Thermal Stress Analysis for Protective Equipment

Infrared images are commonly used to evaluate thermal stress on Personal Protective Equipment (PPE). However, current methods rely on a qualitative assessment of these images and are subjective, prone to errors, and restricted to stationary human subjects or manikins. To address this, IAI has developed a prototype Thermal Image Comparison Software Tool that provides quantitative and objective thermal measurements for PPE.

Data Collection and Registration
TSAPE is a tool that allows PPEs and apparel to be analyzed objectively, accurately, and efficiently on moving subjects.

Sampling on 3D Mesh
TSAPE combines a thermal sensor with a 3D imaging sensor that estimate movement, determine body pose and locate body parts to map surface temperatures to a 3D model.

Comparison Between Garments
Commercial applications include design of outdoor apparel, clothing insulation, and sportswear. It can also be useful in physiology research for bioheat transfer modeling and medical thermal imaging applications.
Warfighter Value

Body-Centric
TSAPE maps temperature measurements of different clothing to a common body reference model.

Realistic Testing
TSAPE allows garments to be compared in realistic usage conditions with body movement.

Objective Evaluation
TSAPE provides quantitative evaluation and comparison of protective clothing.

Specifications

Max Range----------------------------------------8 m
Thermal Camera Resolution----640x512 pixel
Thermal Sensitivity (NEDT)------------------< 50 mK
Data Sampling Rate------------------------30 Hz
Sampling Resolution-----------------------1 inch²
Temperature Accuracy (Black Body)---0.3° C

Features

Thermal and 3D Sensors
TSAPE integrates a thermal camera and a depth sensor to collect temperature data and 3D data.

Sensors Registration
TSAPE’s thermal and 3D sensors are calibrated and synchronized to align data.

Human Mesh Mapping
TSAPE determines the body pose and maps thermal measurements to a 3D human mesh model.

Moving Subjects
TSAPE collects thermal measurements from moving subjects, and tracks and aggregates the measurements over time.

Comparison of Garments
TSAPE provides thermal stress analysis for protective garments as they move.

Analysis and Visualization
TSAPE analyzes the data on multiple body regions and landmarks, and provides a visualization of thermal data on a 3D human model.

Reporting
TSAPE automatically generates evaluation and comparison results, including recordings of temperature change during movement.