Visual Recognition

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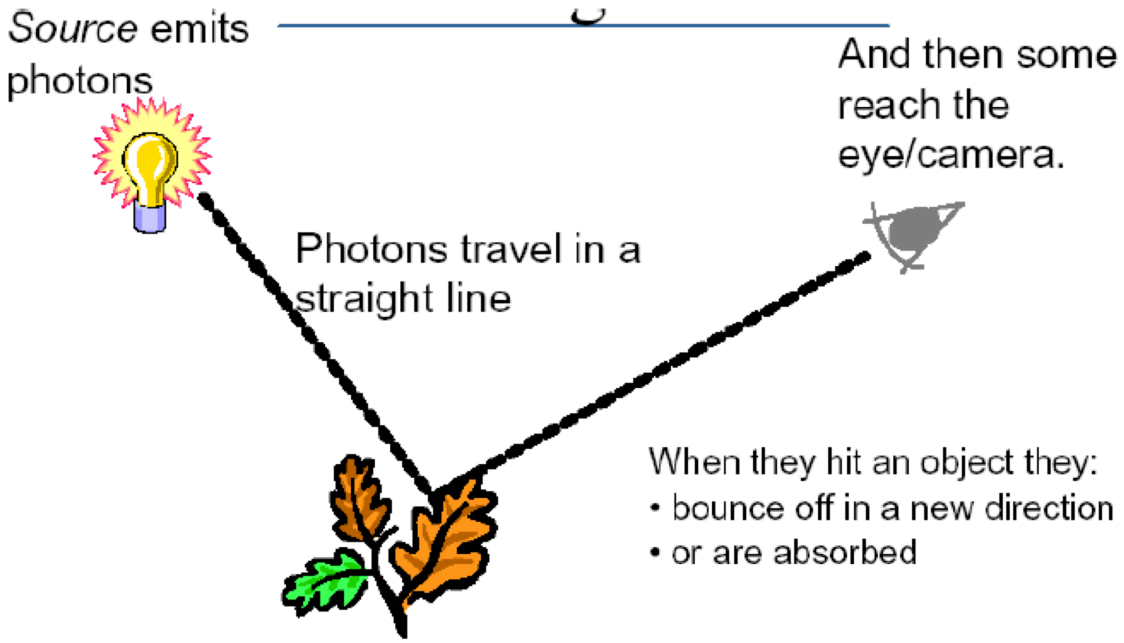
Image Formation

1) How are images formed?

Images are formed when a source of energy (light, ultrasound, electrons) bounces off an object and the way they are perceived by our eyes/camera after reflection forms an image.

Most often the source of energy is light(photons). It interacts with a 3D object in the world and the reflected light received by our eyes forms an image as shown in below diagram



Source https://www.dsi.unive.it/~atorsell/Visione/02-Image%20Formation.pdf

2) What happens to the energy emitted by the source when it interacts with the object?

Different objects have different properties. For eg smooth surfaces reflect light rays in same direction, rough surfaces reflect light in random directions. Shiny surfaces are good reflectors of light whereas dull surfaces are good absorbers. Different objects absorb or reflect a different set of wavelengths which is responsible for different colour of objects.

The different factors in image formation are:

Radiometry is that part of image formation concerned with relation between the light energy emitted from the source or reflected from the surface vs what amount of energy is registered by our eyes/ camera.

Photometry is concerned with methods of measuring intensity.

It describes the effect of visible light on human eye in terms of brightness of colours.

Geometry is concerned with relation between points between three dimensional world and their images. It describes the projection of a 3d object on 2d image plane.

Based on these factors the geometry ie shape and size and appearance ie colour of an object is identified.

Image Representation

A digital image is a composition of individual pixels. These pixels are represented in form of 2d matrix or rows and columns to form a picture area

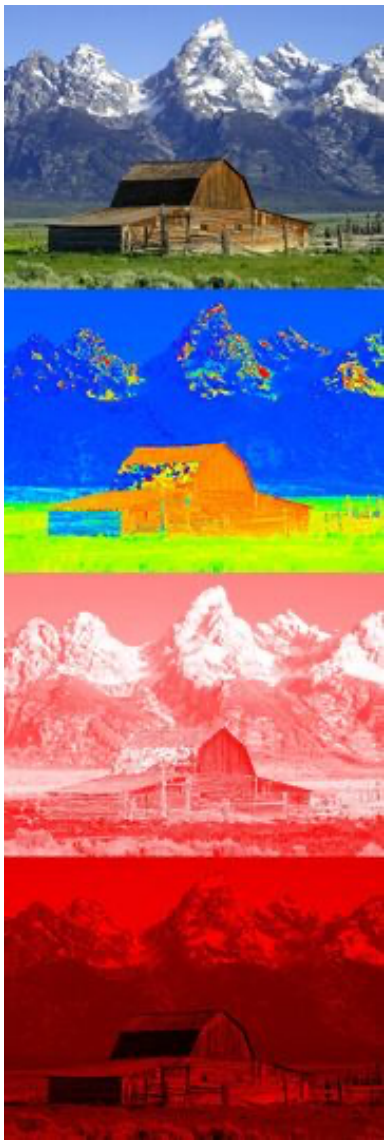
In computer vision, image representation tells us how can a digital image be represented eg colour code of an image.

