Image Processing : Introduction

What is an Image ?

An image is a picture stored in electronic form. An image map is a file containing information that associates different location on a specified image.

Common image file format includes:
1. JPEG
2. PNG
3. SVG

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How does a computer store images?

We all know the answer -PIXELS!

What is a pixel - Its the smallest element of a picture. Pixel stores the color values .

Here is the first digital image. The pixels can be clearly seen in this. As the quality of computers increased, Images with much better resolution are there in present times.

How does pixel store Image Information?

A digital image is a rectangular grid of pixels. Digital image exists as an array of bytes in Computer's RAM and as files(various formats mentioned above) in memory card, hard drive, CD etc.

Each pixel consists of 1 byte(8 bits) for black and white image and 3 bytes for a color image(one byte for Red, Blue and Green color values in RGB space).
The more number of bytes a pixel stores for a color value, the more tonal levels are available and more clearer the picture will be.

Computer Vision and Image Processing

Computer Vision means understanding the scene based on image data while **Image Processing** is to manipulate the pixels in the image in order to get some useful information about the characteristics of the image like brightness, contrast, etc.

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Why Image Processing?

An automated robot responds to its environment only after analysing the data it receives from different sensors.(You will have a lecture on sensors).

Camera is one of the many important sensors in a robot. And to make the bot more informed of it's surroundings, we need to provide it with proper visual aids.

So, the data received needs to be analysed before we could put it in use. That's where Image Processing comes into picture.

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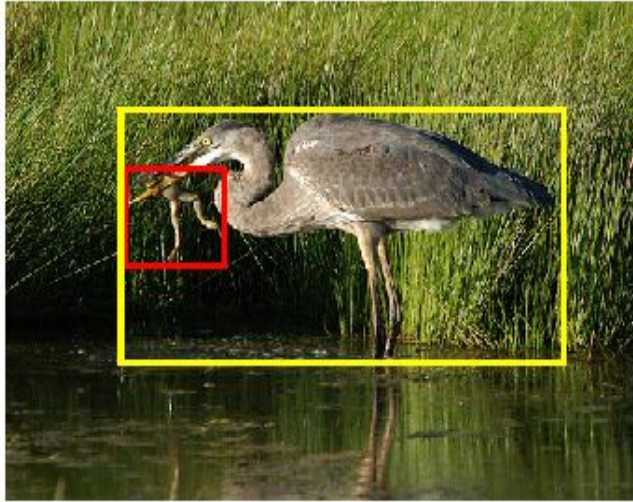
bird
frog

OpenCV

An open source computer vision and machine learning software library. Implemented in c/c++ , python and Java supported by Windows, linux and MacOS.

Library has more than 2500 optimized state of the art computer vision and machine learning algorithms.

➜ **Image Processing (imgproc module)**
Contains the image processing (manipulation) functions inside OpenCV.

➜ **High Level GUI and Media (highgui module)**
Contains built-in graphical user interface of the library.

➜ **Image input and output (imgcodecs module)**
Contains functions to read and write images.

Link for tutorials : https://docs.opencv.org/2.4/doc/tutorials/tutorials.html

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How does OpenCV stores images?

The data type for an image variable is Mat. It is similar to any other data type that we generally encounter, for example int/double/char/vector etc.

Declaration: Mat <image variable name>

Ex : cv: :Mat ima(240, 320, CV_8U, cv: :Scalar(100)); (For a greyscale image)

For a color image, we have to specify three channels (CV_8UC3).

## How do we take image as input?

1. We can take an image from the console, in any valid readable image format as .jpg, .jpeg, .png etc.

2. The more useful way that we might need is to take image from a real time environment, say camera. The camera feed is a video stream, hence an image is taken as input inside a continuous loop so as to perform the required functionality in real time.

Ex : cv: :Mat image = imread(argv[1], CV_LOAD_IMAGE_COLOR) ;
         cv: :Mat image = imread(" image.jpeg ") ;

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How can we interpret an image?

A color model is an abstract mathematical model describing the way colors can be represented as tuples of numbers.

