MEASURING IR RADIATION

Satellites can detect parts of the electromagnetic (EM) spectrum that are beyond visible light.

Whilst we cannot see this kind of radiation, we can create and use false colour images to show what levels of radiation are being detected.

We can use an infrared (IR) camera to visually detect and display the temperature of objects in real-time without physical contact. The IR camera detects infrared radiation emitted by objects due to their temperature, converting this invisible energy into a visible, color-coded image that represents different temperature levels. This allows us to observe thermal patterns that are otherwise invisible to the human eye.

Anything with a temperature above absolute zero (-273°C) will emit IR radiation. The hotter an object is, the more IR radiation it will emit per unit mass. This allows a direct link to be made between the amount of IR radiation observed and the temperature of the object, including objects on the Earth's surfaces – land, ocean or ice – as seen from space.

EXPERIMENTS TO TRY WITH IR CAMERA

1. HEAT TRANSFER

The IR camera allows heat transfer to be observed. The three methods of heat transfer are conduction, convection and radiation. Radiation needs no particles as it transfers as an EM wave alone. Conduction and convection on the other hand require particles to be present. These particles can interact and transfer heat. This experiment works best on a non-carpeted floor. A volunteer should be selected and asked to remove their shoes and stand on the spot without moving their feet at all. When the feet are observed through the IR camera they will appear brighter, and therefore warmer, than the floor. When the volunteer steps back, a set of footprints invisible in normal light should be visible on the IR image of the floor where its temperature has risen due to the volunteer's heating effect via their feet. These footprints will fade over time as the locally heated floor cools down again.

2. LOOKING AT HOT AND COLD WATER MIXING

One of the principal uses of IR is in the field of Earth Observation (EO) science. Since it would be impractical to physically measure the temperature of the oceans with a thermometer on a regular continual basis, satellites with IR detectors are used to scan the oceans and calculate the temperature using the IR data obtained. This can be demonstrated by boiling some water and pouring it into a tray of colder water. As the waters mix, temperature- driven currents are set up, which are clearly visible as different colours on the IR camera's image. Compare this image with real images taken of the Earth's oceans from space, including composite images over large ocean areas.

3. OBSERVE SOMEONE WEARING GLASSES

If someone is wearing spectacles with glass lenses they appear black on the IR camera image. This is because the IR being produced by the person's eye sockets and eyeballs is being reflected/absorbed by the glass rather than being transmitted through it. When the person removes their spectacles the IR being emitted from their eyes is no longer reflected/absorbed and so the eye sockets are clearly visible on the IR camera image.

4. BIN LINER ANALOGY

Another way that IR is useful for EO is observing through clouds, which can obscure visual images as they block visible light. This can be represented by having a volunteer stand in a bin bag. It will be impossible to see their legs in visible light, but as soon as you turn the IR camera onto them, suddenly their legs become clear as the IR they produce is absorbed to a much lower degree by the bag material than visible light is. In much the same way IR detectors on satellites can be used to observe areas of interest that would otherwise be obscured – for example detecting the location of wildfires when large areas of the surface are obscured by clouds of smoke.

5. STANDING IN FRONT OF A REFLECTIVE SURFACE

Just like visible light, IR can be reflected. If a volunteer stands in front of a window or a whiteboard, when the camera is turned towards that surface, a ghost-like IR reflection can be observed. IR is reflected by Earth's surfaces, and in this way some IR radiation escapes the Earth's atmosphere, one of the processes affecting global temperature. However, IR can also be reflected by greenhouse gases in the atmosphere, preventing it from escaping and contributing to the greenhouse effect and climate change.

Credit: ASDC