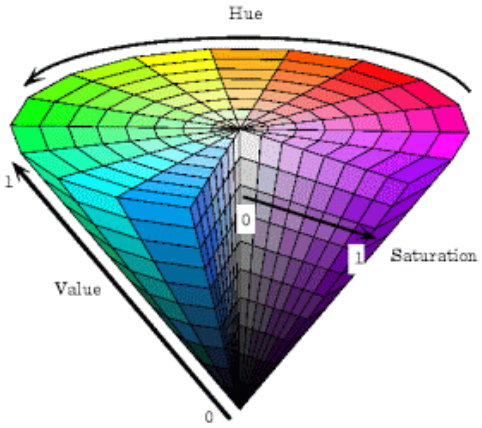
The two image representation we will discuss are

HSV

HSV stands for Hue-Saturation-Value also known as hue(colour), saturation(shade), brightness. It is an alternate representation of RGB colour model. In this model colours of each Hue are arranged on a radical slice around a central axis of neutral colours which range from black at the bottom to white at the top. This colour model is more closer to how humans perceive colours. RGB colour model is very good model but is not a very good model for image enhancement. In this cases HSV model is better.

An image along with its H, S, V representation



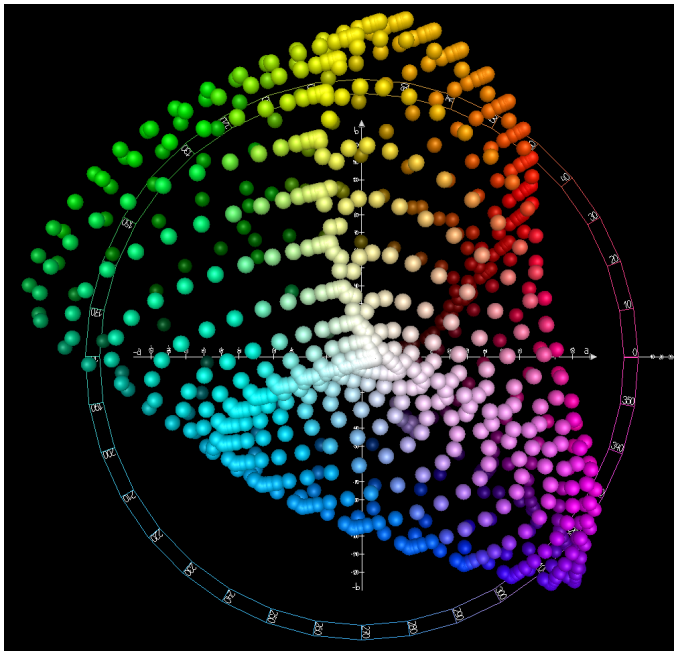


Source https://psychology.wikia.org/wiki/HSV_color_space

L*a*b*

This is another form of an image representation. It expresses colour as three values: L* stands for Lightness(Luminous) , a* is to specify hue and saturation along red/green axis and b* is to specify hue and saturation along yellow/blue axis.

In this form of representation all 3 components are measured relative to reference white colour. It is useful for detecting small differences in colour.



Source https://en.wikipedia.org/wiki/CIELAB_color_space

Representing an image in L* a* b*

(i) L* (j) a* (k) b*

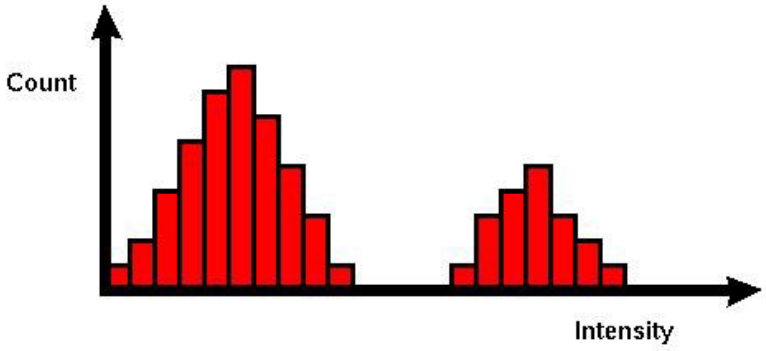
Image Enhancement

It is the process of improving the quality and information content of original data before preprocessing.

We will discuss about one of the enhancement techniques

Histogram Equalization is image processing technique which improves the quality of image. It does so by improving the contrast in the images.

Histogram of an image is a graphical interpretation of the images pixel intensity values.



X-axis represents pixel intensity which usually ranges from 0-255.

For gray scale image there is only one image, for RGB image histogram will be 2D histogram one for each colour.

Histogram equalization improves the quality of an image by adjusting the contrast of the image by using its histogram. It spreads out most of the frequent pixel intensity values or stretches out the intensity range of the image.

Original image

Enhanced image