Aim: Processing image with OpenCV3.

Objective: To convert between different color spaces, the fourier transform, high/low pass filter.

Theory:

Conversion between different color spaces

Gray

Decimal Code: (128,128,128)

Gray color is actually the midpoint. In an 8-bit format, the midpoint is 128 or 127. In this case we choose 128. So we set each of the portions to its midpoint which is 128, and that results in overall mid value and we got gray color.

BGR/RGB

RGB and BGR are both color models used to represent colors in digital images. However, the main difference between these two color models is the order in which the color channels are arranged.

- In the RGB color model, the colors are represented by the Red, Green, and Blue color channels. The red channel shows information about the amount of red color similarly for the blue and green channel. On combining these information, we get the whole image.
- Whereas in the BGR model which is also called OpenCV model the color channels are a reverse of the RGB model. But the particular light contains information about the intensity of that particular light.

A normal grayscale image can be defined by only one matrix, but a color image is actually composed of three different matrices. One color image matrix = red matrix + blue matrix + green matrix

The common applications of RGB model are

- Cathode ray tube (CRT)
- Liquid crystal display (LCD)
- Plasma Display or LED display such as a television
- A compute monitor or a large scale screen

HSL/HSV

HSV color model comprises Hue, Saturation, Value also known as HSB (Hue, Saturation, Brightness).HSV is an alternative representation of RGB color model. It is aligned in a way how human vision perceives color making attributes. This color model is more often used by artists due to its natural color scheme. The three attributes of the HSV can be additive as well as subtractive. The HSV image also has three channels, the Hue, Saturation and Value channels. In

OpenCV, the values of the Hue channel range from 0 to 179, whereas the Saturation and Value channels range from 0 to 255.

Fourier transform

The Fourier transform is a representation of an image as a sum of complex exponentials of varying magnitudes, frequencies, and phases. The Fourier transform plays a critical role in a broad range of image processing applications, including enhancement, analysis, restoration, and compression.

Working with the Fourier transform on a computer usually involves a form of the transform known as the discrete Fourier transform (DFT). A discrete transform is a transform whose input and output values are discrete samples, making it convenient for computer manipulation. There are two principal reasons for using this form of the transform:

- The input and output of the DFT are both discrete, which makes it convenient for computer manipulations.
- There is a fast algorithm for computing the DFT known as the fast Fourier transform (FFT).

Advantages

- The Fourier Transform is a powerful tool for analyzing signals in the frequency domain.
- It is easy to implement and can be used to analyze both linear and nonlinear systems.
- It is computationally efficient and can be used to decompose signal into their constituent frequencies.
- It can be used to identify and isolate specific frequencies or frequency bands in a signal.
- It is widely used in applications such as digital signal processing, image processing, and communications.

High Pass Filter

A High Pass Filter(HPF) main advantage is used to sharpen the image by attenuating the low frequency. When the impulse response or signal is passed through a high pass filter, an HPF mainly allows high frequencies to pass through. As High pass filters are used for sharpening the images, the frequency obtained is less compared to the cut-off frequency(ωc). In OpenCV and in digital image processing we also use HPF functionality to find the edges in an image. High-pass filtering works in exactly the same way as low-pass filtering; it just uses a different convolution kernel. A high pass filter is used for passing high frequencies but the strength of the frequency is lower as compared to cut off frequency. Sharpening is a high pass operation in the frequency domain. As a low pass filter, it also has standard forms such as Ideal highpass filter, Butterworth highpass filter, Gaussian high pass filter.

Low Pass Filter

A low-pass filter, also called a "blurring" or "smoothing" filter, averages out rapid changes in intensity. The simplest low-pass filter just calculates the average of a pixel and all of its eight immediate neighbors. The result replaces the original value of the pixel. A low pass filter is used to pass low-frequency signals. The strength of the signal is reduced and frequencies which are passed are higher than the cut-off frequency. The amount of strength reduced for each frequency depends on the design of the filter. Smoothing is low pass operation in the frequency domain. It also has standard forms such as Ideal highpass filter, Butterworth highpass filter, Gaussian high pass filter.

Conclusion:

Color space conversion is the translation of the representation of a color from one basis to another. This typically occurs in the context of converting an image that is represented in one color space to another color space, the goal being to make the translated image look as similar as possible to the original. The Fourier Transform is an important mathematical tool that can be used to analyze and manipulate signals. It can be used to study the frequency content of signals, filter out unwanted frequencies, or to reconstruct signals from their frequency components. Low-pass and high-pass filters are two fundamental types of filters used in signal processing. These filters have opposite characteristics and are used to filter out unwanted frequency components from a signal. Understanding the characteristics of these filters and their applications can help in designing effective signal-processing systems.