FLIR SOLUTION SERIES

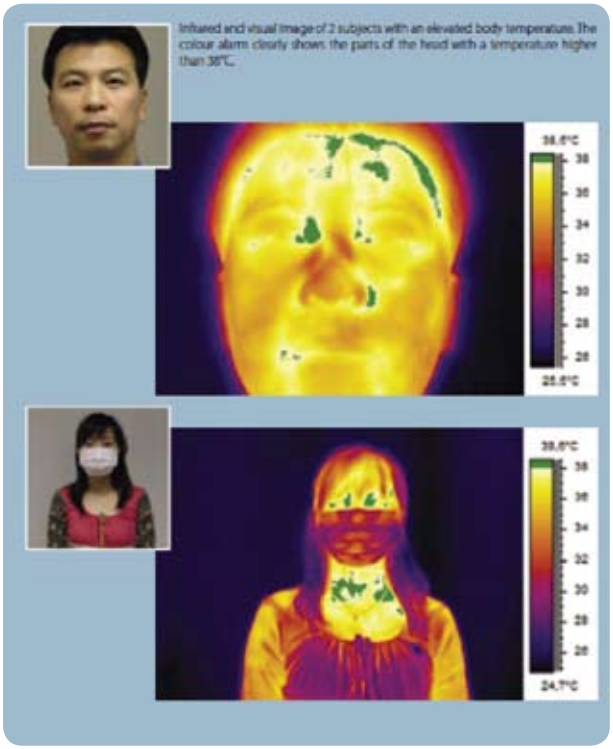
Use of Thermal Imaging to Detect Elevated Body Temperatures

Viral and bacterial infections that spread through human contact and airborne transmission pose a serious health problem, including the possibility of pandemics, as shown by recent flu outbreaks.

Minimizing the spread of infections

Infrared thermography can help detect elevated body temperatures which may indicate the presence of a fever. As such, the use of thermal imaging as an adjunctive diagnostic tool to help detect those persons with a potential fever may contain or limit the spread of viral diseases such as bird and swine flu, or bacterial infections such as SARS.

The growth of international travel and economic migration require a consistent, prompt, effective and global disease prevention policy. Elevated human body temperature, or fever, is often times a reliable indicator of many serious infections. Since the recent outbreak of serious flu strains such as H1N1, and the spread of severe acute respiratory syndrome (SARS), public health authorities have been looking for a fast, easy, contactless (non-invasive), and reliable method to detect elevated human body temperature. When used properly, thermal imaging screening is such a method: a vital tool in the detection of elevated body temperatures in high-risk groups such as travelers. It is being used by health authorities around the world to screen passengers entering a country via mass transportation, and has proven itself as an effective monitoring method.



FLIR Systems IR cameras automatically detect elevated skin temperatures that may indicate a fever and underlying infection. Each camera's unique Automatic Temperature Compensator (ATC) adjusts for ambient conditions to minimize false readings. The color image, temperature scale, and alarm mechanism make it easy to decide when a person needs further examination.

This publication is one of the FLIR Solution Series that describes important applications for IR camera systems. This Series is designed to show our customers how FLIR systems can be used to help reduce costs by protecting their assets, improving production automation and machine vision processes, and increasing the value of their predictive/preventative maintenance operations. The images, case histories, and system designs described in this Series are merely examples of the many possibilities available to users of FLIR IR cameras. Your feedback on the Series will be sincerely appreciated; you can respond by email to moreinfo@flir.com, by telephone to 800.464.6372, or by letter to FLIR Systems, Inc. 25 Esquire Rd. North Billerica, MA 01826.

This makes IR cameras a cost-effective way to help prevent pandemic outbreaks and the deaths that often follow. Public health authorities remember all too well that SARS took the lives of some 10% of infected people. Similarly, the H5N1 strain of avian influenza at one point had a death rate of over 50% in Asia and Europe. Since influenza viruses have the ability to quickly mutate, scientists are concerned about their ability to make effective vaccines that prevent high death rates among weaker members of the global population.

Infrared thermography: an effective tool to detect elevated body temperatures

An infrared camera produces thermal images or heat pictures that display even the smallest temperature differences.

