Thermal Imagers Use for Detecting Elevated Temperatures in Humans

Content Provided By:
Brad Harvey | Senior Application Engineer - Fire Service & SCBA
3M Personal Safety Division

Introduction

In light of the current COVID-19 epidemic, numerous fire departments have inquired about the potential to use their thermal imager for detecting elevated temperatures in people, possibly indicating a fever. The short answer to this is “no”, which I will explain, but it also brings up another question: why?

Thermal imagers commonly in use by firefighters specifically designed for the tasks associated with firefighting and, as such, span a broad range of temperatures,

Qualitative vs. Quantitative

Most thermal imagers provide the user with both qualitative and quantitative information. Qualitative information is descriptive or conceptual. It is more likely to be based on traits and characteristics. Quantitative information is specific. It can be counted, measured, and expressed using numbers.

It is easiest to think of in these terms:

- Qualitative is exploratory. Like the information gathered during a three-sixty on initial sizeup. It is evaluative.
- Quantitative is conclusive. Like the number of victims trapped or the number of bedrooms. It is decisive.

In thermal imaging, qualitative is comparative. It is observing an object in its entirety. Qualitative is the overall visual image and is great at discerning differences. Qualitative is image interpretation, the identification of heat patterns, and knowing that one part of an object is warmer than another part, and in this regard, accuracy isn’t all that important.

Quantitative is temperature measurement. If you thermal imager is equipped with the ability to report a temperature, and most fire thermal imagers are, then a certain number of pixels have specifically calibrated to provide a quantitative output (the numbers on the display). Quantitative pixels are referred to as radiometric.

Radiometry

Thermal radiometry is a collection of techniques designed to measure electromagnetic radiation, specifically within the long wavelength infrared (LWIR) spectrum as this is the part of the electromagnetic spectrum most commonly associated with heat transfer.

Commonly referred to as “temperature measurement” radiometric pixels are essentially reading the intensity of thermal radiation that an object is emitting. Although this measurement is being reported as a “temperature”, it is actually a measurement of “how much energy” an object is giving off and, although these two concepts are related to each other, they are not the same thing and not interchangeable.

There are several things that contribute to the accuracy or inaccuracy of reported temperature.

Surface Measurement Only

The first obstacle is that a thermal imager is a passive device and can only measure that energy being radiated from a surface. Since the surface an object is where most heat transfer occurs, the surface of an object could be warmer or cooler than the object itself.

Emissivity

Emissivity is how efficiently an object radiates heat and defined as the ratio of infrared energy emitted by the object, compared to that emitted by an ideal blackbody, if both are at the same temperature. An ideal blackbody is considered a perfect emitter in that its surface is accurately represents the temperature of the object and is used in laboratory settings for calibration of thermal imagers.

An objects emissivity is expressed as a decimal value between 0.0 and 1.0, where low emissivity objects tend to me reflective-type materials and high emissivity objects are more likely to be organic in nature. An object's emissivity is also highly dependent on surface composition, so whether a surface is rough or smooth, rusty or clean, new or used, can all lead to a slightly different emissivity.

Emissivity must be known in order to interpret as a temperature. As stated before, where radiometry measures how much energy is being given off, emissivity tells the thermal imager what the source material is. Given these two points of reference, a temperature can then be quantified.

Fire thermal imagers typically used a fixed emissivity that is chosen by each manufacturer. That emissivity is typically at the higher end the of scale, in the 0.93-0.95 range which corresponds to materials such as wood, concrete, or heavily rusted iron.

Distance-to-spot

Target size and distance are also important considerations. Only a certain number of pixels on a firefighting thermal imager are calibrated to be quantitative. While the number of pixels utilizes varies by manufacturer, these pixels are indicated by the crosshairs or box at the center of the thermal imager display. All of the measurements within this zone are then averaged together to report one temperature.

The optics in a thermal imager create a circular area of measurement that enlarges with distance, measuring an ever-larger area. The ratio of how large the measurement area is to the distance from the target is referred to as the Distance to Spot (D:S) ratio. The larger the ratio number, the smaller the spot being measured.

Detecting Elevated Skin Temperature

There are thermal imaging systems on the market that are designed specifically for the purpose of detecting elevated skin temperature and with the current pandemic, interest in these systems is high and may contribute to the increase in question from firefighters regarding using fire thermal imagers, so let's look at some of the differences.

These systems are not intended to as a one-off assessment tool; rather, they are designed for use in high-traffic public locations to screen a large number of people in a short period of time, identifying those individuals who exhibit temperatures above the user-determined threshold. The intent of these systems is to narrow the focus of more in-depth evaluation and, more importantly, are only a part of an overall screening system, supplemented more diagnostic devices such as temporal thermometers.

These systems also have a certain rate of false negatives and false positives associated with them. Efforts can be taken to minimize the risk, but it cannot be eliminated. As an example, a person's skin temperature is different than core body temperature and has implications for the threshold temperature target. If you want to eliminate the risk of missing someone who might be sick, you would lower the temperature threshold; however, this would have the effect of increasing false positives.

Treat the Patient

The problem of mass screening is not what the fire service is typically dealing with. In most of these situations, someone has already indicated they are sick by dialing 9-1-1, so the screening portion is essentially complete, and the next step would be more conventional body temperature measurement. When dealing with an individual patient, there is no need to screen anything. When dealing with an individual patient, what difference does the temperature make? It is a data point, but you are going to treat the patient and not the measuring device. Like any other vital sign, patient temperature is simply one piece of the data puzzle and, in the case of COVID-19, not a terribly important piece as presence of a fever does not necessarily mean COVID-19, but the absence of a fever doesn't necessarily indicate that it is not COVID-19. Treat the patient.