Thermal imaging and its applications

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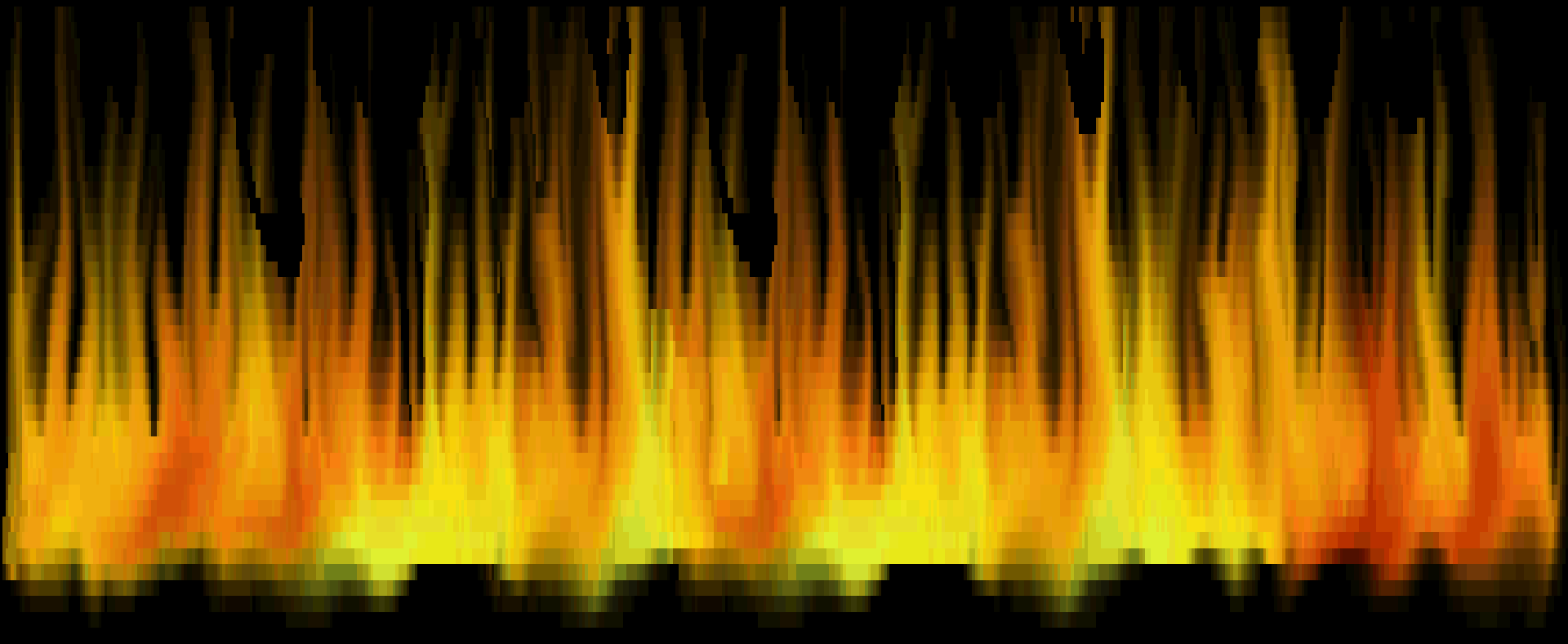
Date – 07-09-19



Introduction – Thermal Imaging

✓ Thermal imaging is the technique of using the heat given off by an object to produce an image of it or to locate it.

✓ It uses infrared radiations (2-14 μm) to study heat distribution in structures and regions.

✓ Other terms used are 'thermography or infrared imaging.'

✓ First developed for military purposes in the late 1950s and 1960s by Texas Instruments, Hughes Aircraft and Honeywell.

