

# An Overview of Thermal Image Processing and Its Various Applications

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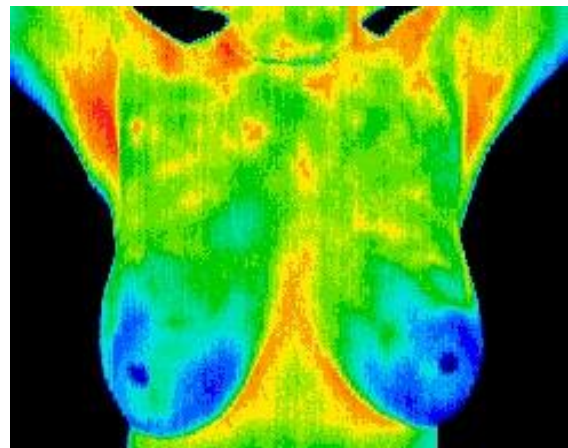
## ABSTRACT

Recent development in technology is focusing on modern and simple methods for diagnosing of fatal and incurable diseases using thermal image processing. Thermal Imaging is a type of imaging that determines an image based on the absolute temperature of the subject. The image is formed based on the heat signature of objects. Thermal imaging method is non-invasive and non-destructive method used even when the equipment is running, in production and on load. The image produces fast, accurate and immediate temperature measurement and helps in fault detection. The technique uses infrared radiations and includes most of the thermal radiation emitted by objects near room temperature. Using these images deadly diseases like tuberculosis, cancer, inflammatory diseases, complex pain syndromes can be identified. Diseases diagnosed early can be treated well and cured as quickly as possible.

**Keywords:** Thermal Images, Invasive, Inflammatory, Syndromes

## I. INTRODUCTION

The expansion of software that could identify objects of interest sensed with thermal imaging video equipment, which the previous research specified with the use of infrared video cameras. Unlike traditional methods, video recording provides a real-time archive of what was observed and could be conducted at remote locations.[1] Thermal image processing concerns with infrared radiation. Infrared (IR) light is electromagnetic radiation with a wavelength longer than that of visible light, measured from the nominal edge of visible red light at 0.7 -300 micrometres. Thermal images use the heat emitted by any object captured by the infrared cameras which produces images usually grey scale in nature. Hot objects are indicated by white colour while cold objects with black. Different temperatures are identified by various colours which is seen later in this paper.



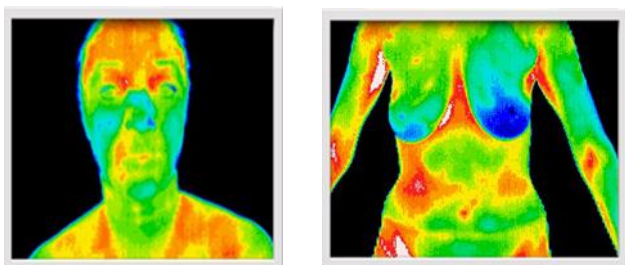
**Figure 1.** Ordinary Thermal Image

Good thermal symmetry with no suspicious thermal findings. These patterns represent a baseline that won't alter over time and can only be changed by pathology.

## II. DEFINITION FOR THERMAL IMAGE

A thermal image (thermo gram) is a digital representation of a scene and a measure of the thermal radiation emitted by the pictured objects. Thermal images are captured via thermo graphic cameras, which are devices capable of sensing this radiation in the form of infrared light. A thermal image remotely senses the temperature of an object or at least accurately tell its temperature relative to its environment. The objects can be seen in the dark as well as perceive the temperatures of many objects remotely.

Thermal Imaging is the conversion of radiated or reflected heat into real-time pictures or images. A thermal image is an analogue visual representation of temperature differences. All objects above absolute zero (-273 degrees) emit radiation waves that are infrared. Depending on temperature and emissivity, most objects in the world can be thermally imaged. Human beings emit the heat pattern captured by the thermal IR sensors and images are created. According to their temperature and characteristics different objects emit different range of Infra-red energy. The temperature of the human body varies between 35.5°C to 37.5°C [2].



**Figure 2.** Different Thermal Images

The problems related with difference in temperature can be easily detected using thermal imaging. A variety of heat detection tasks uses thermal imaging for checking any leakages, any abnormal body temperatures when naked vision is not possible. Thermal infrared images have detectors and lens combination that provides a visual representation of objects.

The most common tool used for thermal imaging today is the thermal infrared camera. Thermal infrared cameras can be used to detect and display the presence of anything radiating heat above absolute zero. They supply visual representation of the infrared energy emitted by all objects.

The advantages of thermal imaging are

- Non-invasive and non-destructive so used for any applications
- Fast, accurate, helps in fault detection
- Easy installation of cameras at convenient times
- Real time applications and low light conditions
- Passive usage of cameras independent of light

## III. MECHANISM BEHIND THERMAL IMAGE

As thermal images allow to "see" in the dark, images are received clearly even in poor light conditions. The technique used is based on 'blackbody radiation' where most objects emit electromagnetic radiation as a function of its temperature. In room temperature this radiation is at infrared wavelengths. As temperature grows light emitted is in visible spectrum releasing energy in ultraviolet wavelengths. Infrared light consists of long wavelengths in the visible spectrum is absorbed by the objects soon increasing its kinetic energy thereby creating thermal image.

