SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE NAME : 19EC513 – IMAGE PROCESSING AND COMPUTER VISION

III YEAR / V SEMESTER

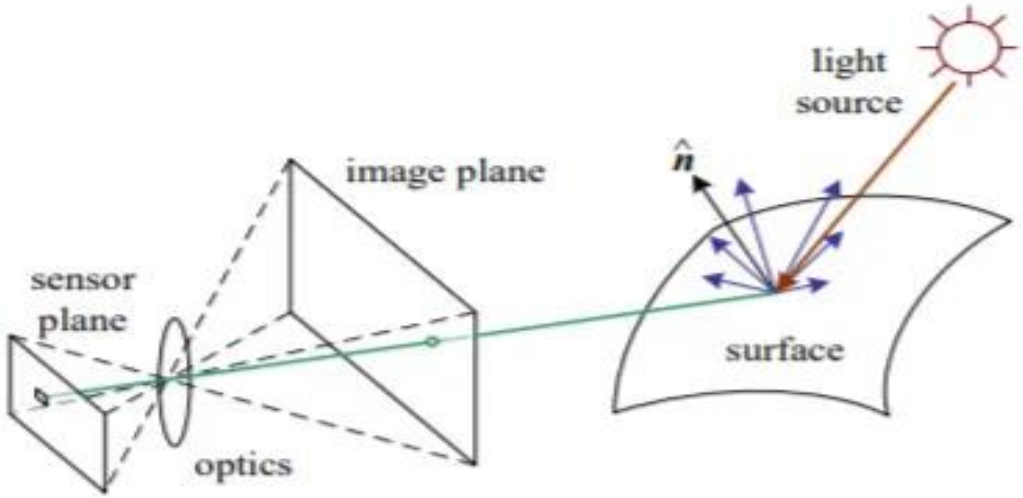
Unit V- Computer Vision

Topic : Photometric image formation

In modeling any image formation process, geometric primitives and transformations are crucial to project 3-D geometric features into 2-D features. However, apart from geometric features, image formation also depends on discrete color and intensity values. It needs to know the lighting of the environment, camera optics, sensor properties, etc. Therefore, while talking about image formation in Computer Vision, the article will be focussing on **photometric image formation.**

Photometric Image Formation

Fig. 1 gives a simple explanation of image formation. The light from a source is reflected on a particular surface. A part of that reflected light goes through an image plane that reaches a sensor plane via optics.



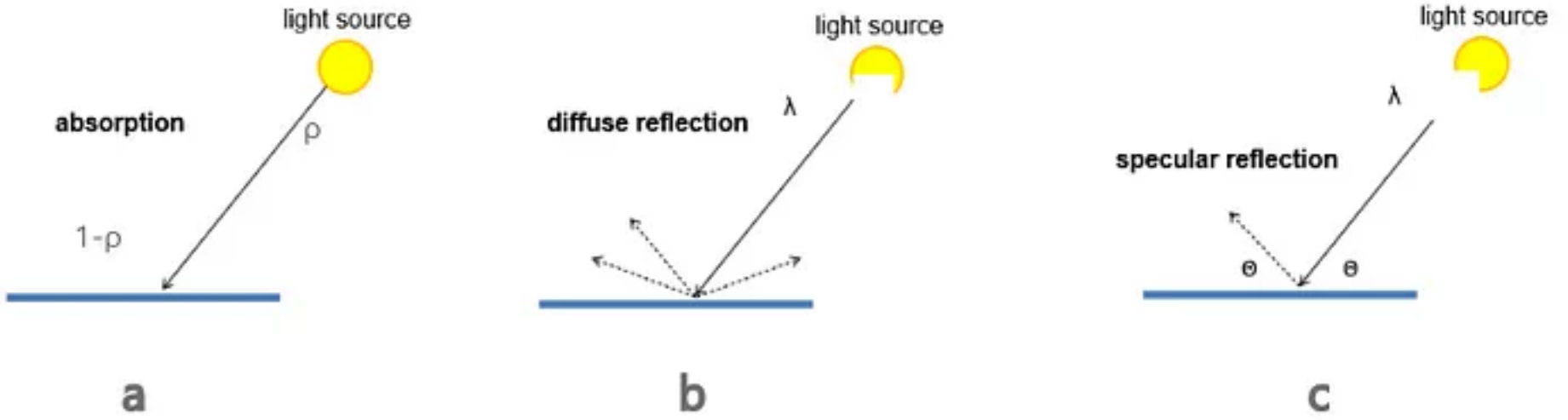
Some factors that affect image formation are:

- The strength and direction of the light emitted from the source.
- The material and surface geometry along with other nearby surfaces.
- Sensor Capture properties

Reflection and Scattering

Images cannot exist without light. Light sources can be a point or an area light source. When the light hits a surface, three major reactions might occur-

