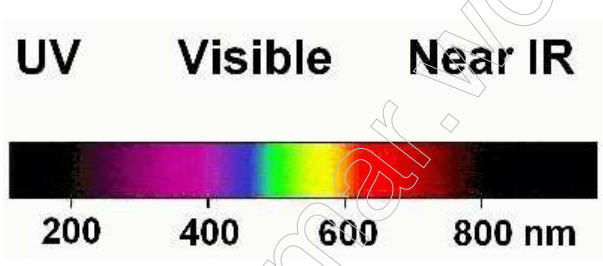
Thermal Imaging

Thermal imaging is the technique of **Infrared imaging** to produce infrared images called Thermograms. Thermal imaging is also known as **Infrared Thermography** or **Thermal Video**. It uses the infrared energy above 900 nano meters. The Thermal imaging is based on the **Black Body radiation law** which states that all objects emit infrared radiation at room temperature. Passive infrared radiation in very high in warm blooded animals especially in Mammals and by using a Thermal imaging Camera, the warm blooded animals can be viewed in total darkness.

Visible and Infrared light

Light is a form of electromagnetic energy propagating in different wave length. Only a small portion of light is visible to human beings since the retina of eye is sensitive only to a narrow part of the light spectrum. Human beings can detect light rays in the **visible spectrum** ranging from **400 to 800 nanometers**. Human eye is most sensitive to **550 nm** wavelength of yellow green part of the spectrum since green colour is most abundant one in nature.



A light ray below **400 nm** is the **Ultraviolet** and above **800 nm** is the **Infrared**. The amount of energy in the light is related to the wavelength of the individual light rays. Shorter wavelength light has high energy. For example in the visible region, **Violet** has very high energy while **Red** has least energy.

Infrared spectrum

Infrared light can be divided into three types

1. **Near Infrared or NIR**

   This is close to the visible light and its wavelength range between 0.7 to 1.3 microns

2. **Mid Infrared or MIR**

   The wavelength of MIR range from 1.3 to 3 microns. MIR is used in remote control applications.

3. **Far Infrared or FIR**

   This occupies most of the Infrared region and is responsible for heat. Its wavelength range from 3 to 30 microns. Objects emit **Far infrared rays** and the emission is at the Atomic level. Far Infrared light is also called Thermal Infrared since it has high temperature.

Theromographic Camera

The Theromographic camera is similar to a **Camcorder** in operation but it uses specialized **Focal Plane Arrays** (FPAs) to capture longer wavelength Infrared rays. The most common FPAs used are **InSb, InGaAs HgCdTe** etc. The resolution of the Theromographic Camera is around 160x120 or 320x240 Pixels which is low when compared to the Optical camera.

How it works?

The **Thermal images** or **Thermograms** are visual displays of the Infrared energy emitted or reflected by an object. In order to distinguish between the warm blooded animals and other sources of IR energy, the Infrared camera uses **Algorithms** to interpret the data to build the image. The principle behind the operation of Infrared camera is that, it collects IR energy from all sources and **compares the difference** in energy between the objects and the surroundings.

The following types of Energy levels are compared by the Infrared camera.

1. **Incident Energy** – Energy when viewed by the camera
2. **Emitted Energy** – Energy from the object that is to be measured

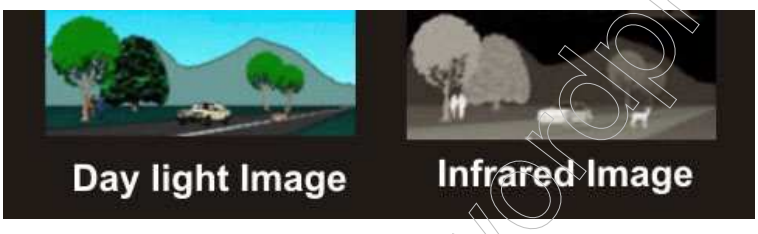
3. **Transmitted Energy** – Energy passing through the object from a source
4. **Reflected Energy** – Energy that reflects from the surface of the object

So the Infrared camera uses the relation

Emitted energy + Transmitted energy + Reflected energy is the Incident energy

Since human eye is insensitive to Infrared ray, the image will be created in **JPG format**.

The **Thermal Imaging Camera** consists of five parts namely an **Optical system**, a **Detector**, **Signal amplifier**, **Signal processing unit** and a **Display**. These parts work together to collect the informations from a warm area and converts the informations into visible light representation. The output difference is displayed so that the areas of same temperature appear in same colour. Usually the normal temperature areas are represented by **grey scale** while hot areas are represented by **different colors**.



The **Thermal imaging camera** has a lens system that focuses the Infrared rays from the Object on to a Detector. The Semiconductor Array in the detector will create a detailed temperature pattern known as Thermogram. The formation of Thermogram is very fast and it takes only 1/13 th of a second. The Thermogram contains informations from thousands of points from the field of view. The detector then translates the thermal informations into electric pulses which then pass into the **Signal processing circuit**. The circuit has a **Microprocessor** which transforms the informations into a **visible display** which can be viewed through the screen. The display shows various colours in the image depending on the intensity of the IR emission. The combination of all signals creates an image.

Most of the Thermal imaging devices can **scan** the object at the rate of 30 times per seconds and the temperature ranging from – 20 Degree to 2000 degree Celsius. These devices can also detect a change of temperature around 0.2 degree Celsius.

Active and Passive Thermography

Active thermography is the detection of Infrared from a heat source. It compares the temperature of the object with the surroundings. Thermal imaging camera (TIC) finds great use in Fire fighting. These cameras allow the **Fire fighters** to see areas of heat through smoke and darkness. In **Passive thermography**, the object will be at higher or lower temperature compared to the back ground. **Passive Infrared imaging** has many applications in **Surveillance systems**. The **PIR Sensors** are designed to detect passive infrared rays from human beings.