Thermal cameras are used to capture the images depicting thermal scenes by detecting IR radiation from an object, is a part of the thermal radiation which is the function of the objects temperature. An array of micro bolometers act as simple sensor in the cameras to detect long IR wavelengths of objects temperature by absorbing thermal radiation and changes resistance as result. This can be electrically measured and determine the images thermally.

A few thermal properties which are used in accurate producing of images are

**Absorption**—understanding absorption is more important because various materials absorb and emit certain wavelengths of light at varying levels affecting thermal energy.

**Transmission**—materials not only transmit light wavelengths of the objects alone but also some EM radiation is transmitted into the camera which affects the image

**Emission**-- For a given temperature, different materials emit thermal radiation at widely varying levels. Understanding two dissimilar materials at

different temperature to sense the object emissivity is important.

Reflectivity—the radiation can be reflected based on the surface conditions of an object bounce and strike the camera sensors, similar to directly emitted radiation.

#### IV. APPLICATIONS OF THERMAL IMAGES

A thermal imaging camera can scan entire areas and objects all at once, never missing any overheating hazards. This enables the viewer for instant diagnostic insights showing the full extent of the problem. This property is used for various applications in certain areas like building Surveyors to detect moisture, identify energy loss & poor insulation. Electrical/Mechanical Engineers use thermal image to find electrical faults and use as fire prevention. Industrial/Civil Engineers use to identify water ingress in aeroplanes. Environmental Engineers use to detect anomalies in solar panels.

The study of temperature has widespread applications across science and medicine. [3]The human body is homoeothermic, i.e. self-generating and regulating the essential levels of temperature for survival. The association between human body temperature and disease is almost as old as medicine itself. So thermal images are used to study a number of diseases where skin temperature can reflect the presence of inflammation in underlying tissues, or where blood flow is increased or decreased due to a clinical abnormality. In principle, thermal imaging can be applied in medicine either as a diagnostic test or as outcome measure for clinical trials.

##### A. Diagnosis of Diseases

Most of the diseases could be cured if diagnosed in the early stage. This reduces the death rate in many dangerous and malignant diseases like cancer and contagious diseases like tuberculosis.

##### B. Breast Cancer Screening

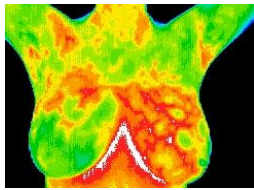
Early-stage cancer detection could reduce breast cancer death rates significantly in the long-term. The most critical point for best prognosis is to identify early-stage cancer cells. Investigators have studied many breast diagnostic approaches, including mammography, magnetic resonance imaging, ultrasound, computerized tomography, positron emission tomography and biopsy.[4] However, these techniques have some limitations such as being expensive, time consuming and not suitable for young women. Moreover involves high radiation levels for some method and low specificity leading to over diagnosis.

Improving screening practice in order to reduce breast cancer mortality has been developed. Many established risk factors for breast cancer, including being a woman, aging, breast density, family history, genetics, or a prior breast cancer diagnosis, cannot be modified. Breast cancer screening, referred to as secondary prevention, is the routine testing of individuals without symptoms that aims to detect breast cancer at its earliest stages so effective treatment can be offered[5]. Thermal imaging enhances screening of breast cancer.

This quick and easy test starts with medical history being taken before the scanning to be performed. When doing a breast series, this first session provides the initial portion of the person's baseline in developing "thermal thumbprint". A subsequent session in 3 months assures that the patterns remain unchanged and with these two sessions baseline is established. Standard region of interest exams take approximately 15 minutes and a full body 30 minutes.



In this method there is no invasive problem, no radiation effect. This method is also painless and for this test there is no contact with the body.



**Figure 4.** Thermal Image of Cancer Affected Patient

Fibrocystic Significant vascular activity in the left breast. Women at any age can begin utilizing thermography as a safe means of screening for breast disease. Thermography is not dependent on the density of a women's breast or do implants or surgical procedures affect the process of detecting thermal pattern. Thermography is especially appropriate for younger women between 30 & 50 whose denser breast tissue makes it more difficult for mammography to pick up suspicious lesions. This test can provide a 'clinical marker' to the doctor or mammographer that a specific area of the breast needs particular close examination

### C. Tuberculosis Identifying Using Thermal Image

Even if a person has symptoms of TB, it is often difficult to diagnose TB, and is particularly difficult to diagnose rapidly. Though there are various methods to diagnosis tuberculosis, there are certain disadvantages. Chest x-ray, sputum, skin test and culture methods are used in the hospitals to check if the patients are affected by mycobacterium tuberculosis. The problems faced are need of sophisticated infrastructure and trained professional. Time delay and negative results lead to fatal effects. Thermal images provide thermo gram, a representation in colour of radiation differences in affected areas. Thermal cameras uses infrared radiation related to temperature to realize the differences in heat emitted by the affected portion. The software of the thermal cameras emits a visible

alarm to the PC when a higher level of temperature is detected. High accuracy is assured in this method.



**Figure 5.** Thermal Images

Affected areas are shown by orange colour; other parts are shown by blue colour to indicate normal status.

## V. CONCLUSION

Thermal imaging has developed for multiple applications because of practical technology, more reliable and portable mode. Standard software and devices when used in this technology is used for many applications in image processing. Thermal imaging applications are widely spread because of the advantages of thermal cameras. This technique is used for diagnosing dangerous diseases. There is a scope for working on development of innovative, efficient & fast interpreting algorithms which will help doctors in detecting the deadly disease

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