Efficacy of Veterinary & Equine Thermal Imaging

PREVIEW OF SOME OF THE CONTENT PROVIDED IN THE FULL PROGRAM

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Getting Started

- Historical Reference
- Understanding infrared
- Relating IR to physiology
- Terminology
- Establishing Protocols
- Therapy Applications
- Current research outcomes
- Image processing requirements
- Image Examples
Terminology

- Thermography (outdated)
- Telethermography (technically correct)
- IRT – Infrared Thermal Imaging
- DITI - Digital Infrared Thermal Imaging
- Infrared Thermography
- (Medical) Thermal Imaging
- (Medical) Infrared Imaging
- Thermograms
- THERMOLOGY
Sir William Herschel – 1800.
Measuring the temperature of each color in the spectrum from directed sunlight through a prism. Highest temperature beyond red portion.
All objects emit light

- Sun – 10,000 K
- Incandescent bulb ~2700 K
- Human or animal closer to 300K
- The distribution of intensity varies
- We assume emissivity is ~100%.
- Increase Temperature, colors shift towards visible (0.5 microns)
- At 10 microns wavelength, increase in temp, the intensity increases.
Infrared radiation is electromagnetic radiation whose wavelengths are longer than those of visible light but shorter than those of microwaves.

- Infrared radiation is radiated heat that can be sensed by our skin, yet cannot be seen by our eyes.
- All objects, whatever their temperature, emit infrared radiation.
- The intensity of infrared radiation depends on the temperature and a material surface property termed “emissivity”.
Intensity compared to physiological temperature

Excellent for calibrated, narrow range infrared cameras
Microbolometer
Detector element in an uncooled camera

Cooled Systems increase sensitivity

Single microbolometer element

Corner Section Of Microbolometer Arrayr
Human beings/Animals must thermo-regulate in order to survive.

The body is an efficient radiator.

Possible to detect infrared emission from the skin.

Create a thermal map of temperature distribution by remote sensing.

Heat is produced by the vascular activity and metabolic reactions taking place.
Infrared camera is not a thermometer

- An infrared camera is not to be classified as a thermometer. It would be regulated differently by the FDA in that event.

- While the readings can get close to actual temperature, all measurements are relative to some standard.

- Even a thermometer is a relative measurement, calibrated to some thermodynamic reference.

- The infrared camera is typically calibrated at the factory. However, there is a way to enable the user to calibrate the camera in the field, depending on the software supplied with the unit.
Key Elements of thermal imaging

- **It's Objective** – No bias or influencing of results. Detector element picks up whatever is transmitted from the subject.

- **Non-invasive** - no contact or sending of any rays, vibrations or use of dyes.

- **Quantitative** - shows the temperature differences. Captures thermal range.

- **Qualitative** – Color depiction of regions. There are pattern formations associated with the various areas of the body.
Objective test

- Independent observation
- Remote assessment of condition
- Influences would be positioning, focusing, calibration factors.
- Deals with fundamental elements of temperature differentials
- Reads whatever is captured by infrared imager
- RADIOMETRIC
Non-invasive imaging

- No contact
- No intrusive rays
- No health risk
- Receptive technology
- Can avoid more expensive, risky procedures
Quantitative

- Provides temperature range with values
- Temperature differential
- Delta T
- Maps thermal zones
- Identifies specific pixel values
- Ability to Graph/export data
- Records date/time/i.d.
Qualitative

- Assess color distribution
- Locate thermal patterns
- Relating to hot and cold
- Symmetry is normal
- Identifying focal thermal zones of interest
- Changing palette combinations
The scanning area layout should be able to consider the number of animals being scanned, size, and temperament of the animals. With a remote or Wi-Fi controlled scanning system, the technician could actually control the capture of images from a completely separate location.

The typical distance from the camera to the subject is approximately 42.” This varies based on focusing ability of the camera and size of the subject to encompass most views that need to be taken.
Other Factors

- **Equipment Selection – hand-held vs. stationary**
  - for repeatability and stability of examination
  - should not be easy for settings to be altered accidentally

- **Environment suited for repeatable studies**
  - stable testing area for consistent imaging
  - controls and protocol established regardless of technician

- **Easier to operate and use infrared imager, the better**
Stress level effects on sport performance during trotting races in Spanish Trotter Horses.

Eye temperature and heart rate measurements were collected 2h before the race and immediately following the race.

The stress levels of the horse before the race influence its competition results, and ∆ET or change in eye temperature during competitions reached a threshold point related to an improvement in performance results.

Dept of Agro-sciences – Univ. of Seville, Spain; Dept. of Genetics - Univ. of Cordoba, Spain
Unit of Animal Genomics – University of Liege, Belgium
Eye Surface Temperature as a Potential Indicator of Physical Fitness in Ranch Horses.

Results suggest that Eye Surface Temperature has potential to predict changes in Creatine Kinase Activity and, thus could be a useful indicator of physical fitness in ranch horses; although, its effectiveness has to be confirmed in future studies.

