D46 Using Thermal Imaging to Detect Trauma and Disease Processes in Animal Cruelty Cases

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The goal of this presentation is to understand how thermal imaging works and how it can be used to help diagnose injuries in animal victims.

This presentation will impact the forensic science community by exploring a method of identifying recent and healed traumas, as well as infections, in victims of animal cruelty. Due to limitations set by animal fur, and the sometimes-fractious nature of injured animals, a method of examination that requires minimal handling is beneficial.

Based on the electromagnetic spectrum, infrared light is a wavelength of light that is not visible to the human eye. Within the spectrum, visible light consists of seven colors with a range of wavelengths. Violet has the shortest wavelengths and red has the longest. The prefix "infra-" is derived from the Latin word infrā, meaning "below or further on". Therefore, the word "infrared" means "below red" indicating its position in the electromagnetic spectrum, with wavelengths longer than the color red.

According to the International Commission on Illumination, infrared light can be broken down into three bands:

- IR-A: 700 nm – 1400 nm (0.7 µm – 1.4 µm)
- IR-B: 1400 nm – 3000 nm (1.4 µm – 3 µm)
- IR-C: 3000 nm – 1mm (3 µm – 1000 µm)

This division structure is commonly broken down into five sub-divisions:

- Near-infrared: 750 nm – 1400 nm (0.75 µm – 1.4 µm)
- Short-wavelength infrared: 1400 nm – 3000 nm (1.4 µm – 3 µm)
- Mid-wavelength infrared: 3000 nm – 8000 nm (3 µm – 8 µm)
- Long-wavelength infrared: 8000 nm – 15000 nm (8 µm – 15 µm)
- Far infrared: 15000 nm – 1,000,000 nm (15 µm – 1000 µm)

Near infrared and short-wavelength infrared are considered "reflective" infrared. It is within these two ranges that forensic science applications typically fall. Both ranges are effective based on the amount of water absorbed by the surface being examined and its contrast to the evidence on it (i.e. fingerprints, bitemarks, bloodstains, etc.). The near and short-wave infrared ranges are also used to identify chemicals based on the substance's ability to absorb the wavelengths.

The term "thermal infrared" includes the mid- and long-wavelengths of infrared light. Unlike the near and short-wavelengths of infrared light which are reflected off of surfaces, thermal infrared is emitted by an object in the form of heat (radiation). These ranges are used only minimally in forensic sciences. The long-wavelength range is considered the "thermal imaging" range and is typically used for the investigation of mechanical and structural systems.

In the practice of human medicine, thermal imaging is being researched as a possible detection tool. It is currently used as an alternative, non-invasive diagnostic procedure for detecting breast cancer, as well as for monitoring conditions such as back injuries, vascular disease, and stroke screening. The principle behind using infrared imaging for the detection of cancerous growths is that tumors have an increased amount of blood vessels, which are necessary to sustain the high metabolic rate of cellular growth and replication. This increase in blood flow results in an increase in temperature. Similarly, nerve compression and soft tissue inflammation that may be a cause of pain can be visualized through thermal imaging when it may not be apparent on x-ray or MRI.

Thermal imaging has been researched and used within veterinary medicine for over 40 years. While the technology has been used on a variety of animals (including livestock and zoo animals), the majority of research has centered on injury detection and diagnosis in racing horses. Thermal infrared has been used to diagnose joint inflammation, tissue injury, muscle atrophy, and general diagnostics. The same principles will apply, to the detection of contusions as to that of cancerous growths. If there is an area of increased blood,

this should show as an area of increased heat. Areas of infection should also show up as hot spots. In contrast, scars should show up as cold spots due to minimized blood flow.

Case studies will be conducted using a Forward Looking Infrared (FLIR) camera, model i60. This camera has a spectral range of 7,500 to 13,000nm (7.5 to 13µm) and a temperature range of -4 to 662°F. Information will be gathered from canine and feline patients of the University of Florida College of Veterinary Medicine. Case studies will include patients with confirmed traumatic injuries, suspected trauma, no traumatic and surgical procedures performed. When possible, animals will be scanned multiple times in an attempt to record the thermal image differences between recent and healing injuries. Trauma data, as well as thermal images will be documented and analyzed.

The use of thermal imaging in veterinary medicine has primarily focused on large animals. In dealing with animal cruelty cases, the question has arisen as to how thermal imaging can be used as a non-invasive way of diagnosing trauma and infection in animal victims. Because animals are typically covered by fur, the identification of contusions and scars can be difficult and sometimes impossible. It is hypothesized that these injuries will be detectable with the thermal infrared camera, and possibly a general stage of healing/time since injury can be established. Because close contact is not required to use this device, veterinarians and technicians will be safer in dealing with fractious animals. The data acquired is also in real time, allowing for quick diagnoses.

Animal Cruelty, Thermal Imaging, Infrared Photography

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