Thermal Temperature Monitoring

Accurate, Safe, and Effective Measurement

Dahua Technology USA Inc.

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Introduction

The COVID-19 pandemic has affected millions of people around the globe, bucking social norms, workplace rules, and basic everyday life. Healthcare workers find themselves at war: they no longer just go to work; they are now on the "front lines," engaged in battles with an invisible foe. The pandemic brought unprecedented challenges and decisions that require nimble and unique solutions. One such solution employs thermal camera technology for continuous and non-invasive measurement of external skin temperature, without personal contact.

Disclaimer

The Dahua Thermal Temperature Monitoring Solution is not FDA-cleared or approved. The Solution should not be solely or primarily used to diagnose or exclude a diagnosis of COVID-19 or any other disease. Elevated akin temperature in the context of use should be confirmed with secondary evaluation methods (e.g., an NCIT or clinical grade contact thermometer). Public health officials, through their experience with the Solution in the particular environment of use, should determine the significance of any fever or elevated temperature based on the skin telethermographic temperature measurement. The Solution should be used to measure only one subject's temperature at a time. Visible thermal patterns are only intended for locating the points from which to extract the thermal measurement.

The Dahua solution, when properly installed and configured displays the highest temperature measured from an individual's face. This temperature may include the temperature of the region adjacent to the Medial canthus of the eye, the part of the eye that includes the tear duct. This solution can measure this part of the eye if: A) the application scenario is conducive to allow the camera to capture this part of the eye and B) the eye is not obscured by glasses, a mask, or other obstruction. A temperature measurement from the region adjacent to the Medial canthus more closely correlates to an individual's internal body temperature than a temperature measured from an individual's skin.

Users, through their experience with the solution or the station in the particular environment of use, should determine the significance of any fever or elevated temperature based on the external skin telethermographic temperature measurement. Visible thermal patterns are only intended for locating the points from which to extract the thermal measurement. No matter where the thermal camera measures an individual's temperature, keep in mind that certain individuals with elevated skin temperature (EST) may have an elevated body temperature (EBT). In turn, certain individuals with EBT may have a fever, and a subset may have contracted the COVID-19 virus.

Thermal Temperature Monitoring

This document describes and compares technologies currently popular for temperature-measuring devices. The two main methods are Thermal Imaging and Thermopile. In its most basic operation, both technologies convert heat energy (infrared radiation) to electrical impulses, which is further converted to a temperature value. Thermal imaging devices also display heat energy as a series of colors that depict the intensity of the heat signature. Comprehensive thermal temperature monitoring solutions vary in price and accuracy, and may include a blackbody calibration device that maintains a customizable constant temperature as a reference point for the thermal camera. In addition, a network video recorder (NVR) may be included to provide storage for video and temperature data as well as face detection technology. Dahua offers several thermal imaging temperature monitoring solutions that accommodate varied applications and budgets.

Thermal Basics

The human eye can see in a narrow wavelength of electromagnetic radiation, called the visible spectrum. The human eye is sensitive to electromagnetic wavelengths ranging from approximately 0.4 μm (violet) to 0.7 μm (red). The infrared spectrum ranges from 0.76 μm to 1000 μm or 1.0 mm, thus invisible to human eyes.

Modern thermal imaging devices operate in either the medium-wave infrared region (2.0 μm to 4.0 μm) or in a section of the long-wave infrared region (8.0 μm to 12.0 μm). By detecting infrared radiation from an object, the thermal imager produces a real-time image, reproducing a thermal image of the scene. In effect, it transforms invisible radiation images into visible, clear images of the human eye. The thermal imager is very sensitive and can detect temperature differences less than 0.1° C.

Thermal Imaging Technology

Thermal imaging, or more commonly known as a thermal camera, uses a Vanadium Oxide (VOx) imager, essentially a heat sensor, to detect small differences in temperature. Most thermal cameras measure temperature to an accuracy within 1.8° F (1.0° C) of actual, adequate for industrial or typical surveillance applications, but monitoring skin temperature requires a higher level of accuracy. These cameras collect the infrared radiation from objects in the scene and create an electronic image based on information about the temperature differences.

