

Infrared Thermal Imaging

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Abstract

Infrared Thermography (IRT) is being used in an ever more broad number of application fields and for many different purposes; indeed, any process, which is temperature dependent, may benefit from the use of an infrared device.

All living objects in the world emit infrared energy in the form of heat which is known as its heat signature.

Infrared thermal imaging is a method to improving visibility of objects by detecting the objects infrared radiation and creating a new gray scale image based on that information in a dark environment using the infrared radiations.

Keywords: Infrared radiation, thermography camera, medical, armed forces, breast cancer.

Introduction

Infrared thermal imaging technology is one new method using night vision technologies. Thermal imaging works without any ambient light in environments. In general, a hotter object emits more radiation. Infrared thermographic camera can operate as long as 14,000 nm in wavelengths.

A thermal camera is also known as a thermal imager, infrared camera or thermal imaging camera. It is a heat sensor that capable of detecting minor differences in temperature. The Thermal camera can collect the infrared radiation from a sequence of continuous action in the scene and creates a new image based on information about the objects temperature differences. Because objects are rarely precisely the same temperature as other objects, a thermal camera can detect the objects heat i.e., infrared radiation coming from the object and they will appear as distinct in a thermal image that creates a new image using infrared radiation. Those thermal images are also known as **Thermograms**.

Normally, these images are grayscale in nature in which the white objects are hot, black objects are cold and

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the depth of gray indicates variations between the two objects. Some thermal cameras help users identify an object to add colors to images at different temperatures.

Advantages

1. It has a capability of finding high temperature components.
2. It is used to observe the areas which cannot be accessed by other methods.
3. It is a non-destructive method. It is very useful to detect the objects in dark places.
4. In real time environment, thermography is capable of catching freely targets.
5. Large area temperature can be differentiated as it helps us to show virtual pictures.
6. It is also used in medical field especially in kinesiotherapy.

Disadvantages

1. It has a capability of detecting surface temperatures directly.
2. When accurate temperatures are being measured, they are mostly affected by other surface reflections and different emissivity.
3. Thermal Imaging does not perform well in rain falling.



Figure 1. Thermo Graphic Image of a Ring-Tailed Lemur

In Use

1. As in infrared cameras, the cameras are using image sensors which is not able to distinguish between the different wavelengths of infrared radiations because of this cameras have only single color channel. Out of the normal visible spectrum color has less meaning because of the complex construction of the different wavelengths doesn't map the uniform system of color vision used by humans.
2. Monochromatic images sometimes are displayed in pseudo-color, where the changes in color are used rather than changes in intensity to display changes in signal. As humans have much greater dynamic range in intensity detection. And this ability of seeing fine intensity differences in bright areas is limited; this technique is called density slicing.
3. According to the temperature measurements their colors are set. As warmest part of the image are colored white, intensity temperatures are colored red and yellows, and the dimmest part i.e., coolest parts are colored black. A scale should always be shown to relate the colors of temperature. The expensive cameras are of more resolution i.e., of 1280x1024. And thermo graphic cameras are much more expensive than their visible spectrum, though low performances of thermal cameras for smart phones are available in hundreds of dollars in 2014.
4. In un-cooled detectors the temperature differences at the sensor pixel are minute. At the

range of 10 of milliseconds the pixel response time is slow.

5. Thermography has many other uses too. Thermal imaging cameras are installed in various luxurious cars to aid the drivers. It is used by firefighters to see through smoke to find people and hotspot of fires. Power line technicians' uses thermal imaging to find the overheating joints and parts, to eliminate the potential hazards. Cooled infrared cameras can be found at astronomy research telescopes. And in medical field thermo graphic imaging is used to monitor the temperature in human being and warm blooded animals.