Ex : 1. RGB (red, green, blue)
     2. HSV (Hue, Saturation, Value)
     3. RGBA (red, green, blue, alpha - for opacity)
     4. YCbCr (luminance, blue-difference, red-difference chroma component)

3CCD

R

G

B

RGB
to
Y'CrCb

Y'

Cr

Cb

a b c d e f g
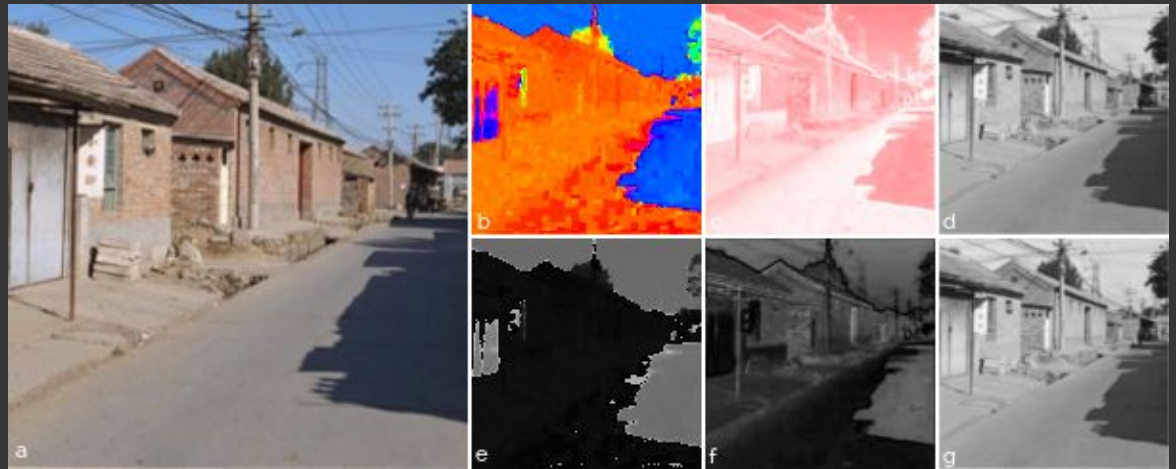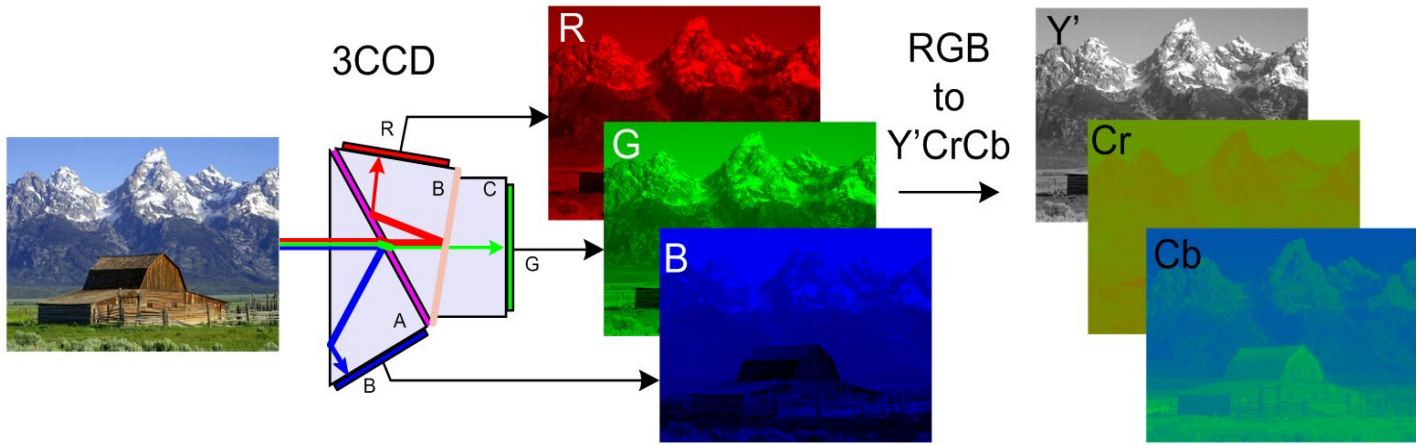
What is thresholding? Why do we do it?

1. Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels above that threshold to one.
2. It is the simplest segmentation technique that is used to separate an image into regions based on the value of the pixel.
3. Removes all the unnecessary parts in an image to focus only on the important aspects of the image.
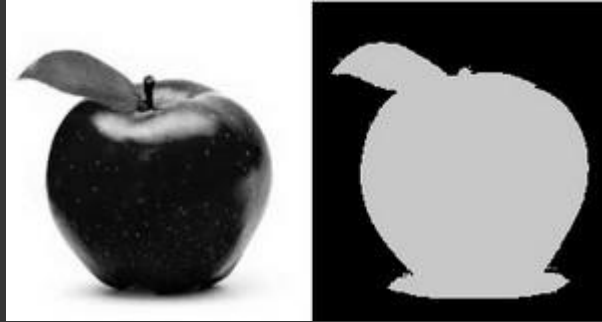
Ex : 1. threshold(src_gray, dst, threshold_value, max_BINARY_value, threshold_type) ;

2. adaptiveThreshold(src, dst, maxValue, adaptiveMethod, thresholdType) ;

3. inRange (frame, Scalar (low_b, low_g, low_r), Scalar(high_b, high_g, high_r), frame_threshold) ;

What are image contours?

Contours can be explained simply as a curve joining all the continuous points (along the boundary), having same color or intensity. The contours are a useful tool for shape analysis and object detection and recognition.

Ex : findContours(Input **image**, OutputArray **contours**, int **mode**, int **method**) ;
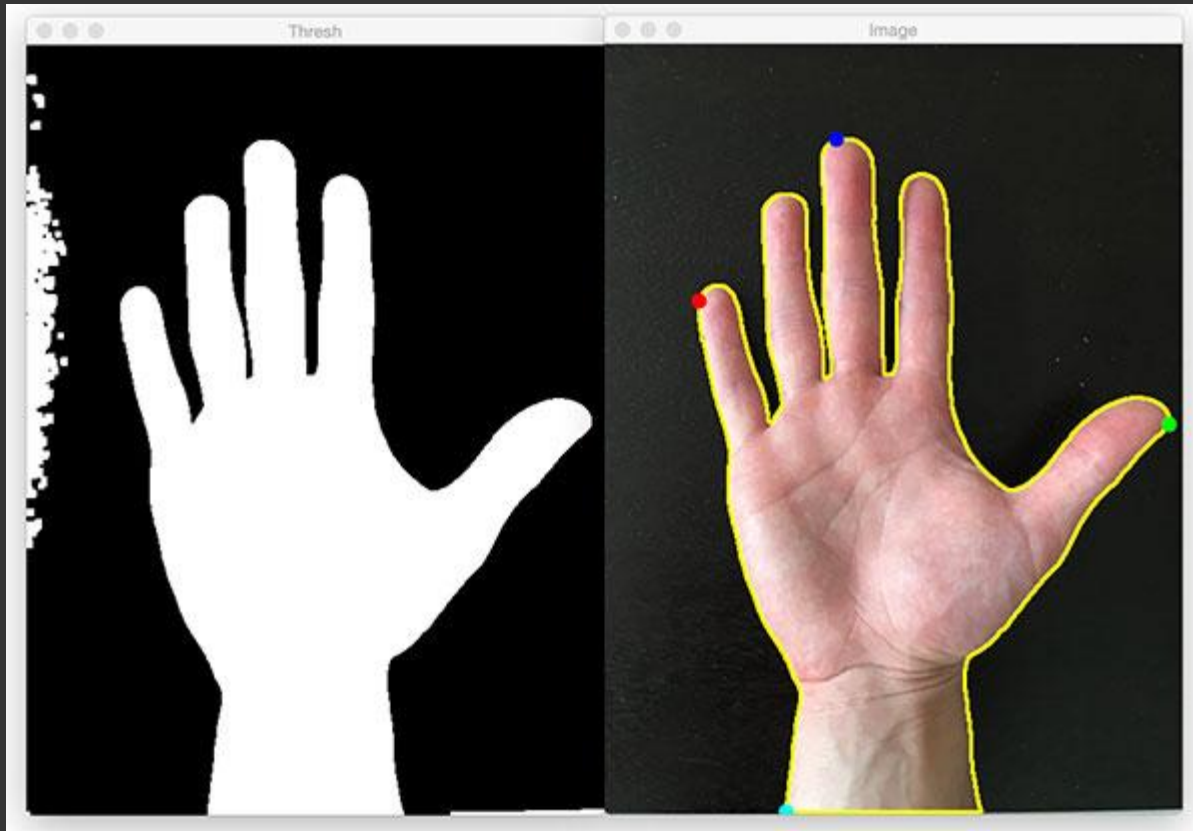
What is image blurring? Types of blurring. Why?