A special lens focuses the infrared light emitted by all of the objects in view, and in turn, is scanned by a phased array of infrared-detector elements. The detector elements create a detailed temperature pattern called a thermogram in about one-thirtieth of a second. The camera obtains this information from several thousand points in the field of view of the detector array.

A circuit board with a dedicated chip then translates the thermogram into electronic impulses, and sends the impulses to a signal-processing unit. The signal-processing unit sends the information to the display, where it appears as various colors, each color based on the intensity of the infrared emission. The combination of all the impulses from all of the elements creates the image.

While all thermal imaging cameras contain an infrared sensor to detect infrared wavelengths, many also incorporate a visible-light CMOS sensor that creates a normal color image to superimpose over the infrared image, providing more context and detail to the infrared image.

Blackbody Technology – Improving Accuracy

A blackbody is a physical body that absorbs all incident electromagnetic radiation, regardless of frequency or angle of incidence. It not only absorbs radiation, but can also *emit* radiation. The name "blackbody" refers to the function of the device to absorb radiation in all frequencies, not just specific ones.

Because of these characteristics, a blackbody device is a desirable calibration source for thermal imaging based temperature measurement systems. The blackbody functions as a calibration tool, and becomes a target object with a precisely known and controlled temperature. This precision is the basis for accurate calibration of infrared pyrometers, increasing the accuracy of thermal imaging equipment. A blackbody at a constant temperature emits electromagnetic radiation called blackbody radiation. This constant temperature is important in external skin temperature measurement where accuracy to ± 0.54° F (0.3° C) is advised by many international standards organizations.

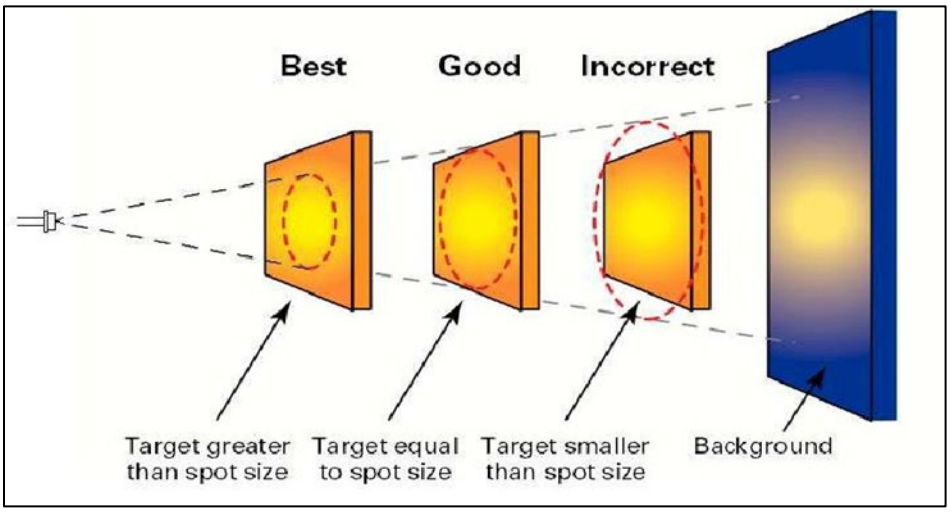
Thermopile Technology

A thermopile is an electronic device that converts thermal energy into electrical energy. It is composed of several thermocouples, usually connected in series (less commonly in parallel). Thermopiles are most commonly used in digital infrared thermometers.

Thermocouples are simple sensors that output a voltage directly proportional to the temperature measured, and adding more thermocouple pairs in series increases the magnitude of the voltage output. A thermopile is a series of interconnected thermocouples arrays, consisting of two dissimilar materials with a large thermo-electric power and opposite polarities.

Field of View

The distance that a thermopile can accurately measure a subject temperature depends on the field of view and the sensor sensitivity. All thermopile sensors have an optimum spot area, and the distance between the thermopile and the target determines this size. A thermopile produces the most accurate results when the target area is greater than the spot size. As the distance increases, the accuracy decreases until the target area exceeds the spot area. Once exceeded, the thermopile reading is not considered accurate.