Human body temperature is a complex phenomenon. Humans are homeothermic; they radiate heat, which must be lost to the environment to control their internal temperature. The interface between that heat production and the environment is the skin. This dynamic organ is constantly adjusting the optimum balance between the physiologic demands of the body and external environmental conditions.

Infrared thermography provides a visual map of skin temperatures in real time. In addition, IR cameras are very sensitive devices. FLIR cameras measure temperature differences as small as 0.07°C.

Fixed-mount A320 w/full thermal " color alarming" in progress.

The built-in functions of FLIR IR cameras include color images and temperature scales, and sound alarms that can be set to go off when a certain temperature threshold is exceeded. These functions make it easy for an operator to instantly decide whether the subject needs to be referred for medical examination. Since the cameras produces images in real-time at a rate of 30 Hz, the total evaluation process takes less than a second. This makes infrared technology very useful for rapidly screening large groups of people.

Unique ATC feature minimizes false readings

A person's general skin temperature is not equal to the person's core temperature. The most practical spot on the body giving the most reliable result (where the skin temperature approaches the core temperature of the human body) is in the corner of the eyes where the lachrymal (tear) duct comes to the surface. (See adjacent images.)

Still, skin temperature is affected by one's surroundings, even if they

Setting up a ThermaCAM with Automatic Temperature Compensator (ATC) for elevated body temperature detection

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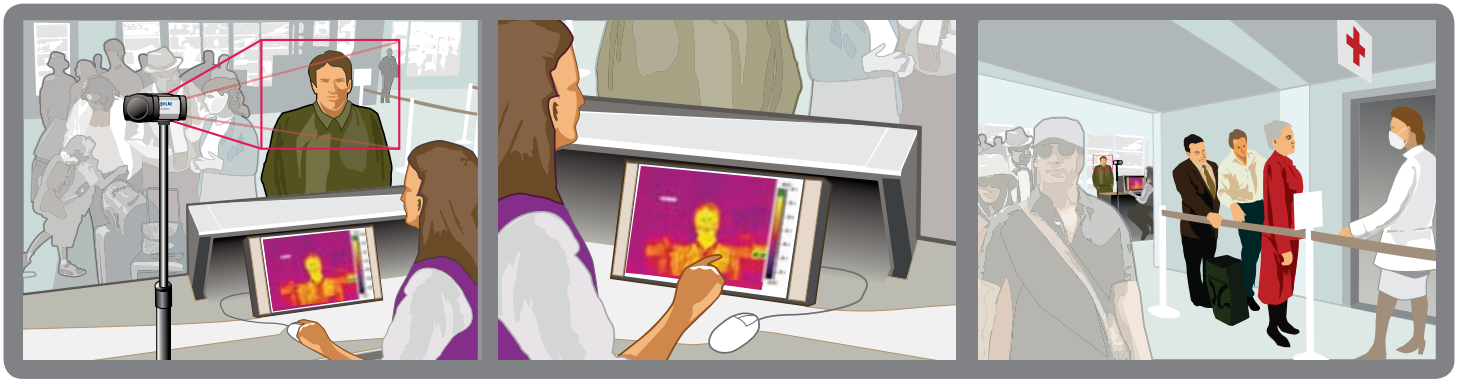

Step 1: Individuals are remotely monitored as they pass a screening check points set up at an airport, border, or in the entrance lobby to a corporation or school.

Step 2: IR camera operator looks at a color monitor that shows audible and/or visible color alarms when an individual shows an "out of norm" body temperature.

Step 3: Persons with an elevated body temperature are sent to a separate line for further screening by a healthcare professional or designate.

have a fever. Nevertheless, their skin will be hotter than other nearby persons (affected by those same surroundings) who do not have a fever. FLIR's unique Automatic Temperature Compensator feature takes this into account and improves the reliability of temperature measurements.

FLIR has verified that a person who is hotter than those around them, at a given time under a given ambient condition, has a higher probability of an elevated temperature, and warrants further screening. When doing mass screenings, the company's ATC technology is much more accurate at finding elevated body temperature than simply setting a fixed alarm threshold of 38°C. (An absolute internal body temperature is more appropriate for screening individuals with a thermometer, because it is not affected by one's surroundings.)