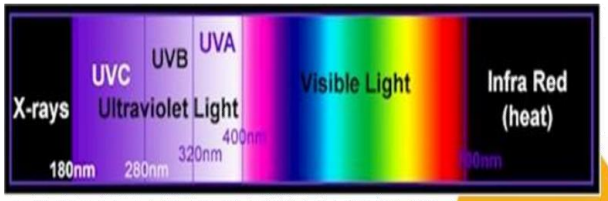
✓ In recent times it is being used in fire-fighting, law enforcement, industrial applications, security, transportation, medical and many other industries.

✓ Works in environments without any ambient light and can penetrate obscurants such as smoke, fog and haze.

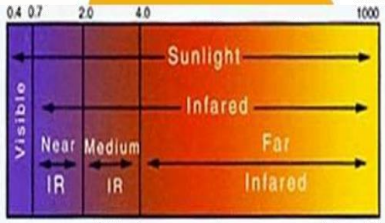
✓ Normally grey scale in nature: black objects are cold, white objects are hot and the depth of grey indicates variations between the two. However, some cameras add color images to help users to identify objects.

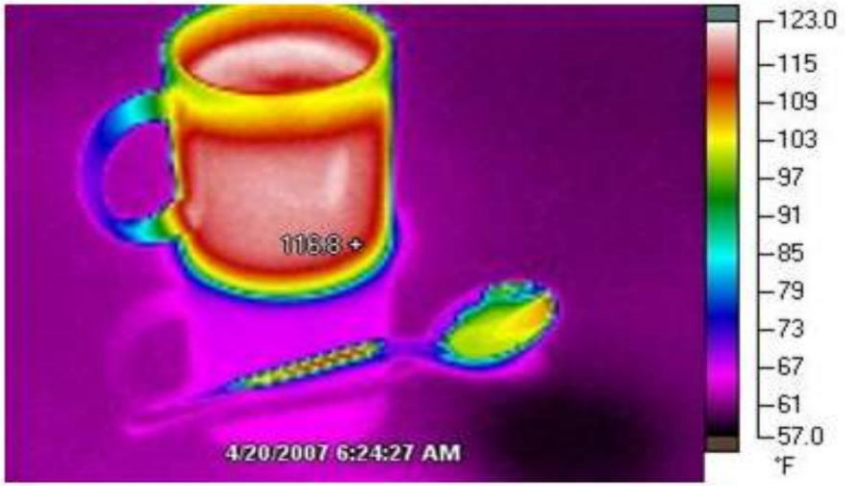
Thermal Imaging Camera (TIC)

✓ A thermal imaging camera records the intensity of radiation in the infrared part of the electromagnetic spectrum and converts it to a visible image.



