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**OpenCV Introduction**

OpenCV is a powerful image processing library originally created by Intel, later supported by Willow Garage, and currently maintained by Itseez.

* Digital images are 2D arrays of pixels.
* In grayscale images, each pixel represents the intensity of a single shade (single channel).
* In color images, there are three channels: Red (R), Green (G), and Blue (B).

**Color Space Conversion**

OpenCV provides over 150 color space conversion methods. One such method is Color to HSV (Hue, Saturation, Value).

* Saturation: Amount of color (depth of the pigment).
* Value: Brightness of the color (0 to 100).

**Computer Vision**

Computer Vision is the process of teaching machines to perceive and understand visual information, allowing them to "see" like humans.

**Masks and Thresholding**

* Masks are binary images indicating pixels where operations are to be performed.
* Thresholding is a segmentation technique used to separate objects from the background by comparing pixel intensities with a predefined threshold.

**Image Reading and Display**

* OpenCV reads images in BGR format, while Matplotlib reads images in RGB format.
* Conversion to BGR is necessary when displaying images using Matplotlib, if we want similar experience as opencv.

image = cv2.cvtColor(cv2.imread(path), cv2.COLOR\_BGR2RGB)

**Morphological Transformations**

* Simple operations based on image shape, usually performed on binary images.
* Operations include dilation, erosion, opening, closing, morphological gradient, and top hat.
* Opening is erosion followed by dilation, and closing is the opposite of opening.

**Kernels in Image Processing**

* A kernel, convolution matrix, or mask is a small matrix used for operations like blurring, sharpening, embossing, and edge detection.

**Smoothing Images**

* Various filters are available in OpenCV for smoothing images, including homogeneous, Gaussian, median, and bilateral filters.
* Homogeneous filter computes the mean of its kernel neighbors with equal weight.

**Image Gradient**

* Image gradient is a directional change in intensity or color in an image.
* Different image gradient methods are available in OpenCV.

**Canny Edge Detector**

* Developed by John F. Canny in 1986, it uses a multi-stage algorithm for edge detection.
* Steps: Noise reduction, gradient calculation, non-maximum suppression, double threshold, and edge tracking by hysteresis.

**Image Pyramids**

A pyramid representation involves repeated smoothing and subsampling of a signal or image.

* Gaussian Pyramid
* Laplacian Pyramid

**Contours:**

In computer vision and image processing, contours are simply the boundaries of objects in an image. A contour is a curve joining all the continuous points along a boundary that have the same color or intensity. Contours are useful for shape analysis, object recognition, and other image processing tasks.

**Histogram:**

A histogram is a graphical representation of the distribution of a dataset. It provides a visual summary of the distribution of a set of values. In image processing, histograms are commonly used to analyze the distribution of pixel intensities.

It is another way of understanding the image.

You can find pixel intensity of an image using histogram.

**Template matching:**

Template matching is a technique in computer vision and image processing used to find a sub-image (template) in an input image. The basic idea is to slide the template over the input image and compare the template with different regions of the input image to find the best match. The match is often determined by a similarity metric, such as normalized cross-correlation.

It is a method of finding and searching a location of a template image inside a large image.

**Hough Transform:**

The Hough Transform is a technique used in computer vision and image processing for the detection of shapes, particularly lines and circles, within an image. It was developed by Paul Hough in 1962. The Hough Transform is widely used in tasks like edge detection, image analysis, and computer vision applications.

It can detect the shape even if it is broken or distorted a little bit.

**Face Detection using Haar Cascade Classifier** is a machine learning based approach where a cascade function is trained for a lot of positive and negative images.

**Harris Corner Detector**

It is a corner detection algorithm used in computer vision and image processing. It identifies corners in an image by looking for significant changes in intensity in all directions.