Thermal Imaging and Skin Temperature Measurement

Deploying a thermal imaging system for skin temperature measurement poses several challenges: Consider the following issues when purchasing a thermal camera system for skin temperature measurement, especially the accuracy of the system and the calibration process.

Thermal Drift Compensation

Even a calibrated thermal camera with thermometry (temperature measurement function) experiences temperature drift when the environment temperature changes. Unless the measurement location is of a constant temperature, and the thermal camera is calibrated to that environment, the system cannot be expected to produce temperature measurements at the published specification.

Temperature Accuracy

Most thermometry-capable cameras are accurate to ± 1.0° F that is less than desirable for many user-defined skin temperature detection thresholds. It is because of these characteristics that the blackbody device is preferred within a skin temperature measurement application. Many blackbody devices are designed for use with thermometry-capable cameras deployed in industrial applications, and measure extremely high or low temperatures. These applications typically do not require the accuracy range suitable for skin temperature measurement. Skin temperature measurement requires a higher-end blackbody device to deliver an accuracy range suitable for fever detection.

The chart below show tests performed comparing several temperature measurement devices. The test was performed in a controlled environment during a four-hour test span over typical indoor temperature ranges. From the chart, you can see where the thermal camera with blackbody closely matches the oral thermometer readings from ambient temperatures ranging from 66.0° F to 81.0° F (18.9° C to 27.2° C). The chart also shows the wide discrepancy between the temporal thermometer (using thermopile technology) and the oral thermometer. The thermal camera measurements without blackbody shows a distinct trend of increased temperature readings with increasing ambient temperature. Without the blackbody device, the thermal camera-only solution is accurate only for use at a narrow ambient temperature range, at which it was calibrated.

°F	°C	Thermal Camera Only	Thermal Camera + Blackbody	Oral Thermometer	Temporal (Forehead) Thermometer	Laser Thermometer (Aimed at Chin)	Ambient Temperature from Meter
66	19	98.9° F	98.0° F	97.8° F	96.6° F	93.4° F	66.6° F
68	20	99.1° F	98.6° F	99.0° F	98.5° F	99.1° F	67.6° F
71	22	99.1° F	98.1° F	98.0° F	97.9° F	98.0° F	69.4° F
72	22	99.2° F	97.9° F	97.4° F	98.3° F	95.8° F	70.0° F
74	23	101.5° F	98.5° F	98.6° F	97.3° F	97.3° F	74.3° F
75	24	100.9° F	98.4° F	98.4° F	97.6° F	97.3° F	75.2° F
77	25	101.2° F	98.4° F	98.6° F	98.1° F	96.2° F	76.8° F
79	26	100.7° F	98.4° F	98.1° F	98.3° F	95.8° F	78.3° F
81	27	101.4° F	98.5° F	98.5° F	98.1° F	96.6° F	80.2° F

It is important to consider that the temporal and laser thermometers require contact or close proximity to obtain measurements. An oral thermometer may be considered invasive and presents great risk of cross-contamination, and can be time-consuming to use. In addition, these methods measure one person at a time, and require a few seconds, at a minimum, to record a temperature. Keep these requirements and limitations in mind when selecting a temperature monitoring system, especially if your needs require accurately monitoring multiple people at one time.

Human Temperature

Human bodies register different temperatures depending on several factors. In North America, we take it for granted that 98.6° F (37.0° C) is normal body temperature. Technically, 98.6° F (37.0° C) is the mean average temperature taken with a calibrated oral thermometer. Generally, the correlation of temperature between methods are as follows[2]:

- The average normal oral temperature is 98.6° F (37.0° C).
- A rectal temperature is 0.5° F to 1.0° F (0.3° C to 0.6° C) higher than an oral temperature.
- An ear (tympanic) temperature is 0.5° F to 1.0° F (0.3° C to 0.6° C) higher than an oral temperature.
- An armpit (axillary) temperature is usually 0.5° F to 1.0° F (0.3° C to 0.6° C) lower than an oral temperature.
- A forehead (temporal) scanner is usually 0.5° F to 1.0° F (0.3° C to 0.6° C) lower than an oral temperature.