Working of Thermal Imaging

1. First of all it is important to understand the light. Wavelength is related to the amount of energy in the light wave. Higher the energy shorter will be the wavelengths. Of all the visible lights, violet has the most energy and red has the lowest. Infrared spectrum is just next to visible light spectrum.
2. Infrared light can be divided into 3 categories:
 3. **Near-infrared (near-IR)** – It is also known as near-IR and is closest to the visible light. Its wavelength ranges from 700 billionths to 1,300 billionths, or 0.7 to 1.3 microns of a meter.
 4. **Mid-infrared (mid-IR)** – It is also known as mid-IR and its wavelengths range from 1.3 to 3 microns.
 5. In electronic devices both Mid-IR and near-IR are used.
 6. **Thermal-infrared (thermal-IR)** – It is also known as thermal-IR and it has wavelengths ranging from 3 microns to over 30 microns which is covering the highest part of the infrared thermal.

Case Study

Recently this technology of thermal imaging systems was used in France by French police to arrest 2 brothers suspected in the Charlie Hebdo massacres because of rapidly evolving technology like in airports,

hospitals etc. Like GPS, thermal imaging was once used exclusively by military and law enforcement.

In the early 1990's, National Guard aircraft relied on thermal sensors to look for illegal drug activity at the Davidian Compound Branch in Waco, Tex.

In 2013, the Massachusetts State Police helicopter used thermal imaging to locate the Boston bombing suspect Dzhokhar Tsarnaev, after a homeowner reported that the bloodied fugitive was hiding in a boat in his yard.

In June last year, a military surveillance aircraft equipped with infrared sensors played a key role in the hunt for Justin Bourque, a refugee who had killed three police officers in Moncton, New Brunswick. He found the camera hiding in deep brush late at night.

Thermal imaging cameras are made up of a large array of unusual Micro-electro-mechanical Systems (MEMS) devices, as well as specialized optics. Predictable glass and plastic lenses can't be used because they wedge heat. Instead, these cameras require special lenses manufactured of transparent silicon.

The cameras, which detect changes in human's body temperature as small as one-tenth of a degree Fahrenheit, were originally used in Southeast Asia in response to outbreaks of SARS and bird flu, and more newly to alert officials to individuals who might have contracted Ebola.

Future Scope

Thermal imaging has been successfully used in several areas. This technology is used by armed forces in various countries. In future we use thermal imaging

to follow the thoughts through infrared radiation detector. The future applications of Infrared Radiation detector systems require:-

- The higher pixel sensitivity and further increase in pixel density.
- The reduction of cost in IR imaging array systems due to less cooling sensor technology combined with integration of detectors and signal processing functions.

Thermal Imaging is now being emerging in smart phones as well and it has been launched by iPhone only. It is the costliest product as it was special product which supports thermal imaging by FLIR. It has several disadvantages to like previously device don't have a battery with a charger. But this advantage has prevailed over. Now a better product has been launched.

Conclusion

As we discussed that infrared thermal imaging can be widely used in medical, armed forces and many more areas where this technology is used. In army, this technology can be used to find the suspected criminals. In medical, this technology is used to find the good solutions to different number of diseases or viruses. For example, today this technology can be used to measure the fever temperature and it can also be used in detection breast cancer. Infrared thermal imaging is a valuable adjunct to mammography and ultrasound, especially with dense breast parenchyma in women.

References

1. Ring EF. Quantitative thermal imaging. *Clin Phys Physiol Meas.* 1990;11:87–95.
2. Anbar M, Gratt BM, Hong D. Thermology and facial telethermography, Part I: history and technical review, *Dentomaxillo, Fac Radiol.* 1998;27:61–7.
3. Vainer BG. FPA-based infrared thermography as applied to the study of cutaneous perspiration and stimulated vascular response in humans. *Phys Med Biol.* 2005;50:R63–94.
4. <http://en.wikipedia.org/wiki/Thermography>
5. http://en.wikipedia.org/wiki/Thermographic_camera
6. <http://www.nytimes.com/>
7. <http://www.nydailynews.com/>