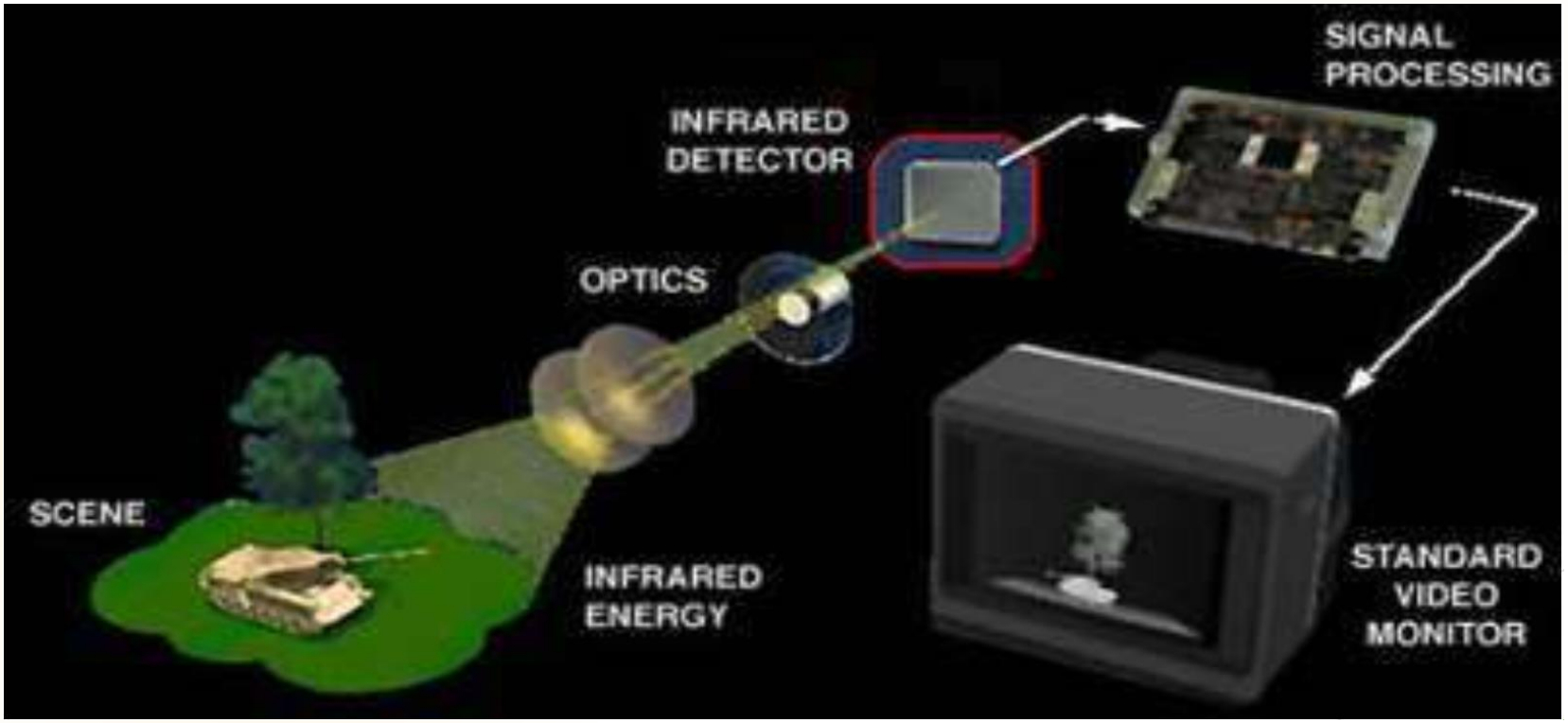
IR Band	Wavelength Range
IR-A	700nm - 1400nm
IR-B	1400nm - 3000nm
IR-C	3000nm - 1 mm