1. Some light is absorbed. That depends on the factor called ρ (albedo). Low ρ of the surface means more light will get absorbed.
2. Some light gets reflected diffusively, which is independent of viewing direction. It follows **Lambert's cosine law** that the amount of reflected light is proportional to cos(θ). E.g., cloth, brick.
3. Some light is reflected specularly, which depends on the viewing direction. E.g., mirror.


light source
absorption
ρ
1-ρ
a
light source
diffuse reflection
λ
b
light source
λ
specular reflection
Θ
Θ
c

Apart from the above models of reflection, the most common model of light scattering is the **Bidirectional Reflectance Distribution Function (BRDF).**

It gives the measure of light scattered by a medium from one direction into another. The scattering of the light can determine the topography of the surface — smooth surfaces reflect almost entirely in the specular direction, while with increasing roughness the light tends to diffract into all possible directions.

Eventually, an object will appear equally bright throughout the outgoing hemisphere if its surface is perfectly diffuse (i.e., Lambertian). Owing to this, BRDF can give valuable information about the nature of the target sample.

There are multiple other shading models and ray tracing approaches that are used in unison to properly understand the environment by evaluating the appearance of the scene.

Color

From a viewpoint of color, we know visible light is only a small portion of a large electromagnetic spectrum.

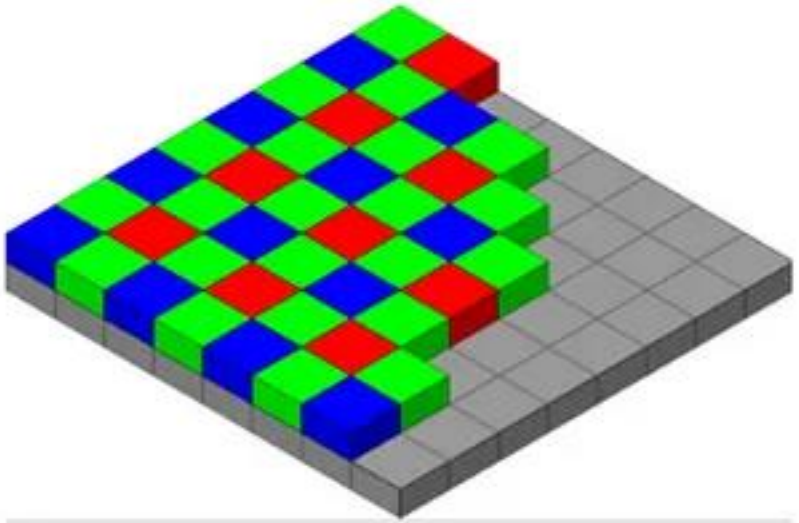
Two factors are noticed when a colored light arrives at a sensor:

- Colour of the light
- Colour of the surface

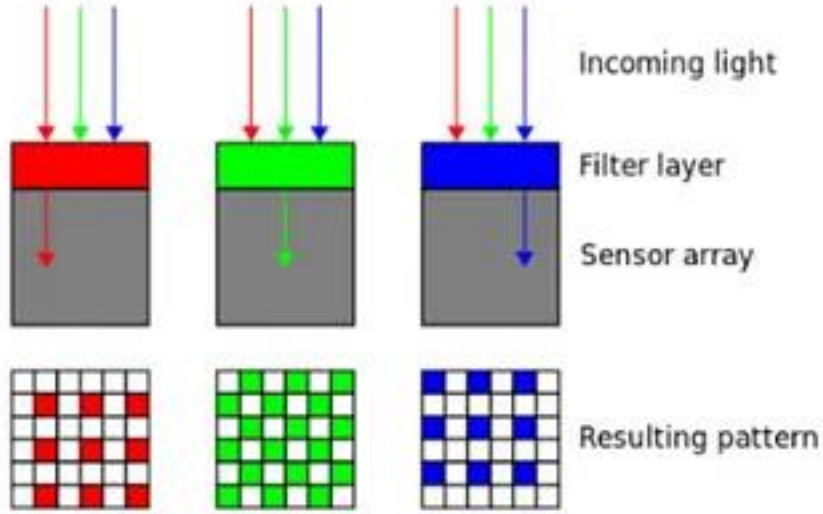
Bayer Grid/Filter is an important development to capture the color of the light. In a camera, not every sensor captures all the three components (RGB) of light. Inspired by human visual preceptors, Bayers proposed a grid in which there are 50% green, 25 % red, and 25% blue sensors.

Demosaicing algorithm is then used to obtain a full-color image where the surrounding pixels are used to estimate the values for a particular pixel.

There are many such color filters that have been developed to sense colors apart from Bayer Filter.



a


Incoming light
Filter layer
Sensor array
Resulting pattern

b

THANK YOU !!!