The differences in Eye Surface Temperature and Creatine Kinase Activity were positively correlated.

Universidade Estadual Paulista, Veterinary Science, São Paulo, Brazil et al.

Fast motion infrared cameras for during exercise routine

Radiometric thermal video

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**Measuring the effectiveness of ice boots**

Thermal images were taken of the 3rd metacarpal region pre-exercise, post-exercise, post-ice boot, and every 2 minutes after until the difference between the temperatures of the control leg and the treatment leg became zero.

Department of Animal Science, California Polytechnic State University, San Luis Obispo, CA

The Effect of Noseband Tightening on Horses' Behavior, Eye Temperature, and Cardiac Responses.

- Investigate relationships that noseband tightness has with oral behavior and with physiological changes that indicate a stress response, such as increases in eye temperature (measured with infrared thermography) and heart rate and decreases in heart rate variability (HRV).

- During the tightest treatment (NAUN), horse heart rate increased ($P = 0.003$), HRV decreased ($P < 0.001$), and eye temperature increased ($P = 0.011$) compared with baseline readings, indicating a physiological stress response.

- Kandoo Equine, Towrang, New South Wales, Australia; Faculty of Veterinary Science, The University of Sydney
Monitoring changes in skin temperature associated with exercise in horses on a water treadmill by use of infrared thermography.

- The findings from this study suggest that IRT is able to non-invasively detect muscle activity and associated changes in blood flow whilst horses are exercised on a water treadmill.

- IRT could potentially be used as an alternative method to assess muscle activity and temperature change in an aquatic environment where existing methods present methodological challenges.

- J Therm Biol. 2014 Oct; Nottingham Trent University, Southwell, UK
Effect of a bandage or tendon boot on skin temperature of the metacarpus at rest and after exercise in horses.

- Determine skin temperature of the metacarpus associated with the use of bandages.
- Skin temperatures under the bandage and tendon boot were significantly higher after exercise than at rest. Skin temperatures at rest were not significantly different with a bare limb, bandage, or tendon boot.
Immediate measure of how an animal is responding to a specific situation in order to evaluate management procedures and adapt them where appropriate to reduce the negative impact on animal health and welfare.

For example, clipping creates an aversive physiological response in both compliant and non-compliant animals.

Ref. Physiol Behav. 2013 Jun 13; Nottingham Trent University, School of Animal, Rural and Environmental Sciences, Nottinghamshire, UK

To determine the amount of time required for surface temperatures of thoracic and pelvic limbs in horses to return to pre-exercise temperatures after high-speed treadmill exercise, as detected via infrared thermographic imaging.

In all regions, significant differences in surface temperatures were detected between thermograms obtained before exercise and those obtained immediately after, 5 minutes after, and 15 minutes after exercise was stopped. There were no significant differences in surface temperatures between thermograms obtained before exercise and those obtained ≥ 45 minutes after exercise was stopped.

Ref. J Am Vet Med Assoc. 2006; Dec 15;229(12): Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University
Non-invasive means of evaluating blood supply to an injured region.

- College of Veterinary Medicine, University of Minnesota. TA Turner
- Telethermography is a practical aid in the clinical evaluation of the equine patient. It is particularly germane to the evaluation of lameness. This modality specifically increases the accuracy of diagnosis.
- It offers a noninvasive means of evaluating the blood supply to an injured region and represents one of the only reliable noninvasive means to evaluate blood flow to the foot of the horse.
- Thermography is an excellent adjunct to clinical examination as well as being complementary to other imaging techniques such as radiology, ultrasonography, and scintigraphy.
Compare regions
Temperature differences
Chronic suspensory problem
Which Image is Most Symmetrical?
The feet
Software processing such as digital zoom or palette change, temperature marking, isotherms and related image evaluation techniques.

Lower Muscle tear on right side
Assess the spinal column readily

Look for projections either side of the mid-line
Eye and Ear Temperature Using Infrared Thermography Are Related to Rectal Temperature in Dogs at Rest or With Exercise.
Zanghi BM – Nestle Purina Research, St. Louis, MO. USA

... study demonstrates that infrared thermal imaging technology effectively measures both ear and eye temperature and enables effective monitoring of body temperature changes at rest, with exercise, and between breeds.
Numerous applications for thermal imaging studies

Infrared imaging is understood by the scientific community

Many veterinary research institutions have applied the technology successfully, not just in equine, but in general animal studies.

The efficiency and non-invasive factor make it an ideal tool to determine whether a particular treatment or therapy is going to have an effect on the physiology of the animal, and show changes thermally that are significant.

Helps to identify therapies and treatments that are sustaining with regard to the care

With difficult cases, it shows a direction to consider for the health care of the animal.

The future is bright for this tool becoming indispensable to the veterinary practitioner, trainer, therapist and owner

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