Note that the ASTM standard[3] for allowable errors of clinical thermometers is:

- 0.18° F (0.1° C) in the temperature range of 98.6° F to 102.2° F (37.0° C to 39.0° C)
- 0.36° F (0.2 °C) in the temperature range of 96.8° F to 98.6° F (36.0° C to 37.0° C) and 102.2° F to 105.8° F (39.0° C to 41.0 °C).
- The allowable error of clinical thermometers was within a band of ±0.54° F (±0.3° C) in the range below 98.6° F (36° C).

Since these systems read the skin temperature, it likely will be less than the measured oral temperature of the individual. Consider this as you set the temperature threshold for alarm conditions.

What to Set the Detection Temperature to?

This number is user-configurable and users can use these guidelines to set the detection temperature. According to the CDC[4], the definition of a fever is a temperature of 100.4° F (38.0° C) or higher[3]. It is recommended that you consult a qualified medical professional for guidance on what temperature threshold is appropriate for a particular application. Confirm elevated skin temperature in the context of use with secondary evaluation methods (e.g., an NCIT or clinical grade contact thermometer). Public health officials, through their experience with the Solution in the particular environment of use, should determine the significance of any fever or elevated temperature based on the telethermographic skin temperature measurement.

Face Detection NVR

A recommended component for the solution is an NVR with face detection capability. Dahua NVR's with face detection can detect a face in a digital image using any ONVIF camera stream, in addition to Dahua Face Detection cameras. Additionally, the face detection process can be applied to the visible image sensor stream of the hybrid thermal camera.

Face Detection and Accuracy

A core requirement of any thermal system is to deliver accurate measurements. One way to increase accuracy and efficiency is to use face detection as a filter, allowing only temperature measurement of detected faces and nothing else. This capability helps minimize measurement of non-human heat sources, like a cup of coffee. It also allows for measurement even when a mask or glasses cover a face partially.

Thermal Imaging vs. Thermopile Technology

The two technologies may perform a similar task, converting the intensity of radiated heat to a temperature reading, but the accuracy of those readings can be quite different. Thermal imaging technology is considered more accurate by industry standards due to several reasons, as summarized in the table below.

	Thermal Imaging	Thermopile
Measuring Distance	0.98 ft to 5.91 ft (0.30 m to 1.80 m)	< 1.64 ft (< 0.50 m)
Measurement Angle	Approximately 50°	< 30°
Speed	0.2 seconds	> 1 second
Temperature Accuracy	±0.54° F (±0.3° C) With blackbody device	±0.9° F (±0.5° C)
Resolution (Pixel Density)	120 x 90 or higher	32 x 32

As you can see, a thermal imaging device offers faster, more accurate temperature reading from a greater distance than from a thermopile device. In terms of reading human skin temperatures, thermal imaging devices with face detection can more accurately determine the hottest part of the face, ignoring hot objects within the camera view. Thermal imaging is also less susceptible to ambient temperature fluctuations, especially if the solution includes a blackbody. Thermopiles use the highest temperature within the field of view and is susceptible to false positives caused by hand-held hot drinks or changes in ambient temperature due to air conditioning or wind. Typically, thermal imaging devices are more sensitive to temperature differentials and can compensate for ambient temperature change, distance, and other factors to improve the accuracy of temperature measurement.

Sensor Resolution

The resolution (or pixel density) of a thermal sensor affects the range and angle of temperature measurement, face detection, and ultimately the accuracy of the temperature reading. The resolution of a thermopile sensor is generally less than 32 x 32 pixels and, because of this small area, the subject's face must appear in a pre-defined area for the thermopile to measure the temperature. This restriction can cause issues if a subject is taller than 5.75 ft (1.75 m) since the thermopile device may not read the temperature of the subjects face. Face detection is not possible, only the highest temperature in the area in view is tested and is susceptible to outside factors.

Thermal imaging devices have a much higher resolution, typically120 x 90 pixels or more, allowing for higher resolution and a larger recognition angle as compared to a thermopile. Thermal imaging devices also offer face detection, a feature that allows the thermal imaging device to locate subject's head in the image, increasing the temperature measurement area.

