

## APPLICATION OF THERMAL IMAGING IN FORENSIC VISION TECHNOLOGY

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### ABSTRACT

*The thermal imaging camera is a new emerging tool in forensic visionary technology for seeing in total darkness and takes an image of heat radiation from an object in diverse weather condition like rain, fog and smoke etc. The normal close circuit television (CCTV) cameras are blinded by the sun resulting they do not see too much in total darkness. All objects, regardless of temperature, emit some level of energy. IR cameras have the unique ability to capture this information and display it in a thermal image to be viewed and analyzed. This paper describes some of science behind this technology and its application.*

**Keywords:** *Infrared Thermal Imaging, Thermogram, Forensic Medicine, Law enforcement, Energy Management, Building Forensic and Polygraph.*

### INTRODUCTION

Thermography is the science of infrared and thermal imaging. More accurately, it is the use of a thermal imaging device or "IR camera" to view and measure the thermal energy emitted from a given object/surface relative to other object/surfaces.

Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum (roughly 900–14,000 nanometers or 0.9–14  $\mu\text{m}$ ) and produce images of that radiation, called thermograms. Since infrared radiation is emitted by all objects near room temperature, according to the black body radiation law, thermography makes it possible to "see" one's environment with or without visible illumination. The amount of radiation emitted by an object increases with temperature; therefore thermography allows one to see variations in temperature. When viewed by thermographic camera, warm objects stand out well against cooler backgrounds; humans and other warm-blooded animals become easily visible against the environment, day or night (Fig.1). All materials, which are above 0 degrees Kelvin (-273 degrees C), emit infrared energy. The infrared energy emitted from the measured

object is converted into an electrical signal by the imaging sensor in the camera and displayed on a monitors a color or monochrome thermal image

It is important to note that thermal imaging displays the amount of infrared energy emitted, transmitted, and reflected by an object. Because of this, it is quite difficult to get an accurate temperature of an object using this method. Thus,

$$\text{Incident Energy} = \text{Emitted Energy} + \text{Transmitted Energy} + \text{Reflected Energy}$$

Where Incident Energy is the energy profile when viewed through a thermal imaging device, Emitted Energy is generally what is intended to be measured, Transmitted Energy is the energy that passes through the subject from a remote thermal source, and Reflected Energy is the amount of energy that reflects off the surface of the object from a remote thermal source. If the object is radiating at a higher temperature than its surroundings, then power transfer will be taking place and power will be radiating from warm to cold following the principle stated in the Second Law of Thermodynamics. So if there is a cool area in the thermogram, that object will be absorbing the radiation emitted by the warm

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object. The ability of both objects to emit or absorb this radiation is called emissivity. Most thermal-imaging devices scan at a rate of 30 times per second. They can sense temperatures ranging from -4 degrees Fahrenheit (-20 degrees Celsius) to 3,600 F

(2,000 C), and can normally detect changes in temperature of about 0.4 F (0.2 C).It is extremely difficult to hide from since thermal contrast in practically impossible to mask.

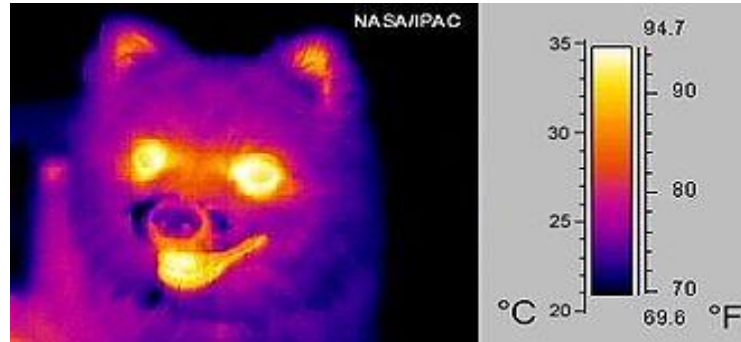


Fig. 1. Thermogram of a small dog

### THERMAL IMAGING IN FIELD OF ENERGY MANAGEMENT, BUILDING SCIENCE AND BUILDING FORENSIC Energy Management

The thermal imaging helps to identify potential area of air loss (heated or cooled) or air infiltration (Fig. 2). Locate the area of missing or damaged wall and ceiling insulation. It also helps to identifying malfunctioning of electrical panel or electrical fuse block.

