Texture

Objective

To understand the concept of texture, texture analysis, texture synthesis with examples from Python OpenCV.

Main ideas

Texture

What is "Texture":

- An image obeys statistical properties. A feature define regions of interest.
- Provides information in colors or intensities of images.
- A texture is characterized by intensity levels in a neighborhood.

Texture analysis

There are two main problems regarding texture analysis, those are:

- Texture classification: concerned with determining the boundaries between texture regions.
- Texture segmentation: concerned with identifying a given texture region from a given set of textures.

There are three main approaches to define what is a texture, those are:

- *Structural* approach.
- *Statistical* approach.
- *Model-based* approach.

Structural approach

This approach sees the image texture as a set of texture elements or sometimes called texels in regular or repeated pattern. To obtain and extract texels, we use *Voronoi tessellation* of the texels, however, extracting texels in real images can be very difficult.

Statistical approach

This method sees the image texture as statistical measurement computed from grayscale intensities in a region. This is easier to compute and applicable to all images, it is the more widely used method. Some statistical texture measurement can be done by:

- Edge detection: characterize the texture complexity by detecting edges as edges found in a specific region can tell us how busy that region is, directions of edges can also help determine the patterns in the texture.
- Laws texture energy measures: filter the image by texture filters then compute the energy by summing the absolute value of filtered results around each pixels. Finally, combine the features to achieve rotational invariance.
- Autocorrelation: use a function to detect repetitive patterns of textures.
- Co-occurrence Matrices: capture numerical features of texture which can be used to represent, compare or classify textures.

$$Angular\ 2nd\ Moment = \sum_i \sum_j p[i,j]^2$$

$$Contrast = \sum_{i=1}^{Ng} \sum_{j=1}^{Ng} n^2 p[i,j], \text{ where } |i-j| = n$$

$$Correlation = \frac{\sum_{i=1}^{Ng} \sum_{j=1}^{Ng} (ij) p[i,j] - \mu_x \mu_y}{\sigma_x \sigma_y}$$

$$Entropy = -\sum_i \sum_j p[i,j] ln(p[i,j])$$

where $p[i,j]$ is the $[i,j]$th entry in a gray-tone spatial dependence matrix, and Ng is the number of distinct gray-levels in the quantized image.

Texture synthesis

Examples in OpenCV