Deployment Layout Planning

Planning the layout of the system prior to deployment is important. First, identify the expected outside temperature versus the temperature inside. If the outside temperature is different than indoors, then that affects ideal location of where the camera should be located (in relation to the entrance) and will affect the accuracy of measurements. This is because the thermal system measures external skin temperature: if the outside temperature is 60.0° F (15.5° C) and the interior ambient temperature is 70.0° F (21.1° C), then external skin temperatures will read lower than actual.

Mitigation Techniques with Large Temperature Differentials

In that case, you need to delay visitors before they reach the thermal measurement area. One way is to create a diversion channel shown in the figure below. Visitors will queue up similar to an airport security checkpoint, where their wait time will be long enough for external skin temperatures to regulate after their exposure to the outside temperature. Length of the wait time should depend on the temperature differential and must be tested comparing temperature measurements between the thermal system and use of a clinical-grade thermometer.

Minimizing Environmental Effects

Avoid positioning the camera within view of any bright light sources, including glass doors or windows that show the outside. In addition, avoid having any heat sources in view of the camera, like heating vents, coffee makers and the like. The thermal camera does require initial setup where you define the target measurement area, in which case you may be able to draw the area to exclude such sources.

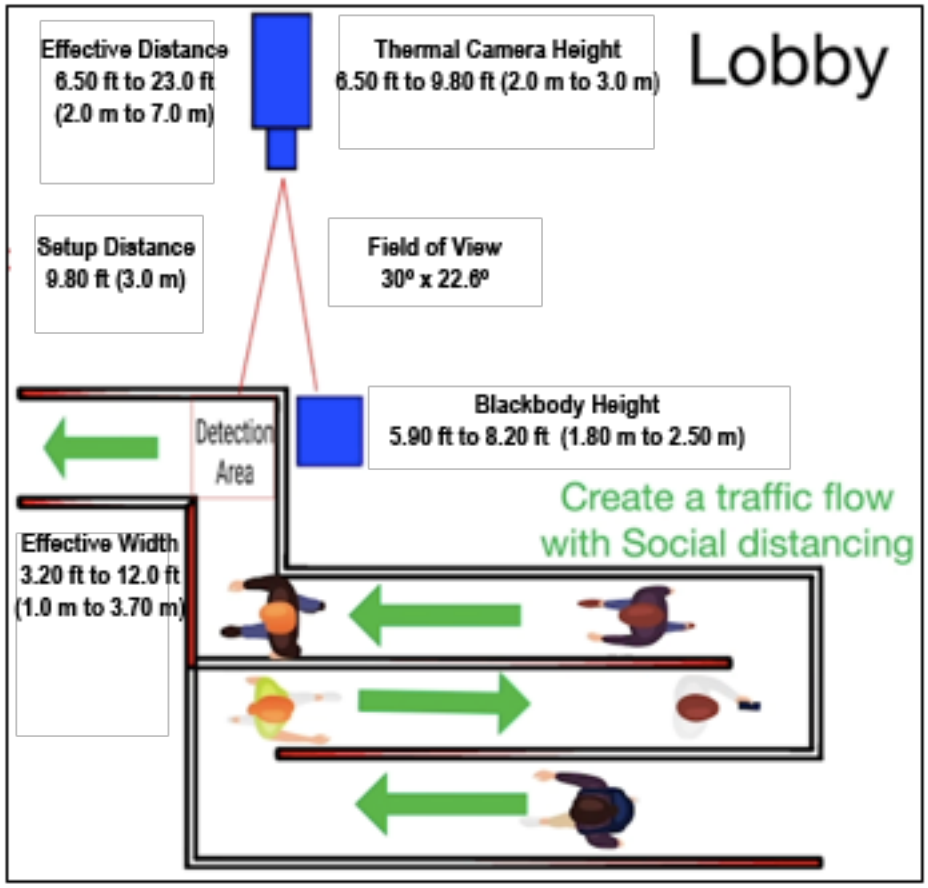


Figure 1: Illustration showing optimal placement of components

- Set multiple lanes when designing the traffic flow pattern. The forehead temperature measurement is more accurate the longer a person is indoors.
- Measure the temperature away from the ventilation at the door.

