Thermography

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Signature: Carmeljcaruana (talk)

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Introduction

Written by Gunilla-Elisabeth Schachten

Thermography is an imaging technique displaying the surface temperature of objects. In this procedure intensity of the infrared radiation (9–14 µm) emanating from a point is interpreted as a measure of its temperature. By using thermographic cameras, the for the human eye not visible infrared radiation is detected and converted into electrical signals, producing images of that radiation, called thermograms.

Principle of Thermography I HAVE IMPROVED SOME SENTENCES AS THEY WERE NOT CLEAR.

Each body with a temperature above absolute zero (0 K, = −273,15 °C) emits infrared radiation, meaning heat radiation. The so called emissivity ε is a term representing a material's ability to emit thermal radiation. Emissivity often varies with temperature. A material's emissivity can range from a theoretical ε = 0 (completely not-emitting) to an equally theoretical ε = 1.00 (perfectly emitting black surface). Quantitatively, emissivity of a surface is the ratio of the thermal radiation from the surface to the radiation emitted from an ideal black surface. The amount of radiation emitted by an object increases with temperature, since with increasing temperature, the emitted spectrum shifts to shorter wavelengths. Thermography is preferably used in infrared radiation ranges, therefore at object’s temperatures of 300 K, which lie in an area of the ordinary ambient temperatures of about 20 °C. To ensure that measurements of objects situated distant from the thermographic camera are not made inaccurate by the atmosphere lying between them, the camera usually works in limited wavelength regions, where the atmosphere hardly emits (and absorbs) characteristic radiation. These wavelength regions are for example in the range about to 8–14 µm. Three heat outputs PTotal contribute to the result: WHAT IS P - EMITTED POWER?

- The main share of thermal radiation PObject radiates FROM the object to be measured itself,
- The surrounding objects of the radiate energy from PSurrounding. This amount of radiation (1 – ε) is scattered by the measured object and is added to the result.
- The intermediary air in turn provides PAir.
- The transmission factor τ describes the amount of "transmitted" intensity of waves through THE AIR

The total received heat output is calculated as:

$$P_{Total} = \varepsilon \tau P_{Object} + (1 - \varepsilon) \tau P_{Surrounding} + (1 - \tau) P_{Air}$$

Thermographic camera

Written by Leon Hollmann

A thermographic camera or infrared camera is a device using infrared radiation to form an image. A normal camera for example uses visible light to form an image and operates with 450–750 nm range of wavelengths, in contrary the infrared camera uses 14.000 nm range of wavelengths. As mentioned before every object emits a certain amount of black body radiation due to their temperature therefore the higher the temperature the more infrared radiation is emitted as black-body-radiation. An infrared camera can detect these radiations which is very similar to a normal camera detecting visible light. Even in darkness this technique is working because the ambient light level does not matter. The images displayed from the infrared camera are at first monochromatic and in several grey levels. Usually an infrared camera is able to display 256 levels of grey which are impossible for the human eye to distinguish, therefore the application of pseudo colours is very useful, where changes in colour are used rather than changes in intensity of levels of grey to display changes in the signal. The technique is called density slicing. In temperature measurement the brightest parts usually coloured in white show the warm parts of the image in contrary the darkest parts show the cold parts of the picture coloured in black. The intermediate temperatures are shown in red and yellow whereas yellow show the slightly warmer parts. Typically there should be shown a scale next to the image to relate colours to temperature. There are mainly two different types of infrared cameras those with cooled infrared detectors and those with uncooled infrared detectors. Like the name implies the infrared

detectors of a cooled infrared detectors camera need to be cooled down to not be blinded or flooded by their own thermal energy. The results of cooled down detectors are therefore more precise but way more expensive to produce and to run and cooling the detectors is energy intensive and time consuming.

The thermographic camera has a lot of applications:

- Night vision
- Building inspection
- Energy auditing of building insulation and detection of refrigerant leaks
- Roof inspection
- Home performance
- Moisture detection in walls & roofs (and thus in turn often part of mold remediation)
- Masonry wall structural analysis
- Law enforcement and anti-terrorism
- Quarantine monitoring of visitors to a country
- Military and police target detection & acquisition
- Condition monitoring & surveillance
- Technical surveillance counter-measures
- Thermal weapon sight
- Search and rescue operations
- Firefighting operations
- Thermography (medical) – Medical testing for diagnosis
- Veterinary thermal imaging
- Program process monitoring
- Quality control in production environments
- Predictive maintenance (early failure warning) on mechanical & electrical equipment
- Astronomy, in devices such as the Spitzer Space Telescope
- Automotive applications
- Auditing of acoustic insulation for sound reduction
- Chemical imaging
- Nondestructive testing
- Research & development of new products
- Pollution effluent detection
- Locating unmarked graves
- Locating pest infestations
- Aerial archaeology
- Paranormal investigation
- Flame detector
- Meteorology (thermal images from weather satellites are used to determine cloud temperature/height and water vapour concentrations, depending on the wavelength)

Application in medicine

Medical thermography can be used to detect whether there is an irregular blood flow somewhere in the human body. Veterinarians and sports doctors frequently use it to determine areas of the body with inflammation. One can screen physiological and patho-physiological processes.in comparison with radiology one can only look at physiologically processes whereas radiology shows anatomical changes something that already changed therefore medical thermography can be used as an preventive medicine.