Blurring simply means smoothing the image. It helps in reducing noise as well as details. It helps in reducing the complexity in order to just look at the noticeable characteristics in an image.

There are various types of blurring. Few common examples are Gaussian Filtering, Median Filtering and Bilateral Filtering.

Each filter has a specific kernel which is convolved with the image to produce the smoothing.

Ex : Kernel

$$K = \alpha \begin{bmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ 1 & 1 & 1 & \cdots & 1 & 1 \\ & & \cdots\cdots\cdots & & \\ 1 & 1 & 1 & \cdots & 1 & 1 \end{bmatrix}$$
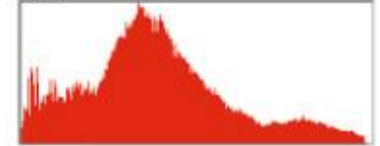
Histogram

You can consider histogram as a graph or plot, which gives you an overall idea about the intensity distribution of an image. It is a plot with pixel values (ranging from 0 to 255, not always) in X-axis and corresponding number of pixels in the image on Y-axis.
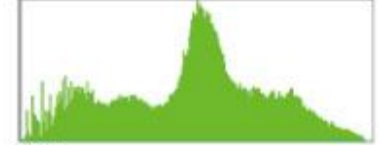
By looking at the histogram of an image, you get intuition about contrast, brightness, intensity distribution etc of that image.

No. of pixels

0 Pixel Values 255

RED

GREEN

BLUE

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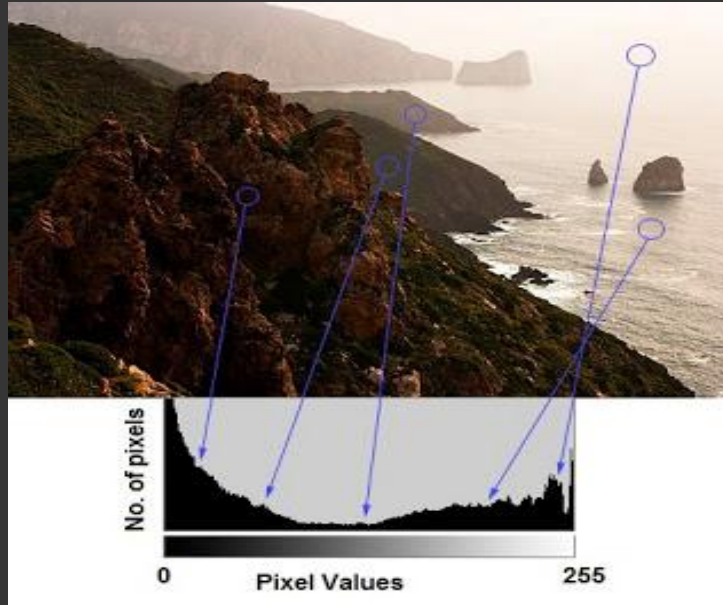
What is Back Projection?

1. Back Projection is a way of recording how well the pixels of a given image fit the distribution of pixels in a histogram model.

2. To make it simpler: For Back Projection, you calculate the histogram model of a feature and then use it to find this feature in an image.

3. Application example: If you have a histogram of flesh color (say, a Hue-Saturation histogram), then you can use it to find flesh color areas in an image.

Thank You.

Any Questions ?