Calibration

The Dahua Thermal Temperature Monitoring Solution and Station has a feature in the web UI for ambient temperature setting. Use a third-party thermometer to detect the actual ambient temperature on site and input that number if it is different from the default value. If the readings are still incorrect, adjust the "Human Temperature correction" value in the camera's Web User Interface, detailed in the setup instructions.

The blackbody module requires twenty minutes of pre-heating before operation or configuration. The target temperature is displayed on the rear of the unit. The proper working temperature of the blackbody device is 95° F (35 ℃). If the temperature is not 95° F (35 ℃), manually adjust it to 95° F (35 ℃).

General Applications for Thermal Measurement

Due to the precise visibility enabled by detecting heat, industries have used thermal cameras for decades, predominantly by law enforcement and the military. In the wake of the 2020 coronavirus pandemic, the technology saw an uptick in demand as a way to detect people with an elevated temperature in a fast, effective, and safe (contact-free) way. Dahua designed its Thermal Temperature Monitoring Solution for rapid and temporary deployments for a variety of verticals such as hospitals, medical centers, education, industrial business, warehouses, casinos, hospitality, and banking.

Featuring high accuracy, high efficiency, strong adaptability and easy deployment, the Thermal Temperature Monitoring Solution offers preliminary and rapid screening. Confirm elevated skin temperature in the context of use with secondary evaluation methods (e.g., an NCIT or clinical grade contact thermometer). Public health officials, through their experience with the Solution in the particular environment of use, should determine the significance of any fever or elevated temperature based on the telethermographic skin temperature measurement.

For example, Wynn Resorts used thermal cameras to detect temperatures of guests. Many airports had passengers undergo thermal screening prior to boarding the aircraft and after arrival. Retailers such as Walmart took the temperatures of associates when they first reported to work, and the Atlanta Journal reported a local grocery chain requiring customer temperature checks.

Hospitals

In times of pandemic, many hospitals implement manual temperature checks at entrances; however, this puts staff at unnecessary risk of exposure. With administrators and staff already overwhelmed from high patient intake, many have deployed an automated thermal temperature measuring solution.

Hospital Entrance / ER Entrance

Hospitals pose many security challenges due to 24/7 public access, high-tension work environments, various entry/exit points, and narcotics storage. It is important to deploy video surveillance at all entry points to ensure not only visibility as to who is coming and going, but to deter crime. Due to possible glare from the constantly opening and closing doors, and sun reflection from nearby windows, a camera with Wide Dynamic Range (WDR) is recommended. Dahua's Thermal Temperature Monitoring Solution offers a visible lens with WDR for surveillance and a thermal lens for detecting a person's temperature. By combining thermal imaging with analytics, healthcare facilities can program the system to notify staff automatically if it detects a person within a defined temperature range.

An often-overlooked advantage of hybrid thermal cameras is that they can provide surveillance and thermal detection without compromising a person's identity. This not only respects patient privacy, but also complies with HIPAA regulations. Additionally, a privacy mask can be used on the thermal image so that just the temperature is visible.

