0,1) G(0,1) B(0,1)
R(1,0) G(1,0) B(1,0) R(1,1) G(1,1) B(1,1)

Tasks

In this project, you are given a full color image. Each pixel of this color image has three components: red, green, and blue components. Each component is an 8-bit unsigned char. There are thus totally 2^24 possible colors. For certain computers which can only display 256 (or 2^8) different colors, that is, each pixel only has 8 bits representing the color information, you are asked to find the best 2^8 colors that can approximate the original full-color image.

- (35) Task 1: Use k-means algorithm to find 256 colors that best represent the original full-color image. Display the color image using these 256 colors only.
- (15) Task 2: Compare the color image you generated with the original full color image. Design some metrics to illustrate the performance gain/loss.
- (15) Task 3: Try to use cluster number of 128, 64, 32, etc. and compare the quality of the pseudo-color image.
- (15) Task 4: Use winner-take-all algorithm and redo Tasks 1-3.
- (20) Task 5: Use Kohonen maps to redo Tasks 1-3.
- (+10) Task 6: Use mean-shift to automatically determine the optimal clusters based on a given bandwidth.

Note that a report is still required. However, you don't need to write a full-length report. The purpose of this report is such that it helps the reviewer understand your experiments and interpret your results. Thus the report only needs to include the cover page, abstract, experiments and results, discussion, and reference sections (if you have any).

Reference

[1] M. T. Orchard, C. A. Bouman, "Color quantization of images," IEEE Transactions on Signal Processing, 39(12):2677-2690, December, 1991.