For example, all people exiting a warm or cool airplane environment will have been affected by its passenger compartment temperature. If the passenger compartment was cool enough, it would have lowered the skin temperature of someone with a fever to a certain degree. It would also have lowered the skin temperatures of those passengers without a fever. Therefore, a relative temperature comparison of several passengers will more accurately reveal someone with a fever and prevent false readings.

This is what FLIR's ATC feature does. In addition to calculating relative temperature readings, it automatically adjusts the generation of visible and audible alarms, thereby greatly improving the screening reliability.

For consistent measurements, it is recommended that subjects be placed in front of the camera at a fixed distance. In general, a distance of 1 to 1.6 meters away from the camera lens allows the subject's face to fill the entire image display.

The subject only needs to look into the camera for less than a second. As the highest temperature will be measured in the corner of the eyes, people can continue to wear a mouth mask or their headwear without influencing the measurement. Glass and plastic do not transmit infrared radiation, so people need to remove their glasses in order to be examined.

It is also advisable to set up the IR camera in a location where people form a queue, such as passport or customs control points. This allows persons to be screened on an individual basis. It is also recommended, though not mandatory, to install the camera on a tripod and connect it to a video monitor to facilitate observations by the camera operator.

Proof that infrared thermography works

Studies have shown that it is not necessary to measure absolute temperatures to determine whether a person has a fever or not. After measuring the true body temperature of many healthy people with a medical ear thermometer, and the face temperature of these

same people with a FLIR IR camera, the average temperature difference was calculated. The average difference between their true body temperature and face temperature was found to be fairly constant It varies between 0.8 and 1.2°C, depending on the environmental conditions of the test area. These environment variables included ambient temperature, air conditioning, wind, weather conditions etc.

This corresponds to the principle that the body temperature of a feverish person is likely to be at least 1-2°C higher compared to a healthy person. Whether the skin temperature turns out to be 32, 34, or 36°C is less important than substantial variations from the norm. It should correlate to the core body temperature and remain stable.

The purpose of IR screening is to differentiate people who are well from those who have a fever, not to measure absolute body temperatures. The absolute error measured on both the threshold values and the subjects who are screened will be the same, as long as the camera temperature is stable.

In practice, infrared cameras with the Ambient Temperature Compensator (ATC) feature can be quickly installed and used immediately: After setup, these ATC cameras measure the skin temperature of the first group of scanned subjects and then calculate an average. An alarm is automatically configured to go off when a measured temperature reaches that average plus 2°C. To allow for changing ambient conditions, a moving average is used as additional subjects are screened.

Quick scans of large groups, with color images AND sound alarms

Temperatures are measured by full radiometric infrared cameras, not by infrared imagers. FLIR Systems offers its A320 and T360 Series as optimum solutions. These systems can be battery-operated for over 2 hours or continuously connected to main power. Adhering to the IP 54 standard, they can be used either indoor or outdoor.

FLIR cameras have built-in functions to measure the highest temperature inside a given field of view area. These cameras can be configured to automatically

INFRARED CAMERAS:

- Allow to screen large numbers of people anywhere at any time
- Display and detect critical temperature elevations in real-time
- Activate color and sound alarm
- Are easy to set up and use
- Can be smoothly integrated in public area pedestrian traffic streams
- Are able to store evidence
- Protect public health

USING A FLIR SYSTEMS INFRARED CAMERA FOR DETECTING POSSIBLE INFECTIONS:

1. Assure that there are no hot objects such as lamps in the filed of view of the camera. The camera should be turned on at least 30 minutes before measurement starts and carefully focused.
2. Set the emissivity value to 0.98
3. Determine the average temperature of a healthy person by using an ear thermometer and an infrared camera (or utilise the built-in ATC function)
4. Add 2° to the average temperature of a healthy person to obtain the critical temperature
5. Set an area in the infrared camera
6. Set the color and sound alarms to signal of the temperature within in the area is higher than the critical temperature
7. Bring the subjects to be tested, one by one, in front of the camera. Each for about 1 second.
8. If the alarms signal, detour the subject for further examination.