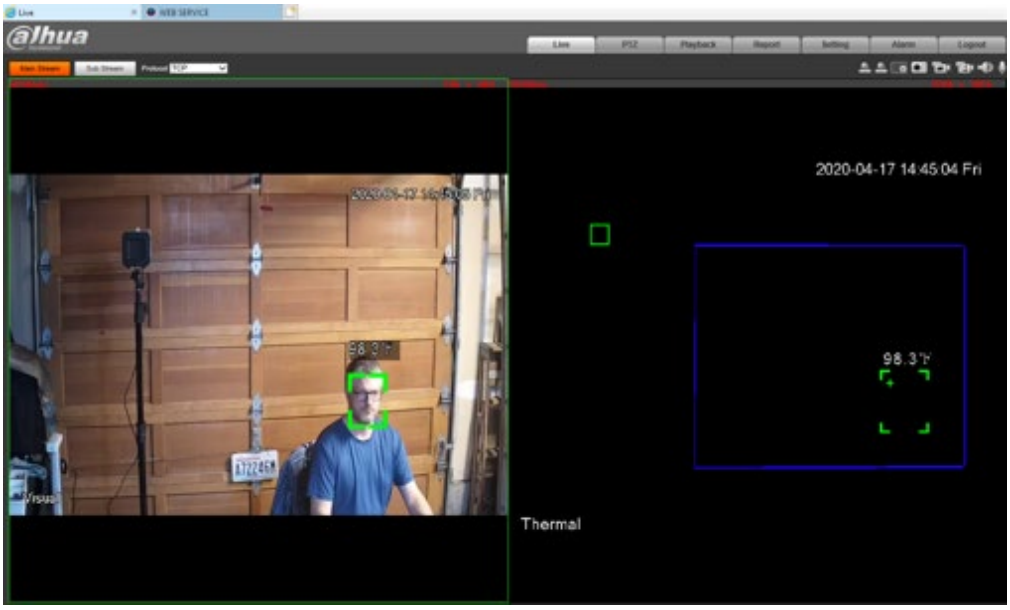


Figure 2 Left side represents the visual lens of the hybrid thermal camera with the temperature reading and the right side represents the thermal lens with a privacy protection mask.

Workplaces

On March 17, 2020, the U.S. Equal Employment Opportunity Commission (EEOC) issued an update to its guidance indicating that employers may implement temperature-screening measures in response to the COVID-19 pandemic. The EEOC noted, "Because the CDC [Centers for Disease Control and Prevention] and state/local health authorities have acknowledged community spread of COVID-19 and issued attendant precautions, employers may measure employees' temperature."

Figure 3 Thermal imaging in use at the entrance to a hospital in Spain.
Photo Credit: David Benito/Getty Images

Warehouses

Many warehousing and logistic centers are considered essential businesses, with employees continuing to work during stay-at-home initiatives. The temperature monitoring solution can provide a time-efficient way to scan for potential elevated temperatures without personal contact. This type of solution is ideal for deploying at employee entrances to mitigate risk of a potential sick worker from entering the building. The solution can also be deployed throughout the facility in the event that someone develops a fever during the workday.

Education

Schools have a high population density, with a large number of students and teachers. The Dahua Thermal Temperature Monitoring Solution can provide a time-efficient way to scan for potential elevated temperatures without personal contact. With schools closed during a pandemic and the curriculum disrupted, having a temperature measurement solution in place lets elementary schools, colleges and universities alleviate anxieties once they reopen.

The technology effectively limits close contact and contributes to combating the virus by lowering the risk of cross-infection caused by contact. It also saves work force and material resources, while guaranteeing efficient and discreet preliminary screening of all staff, students, and visitors.

Retail

Retailers can utilize the thermal temperature monitoring solution by deploying it at store entrances to alert staff if customer or employee temperature readings exceed the user-defined threshold. As a result, retailers can limit access to the store to only individuals who are below the threshold.

Banking

A number of commercial banks have taken the precautionary measure of installing thermal devices to check the temperatures of not only employees but customers too.

Although many businesses post signs restricting entry to high-risk individuals, signage alone is often an insufficient deterrent. The thermal temperature monitoring solution provides a means to enhance enforcement of entrance policies.

Casinos and Restaurants

The gaming and hospitality industry will also benefit from the deployment of thermal temperature monitoring devices at entrances and throughout the facility. For a person with an elevated temperature, a visual alert is sent so that security personnel has a visual image of the person's identity and can re-check their temperature. For smaller restaurants, the Thermal Station would be more cost-effective.

Figure 4: Sample alert of a person with an elevated skin temperature

Dahua Thermal Temperature Monitoring Solutions

Dahua offers two temperature-monitoring solutions: the Thermal Temperature Monitoring Solution and the Thermal Temperature Station. Both solutions incorporate thermal imaging devices for a contactless, accurate temperature reading.

Click here to navigate to the Dahua Thermal Temperature Monitoring Solution Web page or click the links below for detailed information about each component.