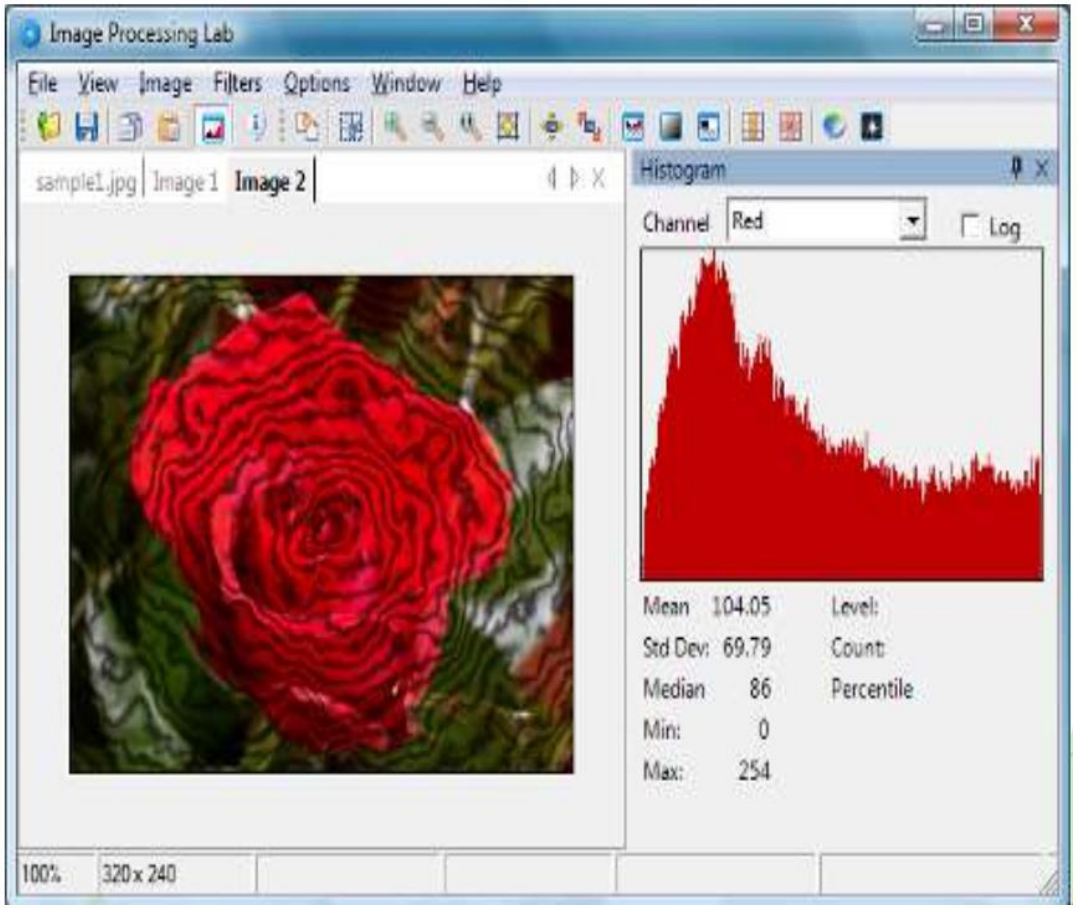
Components of TIC

✓ A thermal imaging camera consists of five components: an optic system, detector cooled and uncooled detector), amplifier, signal processing, and display.



Working of TIC

✓ **Image processing** is any form of signal processing for which the input is an image, such as a photograph or video frame and the output may be either an image or a set of characteristics or parameters related to the image.



Types of TIC

Cooled TIC

- Cooled detectors are typically contained in a vacuum-sealed case and cryogenically cooled.
- Cooling is necessary for the operation of the semiconductor materials used else they would be blinded by their own radiation.
- Cooled infrared cameras provide superior image quality.
- Bulky and expensive to produce and run.
- Cooling is power-hungry and time consuming hence the camera needs time to cool down before it can begin working again.

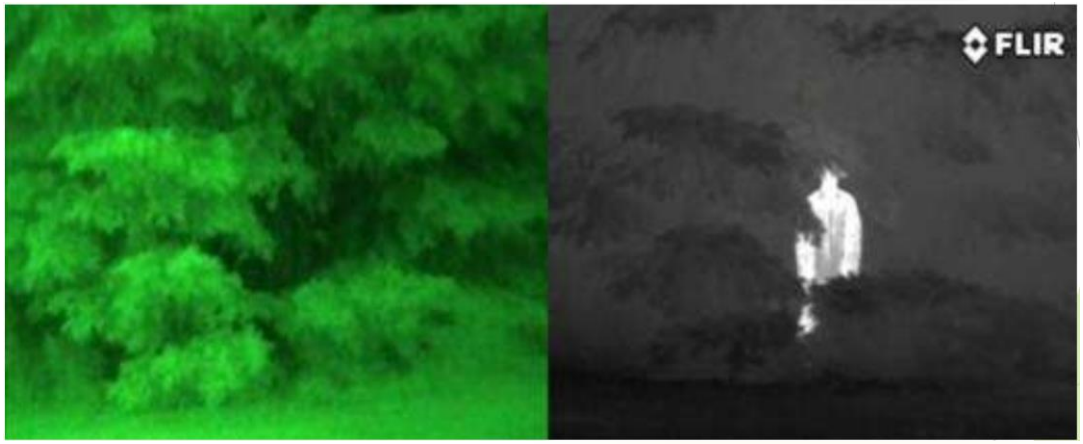
Uncooled TIC

- Un-cooled detectors use a sensor operating at ambient temperature, or a sensor stabilized at room temperature using control elements.
- Resolution and image quality tend to be lower than cooled detectors.
- Smaller and less costly to produce and run.
- Fast operation and consumes less power.

