NUSTL
NATIONAL URBAN SECURITY TECHNOLOGY LABORATORY

SAVER TechNote

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THERMAL IMAGING SYSTEMS FOR FEBRILE TEMPERATURE SCREENING

First responders use infrared thermal detection technologies for a variety of applications, including search and rescue, structural navigation, hostage negotiation, scenarios with barricaded individuals, and enhanced visibility in poor operational conditions [1] [2]. *Such thermal imaging systems are also reasonably accurate (less than ±0.9 °F) for detecting fever among human subjects* [3]. *Therefore, first responders may be able to employ these systems as part of a larger solution for conducting point-of-entry health screenings to protect the safety and health of a workforce and the general public. This technology falls under AEL number 09ME-03-THER, titled "Thermometer."*

Overview

At the onset of the COVID-19 pandemic, the need emerged for safe screening methods to identify individuals infected by the virus in order to protect public health. Studies have shown that some thermal imaging systems are capable of detecting febrile states among human subjects. This capability enables first responders to use a piece of technology that they may already own, albeit for a different application, and provides a contactless method of screening individuals with elevated body temperatures. The Centers for Disease Control and Prevention (CDC) has stated that a temperature of 100.4 degrees Fahrenheit can be used as the threshold for determining fever in most work settings [4].

Figure 1. Temperature screening system with a thermal imaging device
Image credit: PongMoji/Shutterstock.com

Thermal Imaging Technology

Infrared waves are emitted from any object at a temperature above absolute zero (-273 °F or 0 Kelvin) [5]. Thermal imaging cameras measure and focus the infrared radiative heat emitting from objects onto a thermal detector array [1]. The measured infrared radiative heat is transformed into electronic signals that are converted to images by assigning a color to each infrared energy level. This allows heat to be "seen." This technology allows operators to detect and pinpoint large temperature gradients at a scene, and take temperature measurements of specific locations without making contact with an object or subject.

In temperature dynamic environments, use of a blackbody reference can increase confidence in a device's temperature measurements and images. A blackbody reference is an accessory that maintains a steady temperature and uniform infrared emissions, serving as a constant, reliable temperature reference within the frame of the infrared imager.

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) program to inform emergency responder equipment selection and procurement decisions.

Located within the Science and Technology Directorate, the National Urban Security Technology Laboratory (NUSTL) manages the SAVER program and works with emergency responders to conduct objective operational assessments of commercially available equipment.

SAVER knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: "What equipment is available?" and "How does it perform?"

To explore the full library, visit SAVER online at www.dhs.gov/science-and-technology/saver-documents-library.

For additional information on the SAVER program, email NUSTL at NUSTL@hq.dhs.gov.

Science and Technology

Screening Applications

There are several specifications and functions that are necessary to understand in order to successfully screen individuals for fevers using a thermal imaging system: thermal sensitivity, accuracy, stability, and resolution.

Thermal sensitivity (also known as "noise-equivalent temperature difference" or NETD) is the smallest temperature difference that a thermal imager can resolve. It is often measured in millikelvins.

Accuracy is the absolute measurement error between the known temperature of a target and the reported temperature from the device. This specification is often reported in +/- degrees or +/- percentages.

Stability speaks to a thermal imager's ability to provide consistent, accurate measurements in the face of changing environmental conditions, both internal to the camera and external in the scene under interrogation. This specification is often measured as temperature over a given time period.

Resolution describes the image quality. Higher resolution cameras will not only produce sharper images but also provide more reliable and precise measurements of smaller targets from farther distances.

Operational Considerations

When employing a thermal imager for febrile temperature screening, consider:

- What part of the body should the thermal imager take its temperature reading?
- Is a blackbody reference required?
- What is the anticipated throughput of individuals that the screening setup must accommodate for a given location?
- What is the ideal standoff distance between an individual and the thermal imager?

The answer to these questions will depend on the technical specifications of the device being used, the operational environment, and other constraints dictated by the mission.

Some measurement practices can help ensure screening accuracy. When taking readings of an individual's face, studies have shown the inside corner of the eye provides an accurate estimate of core body temperature. If the operating environment is prone to large or rapid temperature changes, using a blackbody reference can increase accuracy by providing a reference point for measuring body temperature.

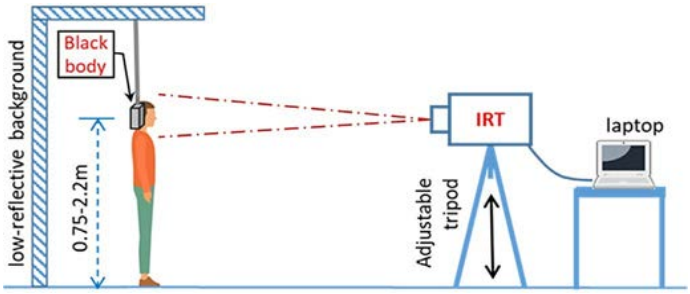

Figure 2. Possible setup of temperature screening system with a thermal imaging device/Infrared Thermograph (IRT)
Image credit: U.S. Food & Drug Administration

Applicable Standards

Compliance with standard IEC 80601-2-59 is a desirable characteristic when procuring this type of equipment, as it lays forth basic safety and essential performance requirements for febrile temperature screening devices. The operational guidelines for identifying febrile humans (standard ISO/TR 13154) may also be useful when selecting or deploying a thermal imaging febrile temperature screening device.

References

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[2] New York Police Department, "Thermographic Cameras: Impact and Use Policy," New York Police Department, New York, NY, 2021.

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[4] Center for Disease Containment and Prevention, "Covid-19: General Business Frequently Asked Questions," 24 May 2021. [Online]. Available: https://www.cdc.gov/coronavirus/2019-ncov/community/general-business-faq.html.

[5] M. F. Modest, Radiative Heat Transfer, Waltham, MA: Academic Press, 2013.