ECEN5283 Computer Vision

Project 3. Texture Classification
(Due: March 16, 2024)

In this project, you are required to perform texture classification for 59 given textures (640x640) using the Laplacian pyramid and Gabor filter bank. Each texture image will be divided into 10x10=100 blocks (64x64) which will be classified based on their feature vectors (Laplacian or Gabor). This project has two parts.

Part I: Texture Analysis Using the Laplacian Pyramid

1. Find an open-source Matlab code for Laplacian pyramid from Mathworks File Exchange and apply it to 59 texture images (640x640) to compute the feature vector for each texture by using appropriate statistics (i.e., mean, variance, skewness, kurtosis) at different layers. Each dimension in the feature vector will be normalized in (0, 1) by the using the minimum and maximum values (see Slides 6-7 of Lecture 19). The 59 normalized feature vectors are called the signatures of 59 textures and stored in a texture library.
2. Given a texture image, we divided it into 100 blocks (64x64). For each block, we extract the Laplacian feature vector for which each element is further normalized by the same constants used before. The normalized feature vector is denoted by U.
3. By finding the best match in the texture library where 59 texture signatures are stored, we can classify the given texture block according to $\text{Class}(U) = arg_{c\in\{1,\ldots,59\}} min|V_c - U|$, where |.| is the Euclidean distance.
4. We compute how many blocks out of 100 can be correctly classified, i.e., Percentage of Correct Classification (PCC) for the given texture. For all 59 textures, repeat Steps 2, 3, 4, and compute the averaged PCC over 59 texture images.

Part II. Texture Analysis Using the Gabor Filter Bank

1. Construct an M-scale and N-orientation Gabor filter bank (M*N<=30) by using the given Matlab function, and apply the Gabor filter bank to each of 59 texture images to obtain their signatures. Gabor filtering of a texture image results in M*N filtered images which have complex coefficients.
2. Construct a feature vector by using some appropriate statistics (i.e., mean, variance, skewness, kurtosis) of the magnitude of Gabor coefficients from each of M*N filtered images. As Step 2 in Part I, after you estimate the feature vectors for all 59 textures, each dimension in the feature vectors has to be normalized between 0 and 1. The 59 normalized feature vectors will be called the signatures of 59 textures and stored in a texture library.
3. The same as Part I, do Steps 3, 4, and 5. Compute averaged PCC over 59 texture images.

The additional requirements of the project

1. You can use Matlab functions (i.e.., mean, var, skewness, kurtosis) to compute different orders of statistics. However, make sure you will need to reshape the matrix data into the vector data first.
2. Optimize each of the two methods by fine-tuning the parameters and computing the PCC for each case.
3. Discuss and compare the two texture analysis methods in terms of their performance.
4. For each method, discuss the mis-classification cases for some poorly classified texture images.
5. Compare the usefulness of different statistics combinations of the Laplacian pyramid or Gabor filtering regarding their performance for texture classification.