Thermal imaging applications

Major applications:

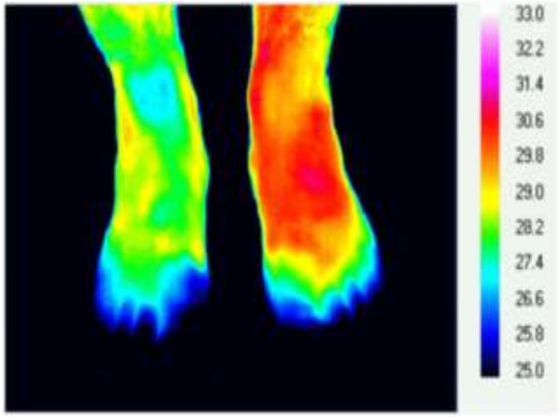
1) Industrial applications
2) Medicine applications
3) Security applications
4) Building constructions
5) Night vision



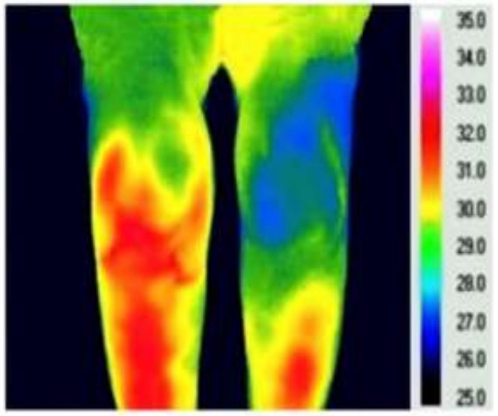
Thermal imaging in night vision

Other applications:

1) Evaluation of Solar Panels
2) Thermal mapping
3) Archaeological kite aerial thermography
4) Veterinary Thermal Imaging
5) Food and Agriculture
6) Research
7) Weather Forecasting
8) Non-destructive testing
9) Defense
10) Chemical imaging
11) Volcanology



(A) Chronic inflammation of the forefoot following a sports injury



(B) Rheumatoid arthritis of one knee (left of the image)

Advantages

✓ Non-invasive and non-destructive hence can be used to survey whilst the plant and equipment is running, in production and on load.
✓ Produces fast, accurate and immediate temperature measurement and helps in fault detection.
✓ Cameras are easy to install and surveys can be performed at a convenient time.
✓ Is capable of catching moving targets in real time and in low light conditions.
✓ Can be used to measure or observe subjects in areas inaccessible or hazardous for other methods.
✓ Can help in identifying air leakages, documenting irregular heat dispersion and identifying possible irregularities in insulation.
✓ Cameras can passively see all objects, regardless of ambient light.

Limitations

➢ Quality cameras are expensive (often US$ 3,000 or more), cheaper are only 40x40 up to 120x120 pixels.
➢ Images can be difficult to interpret accurately when based upon certain objects, specifically objects with erratic temperatures.
➢ Accurate temperature measurements are hindered by differing emissivities and reflections from other surfaces.
➢ Most cameras have ±2% accuracy or worse in measurement of temperature and are not as accurate as contact methods.
➢ Only able to directly detect surface temperatures.
➢ Thermal imaging cameras cannot be used to see objects under water.
➢ Because thermal energy can be reflected off shiny surfaces, thermal imaging cameras cannot see through glass.
➢ Also thermal imaging cameras cannot see through walls.


Thank you