### Building Science and Building Forensic

Thermal imaging cameras provide accurate and real time information in order to identify

vulnerable buildings, risk of short circuits and infiltration of water/air. Thermal imaging camera gives information in following references-

- i. Identify the moisture impacted building material such as walls, ceiling, floors, carpeting etc.
- ii. Identification of the moisture source.
- iii. Survey flat roofing system for leak.
- iv. Identify concealed radiant heating coil, pads or piping in floor and ceiling.
- v. Assist in concealed slab moisture investigation.



Fig. 2. Cool air infiltration through opening under window assembly.

## THERMAL IMAGING FOR LAW ENFORCEMENT

Thermal imagers use infrared technology to give law enforcement officers a reliable heat picture of their surroundings, providing them a range of abilities they do not have when using night vision or flashlights. Thermal imager detects extremely small differences in temperature, so officers can easily distinguish people from their immediate surroundings. Needing no light to operate, Thermal imagers generate high quality images on the darkest nights, even through smoke.

A thermal imager can help officers locate evidence at night, especially smaller pieces of evidence. Drugs, money and weapons thrown by a suspect during a pursuit will retain heat from the suspect. As such, they should be easier to locate with a thermal imager once the suspect is apprehended. A



Fig.3. Thermal view in total darkness, a swimmer in distress is found struggling in the water.

thermal imager can also assist at a static crime scene. For example, the technology can assist officers with locating shell casings and blood trails at the scene of a shooting.

### Surveillance

Because the thermal imager does not require light and only receives heat energy, it can be used to observe potential criminal activity at a distance. Whether a suspect is dealing drugs on the street, or trying to steal purses and stereos from cars, low-light conditions work to his benefit. An officer can use a thermal imager to observe the suspect from a distance, watching his activity and building further reasonable suspicion or probable cause (Fig. 3 & Fig. 4). The thermal imagery can be recorded for use as evidence later, or it can be used to justify specific interaction with the suspect.



Fig. 4. Thermal view of an intruder in total darkness

## THERMAL IMAGING FOR MEDICAL AND VETERINARIAN APPLICATIONS

### Medical Applications

Medical thermography is an accurate, quantifiable, non-contact, non-invasive, diagnostic technique that allows the examiner to visualize and quantify changes in skin surface temperature using high

performance infrared cameras (Fig. 5 & Fig. 6).

Infrared thermography is based on analysis of skin surface temperatures as a reflection of normal or abnormal human physiology using a high performance infrared camera. The camera generates images with thermal data in real time and in a fraction of a second, a large area of the human body can be imaged and dynamic responses to stimuli are easily documented. Skin burns can be

easily visualized by thermal images Thermal imaging was also used to investigate the skin temperature at the entry point after shots were fired from 0.22–0.38-calibre handguns. Whiplash injuries gained importance in liability cases after car crashes. Thermal imaging was successfully used as an alternative to Polygraph testing.



Fig. 5. Normal view of injured skin

#### Veterinarian Applications

An animal's body creates heat so it can survive. That heat fluctuates throughout the body depending on blood flow. Blood flow, to some degree, is regulated by need; for example, injured tissues need more blood to bring in more helpful cells and take away the debris of repair. The body's recognition of injury and a subsequent increase in blood flow can happen even before the animal shows signs of pain, such as lameness.

When used for medico-legal evidence, it is important that a standard protocol for subject preparation, image capture and analysis is used.

#### CONCLUSION

The thermal imaging cameras have a wide range of application in area of building forensic, medical diagnostics, forensic medicine, energy management, security, polygraph test and surveillances. Create a

In this application, psychological effects on blood flow are investigated, and an accuracy of 78% in detecting deceptive subjects is reported. Thermal imaging can be used as a method of temperature measurement in a number of applications of forensic medicine in order to identify the time to death.



Fig.6. Thermogram of injured skin

virtual security fence against intruders at vulnerable places like nuclear plant, petrochemical installation, ports and airport. Thermal imager can detect potential threats for assets and personnel in total darkness in all weather condition.

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