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detect the hottest spot. Its value is immediately displayed on the camera's built-in LCD monitor, and may be connected to a video monitor. The cameras are also optimized for fever detection by recalibrating themselves frequently. FLIR cameras are factory calibrated with NIST certified equipment.

A built-in color temperature scale enables an immediate decision on whether or not the subject requires further examination. All areas within the camera's field of view that are hotter than a predefined temperature can be easily and immediately recognized on the image display.

In addition, FLIR Systems cameras are equipped with a sound alarm. If the temperature exceeds a predefined setpoint value, the audible alarm goes on. A subject activating the alarm can then be isolated for further examination, on site or at a medical centre.

A small investment to protect public health

Major airports in South-East Asia and the Pacific Rim are already using FLIR Systems cameras and have successfully applied this methodology to screen passengers entering and leaving the country. It is a quick and contactless method, which is perfectly safe for both the camera operator and the screened subject.

FLIR IR cameras have proven themselves as tools that can be operated by non-specialists after a few hours of training. They enable a quick and accurate scan of a large number of people to trace fever, a major symptom of viral and bacterial infections.
As some officials have put it, it is a very small investment to protect public health worldwide.

FLIR infrared cameras can help detect persons with elevated body temperatures, which may be an indication of a fever and, in the process, help limit the spread of infectious disease

With their proven track record for detecting elevated body temperature, a reliable indicator of many diseases, FLIR cameras are an effective tool to counter the spread of H1N1 and other dangerous infections.

Thanks to built-in functions such as color temperature scales and sound alarms, the operator can instantly decide whether a subject needs to be referred for medical examination. As the camera produces images in real-time, at a rate of 30Hz, the total evaluation process takes less than a second. This makes the camera ideal for screening large groups of people in environments such as airports, bus and train stations, department stores, or building lobbies. FLIR Systems offers portable infrared cameras such as the T-Series, and also the A320 that can be placed on a tripod or other fixed mount.

FLIR infrared cameras such as these have been used for SARS and viral infection detection in the following countries and regions: Australia, Hong Kong, Korea, Malaysia, Singapore, and Taiwan.

General Procedures for IR Camera Setup

The procedures for setting up a FLIR IR camera to screen for elevated facial temperature (fever) depend on the specific model being used. However, the general procedures are as follows:

1. Turn on the camera, and wait at least 30 minutes before taking any measurements.
2. Start FLIR IR Monitor software.
3. On the Setup tab, set the emissivity to 0.98
4. On the Analysis tab, click Add Box. Select Max as the displayed temperature value. This configures the camera for a rectangular measurement area, and to record the maximum temperature within that area.
5. On the Screening tab, set the Alarm Difference. This value is the difference between the reference temperature (described later) and the maximum temperature at which the camera will trigger the alarm. A typical value is 2°C (3.6°F).
6. Enable the audible alarm (Beep).
7. Click Apply. The camera will now be set up according to the prevailing conditions. This may take 30-60 seconds.
8. Now aim the camera at a face having a presumably normal temperature. Make sure that the person being measured faces the camera, as in a facial portrait. (Any eyeglasses must be removed.) The distance from the camera lens to the person's face should be such that the facial image in the display covers at least 75% of the image width. Adjust the rectangular measurement box to cover the area around the person's eyes and nose.
9. Click Update Reference to store a temperature sample. Repeat this procedure on at least 10 faces with presumably normal temperatures. You have now set the reference temperature. (The camera software keeps a moving average of the last 10 temperature readings in its First In-First Out (FIFO) memory.)
10. You can now begin the screening process. Aim the camera at the face of the person whose facial temperature you want to screen. If the person's maximum measured temperature (within the box area) is greater than 2°C (3.6°F) above the reference temperature, an alarm will be triggered. To disable the alarm, click in the middle of the box.
11. Update the reference temperature on a regular basis (every 10-15 minutes of actual measurement time) to adjust for changing ambient conditions and the most recent 10 persons that were measured.