Thermal Temperature Monitoring Solution

The Dahua Thermal Temperature Monitoring Solution offers the latest hybrid thermal network camera that combines a Vanadium Oxide (VOx) sensor with a 2 MP visible-light sensor. The solution also provides a blackbody calibration device that maintains a customizable constant temperature as a reference point for the thermal camera. The thermal camera coupled with the blackbody calibration device and a feature-rich 4 TB Network Video Recorder delivers a contactless solution for continuous and non-invasive comparison of human skin temperature compared to the blackbody device. Thermal Temperature Monitoring technology enables quick detection of elevated skin temperatures compared to the customizable blackbody calibration device. Thermal imaging equipment is easily installed and implemented, and detects elevated skin temperature in most indoor environments such as airports, hospitals, clinics, office buildings, cruise ships, and any large public gathering location. This high-performance solution measures temperatures with an accuracy of ±0.54° F (±0.3° C).

Required Components (sold separately)

- DH-TPC-BF5421-T or DH-TPC-BF3221-T Thermal Hybrid Network Camera
- JQ-D70Z Blackbody
- DHI-NVR5216-16P-I 16-channel NVR

Recommended Accessories (sold separately)

- VCT-999 Tripod (x2)
- RQW026-00 Mounting Bracket for camera and blackbody (x2)
- DHL43-F600 Full HD Monitor

SafetyTemp Thermal Temperature Station

The Dahua Thermal Temperature Station offers a compact, economical and easily deployed solution for monitoring human skin temperature. Install and implement the station to detect elevated skin temperature in indoor environments such as hospitals, clinics, office buildings, and retail locations. This solution is not compatible with the blackbody device, and provides an accuracy of ±0.9° F (±0.5° C). It can measure temperatures of people up to two per second.

Required Components

- DHI-ASI7213X-T1 SafetyTemp Thermal Monitoring Station with 7-inch Touch Screen

Recommended Accessories (sold separately)

- ASF172X-T1 4.8 ft Floor Stand
- ASF072X-T1 Desktop Stand

Optional Components

- DHI-NVR5216-16P-I 16-channel NVR with Thermal Support
- DSS Express VMS with Thermal Support

Thermal Temperature Applications by Dahua Solution

The chart below shows typical installation applications and suggests the appropriate Dahua Thermal Temperature Monitoring solution. In general, the Thermal Temperature Monitoring Solution is suitable for applications that handle larger foot traffic that needs to monitor multiple people at one time. The SafetyTemp Thermal Temperature Station is the choice for installations that expect few visitors simultaneously, allowing the station to monitor one person at a time.

Application	Thermal Temperature Monitoring Solution	SafetyTemp Thermal Temperature Station
Hospital Entrances	Yes	Yes, with smaller clinics
ER Entrances	Yes	Yes, with lower numbers of expected visitors
Warehouses	Yes	Yes, especially if you want to use Access Control
Educations	Yes	Yes, with smaller areas
Large Retail Establishments	Yes	No
Convenience Stores	No	Yes
Banks	Yes	Yes, with smaller banks
Casinos	Yes	No
Restaurants	No	Yes, with smaller restaurants
Hotels	Yes	Yes, with small-medium hotels
Office Buildings	No	Yes

Conclusion

The COVID-19 pandemic has affected the life and livelihood of millions of people, not discriminating who is infected and who can recover. Viable measurement of skin temperature is one method to help in the fight to stop the spread of the virus. The Dahua Thermal Temperature Monitoring Solution is an accurate, safe, and effective tool that once installed and implemented can detect elevated skin temperature in environments such as airports, hospitals, and clinics.

Endnotes

(1) https://en.wikipedia.org/wiki/Black_body
(2) https://wa.kaiserpermanente.org/kbase/topic.jhtml?docId=tw9223
(3) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257961/
(4) https://www.cdc.gov/coronavirus/2019-ncov/downloads/COVID-19_CAREKit_ENG.pdf

References

- https://www.natlawreview.com/article/latest-covid-19-conundrum-can-employers-institute-temperature-checks-workplaces
- https://www.modernhealthcare.com/providers/covid-19-threatens-rural-hospitals-already-stretched-breaking-point
- https://www.thestar.com.my/tech/tech-news/2020/04/18/covid-19-amazon-deploys-thermal-cameras-at-warehouses-to-scan-for-fevers-faster
- https://instrumentationtools.com/thermopile-working-principle/
- https://www.cnet.com/news/amazon-using-thermal-cameras-for-covid-19-temperature-checks/