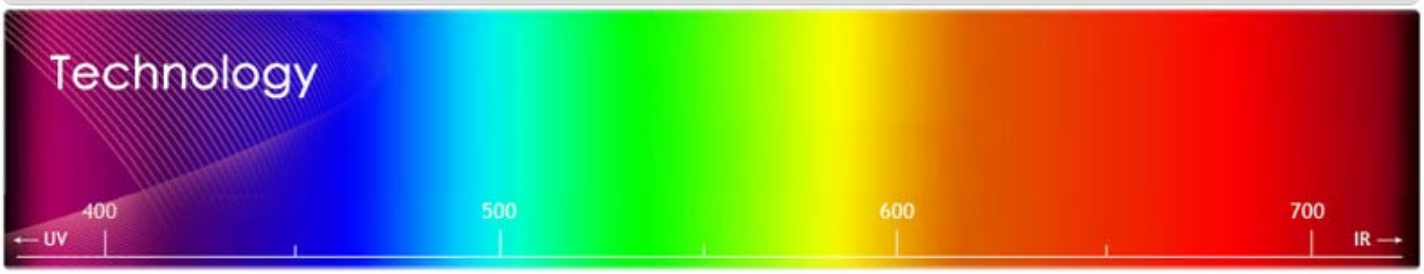

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Hubble and Machine Vision (Part I)

By Marcel Laflamme

We are all working in an industrial environment at varying levels of technical challenge. The Hubble Space Telescope is looking for the minutest display of light in the darkness of the universe. Machine Vision is looking for the ray (or rays) of light that will communicate the information required. Both activities measure light.

So, chin up. We are in good company. **Machine Vision is the computerized measurement of light.** It is the technological basis of Hubble and it is the technology supporting all the applications of Machine Vision. There are of course differences. Hubble breaks light apart to analyze spectral wavelengths in order to identify presence or absence of chemicals and minerals. Machine Vision measures the light reflected from an object to detect the intensity of that light and records a value of I to 255. The camera assigns the numerical value as it converts the photons to electrons. The image we see in machine vision is a reproduction based on these numbers.

The fact is that there is no "vision" without light. The camera does not really "see" the object. The camera measures the light that is reflected by or emitted from the object. Light is energy. It is best conceived of as energy in motion. It is never destroyed. It bounces off, passes through, is absorbed by or excites the object. There are various cameras with different sensitivity to light. Some are highly sensitive and will detect very low levels of energy, others are sensitive in certain wavelengths such as infrared, but they all measure photons that are reflected to the sensor.

Hence, Laflamme's first law of machine vision:
$O+LS=R_{mc}$ Object + Light Source = Reflection measured by camera

Second law of machine vision (I can't claim this one as mine):
Angle of reflection = angle of incidence. A basic law of physics, ignore it at your own risk!

All aspects of lighting – intensity, wavelength, etc. – are all secondary to this law of reflection.

Lights! Camera! Mirror! Do the experiment yourself. Set up the camera facing the mirror. Shine a flashlight on the mirror. By changing the mirror's angle you can make the mirror either fully reflect the light, producing a bright image (figure 1), or you can render a black image, i.e. no reflected light reaches the lens (figure 2).

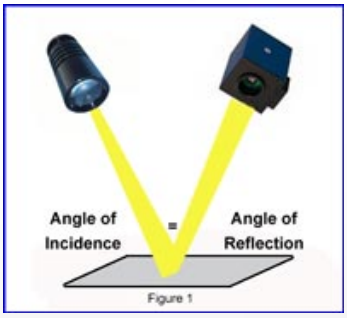

Figure 1

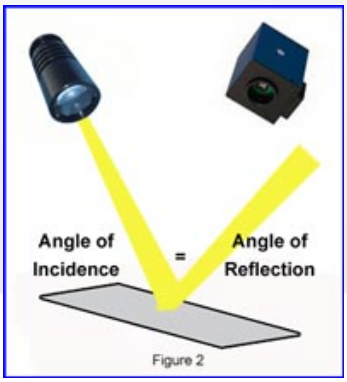

Figure 2

Next time: Part 2, Understanding the "W" model for ray tracing.

Author's note: See HUBBLESITE for some amazing images from the Hubble Space Telescope!