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Non-destructive testing instruments - Infrared thermography - System and equipment - Description of characteristics

无损检测仪器 红外线热成像 系统与设备 性能描述

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1 Scope

This Standard specifies the functions and performance parameters of infrared thermal imaging systems, equipment and accessories for non-destructive testing.

This Standard applies to focal plane infrared thermal imagers. Optical scanning infrared thermal imagers may refer to this Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 12604.9 Non-destructive testing - Terminology - Terms used in infrared testing

GB/T 19870 Industrial inspecting thermal imagers

3 Terms and definitions

For the purpose of this document, the terms and definitions defined in GB/T 12604.9 and GB/T 19870 apply.

4 System overview

Figure 1 is the block diagram of an infrared thermal imaging system, including an objective lens, a detector, an image processor, a display, an excitation source, auxiliary equipment, etc. The objective lens images the infrared radiation of the object to be tested on the detector array, and the detector converts it into an electrical signal, and then the image processor further processes it to obtain information about the object to be tested.

affects the temperature measurement sensitivity of the testing system. The larger the aperture (the smaller the f number), the more the amount of light entering, the higher the system's temperature measurement sensitivity, the smaller the temperature measurement range; the smaller the aperture (the larger the f number), the less the amount of light entering, the lower the system's temperature measurement sensitivity, the larger he temperature measurement range.

The aperture of the lens needs to be larger than the size of the detector to ensure that each element of the detector receives infrared radiation.

6 Detector

6.1 General

Infrared thermal imaging systems use detectors to convert radiant energy into measurable electrical signals. Commonly used infrared radiation sensors include: microbolometers, optoelectronics, pyroelectric or quantum sensors, etc. The detector performance directly affects the spatial, temporal, and temperature resolution of the testing system.

6.2 Detector type

Infrared thermal imaging detectors mainly have two types, i.e. thermal sensors and quantum sensors. Thermal sensors operate at room temperature, such as microbolometers and photoelectric sensors. Quantum sensors need to be cooled to a lower operating temperature. Compared to thermal sensors, quantum sensors have higher sensitivity and sampling frequency.

6.3 Detector array

Infrared detectors can be single point, line array or two-dimensional array. A single point detector requires a scanning system to measure the object to be tested point by point and form a thermal image. A line array detector can be used to image moving objects such as production lines. A two-dimensional array detector uses a sensor unit to perform point-by-point scanning to obtain information to form a thermal image.

6.4 Scanning system

Mechanical scanning can be achieved by moving mirrors, prisms, etc. However, since mechanical scanning limits the frame rate, thermal imagers with mechanical scanning system are not suitable for capturing high speed images compared to infrared thermal imagers with two-dimensional array detector.

6.5 Working band

range.

6.12 Start-up time

For uncooled detectors, a certain amount of preheating is required at startup to ensure that the temperature of the equipment itself is stable, reducing the effect of temperature drift on the measurement. For refrigerating detectors, it takes a certain amount of time to start up to ensure that the detector reaches the required operating temperature. The starting time is mainly determined by the type of chiller and the mode of cooling.

7 Image processor

7.1 General

The image processor is used for the acquisition, analysis, processing, display and storage of infrared thermography. The analysis and processing of infrared thermography usually includes spatial distribution and changes with time of temperature fields, image enhancement, noise reduction, etc. The performance of the image processor mainly affects the speed, dynamic range, and imaging effects of the testing system.

7.2 Image acquisition

7.2.1 Timed acquisition

Timing acquisition refers to image acquisition based on the internal clock of the system. Timing acquisition includes: single frame acquisition, equal time interval acquisition, and arbitrary set time interval acquisition.

7.2.2 Trigger acquisition

Trigger acquisition is image acquisition based on the trigger source signal. The trigger source can be a trigger signal set internally by the system and a trigger signal input externally. This function is commonly used in active infrared thermal imaging testing methods, including pulsed thermal imaging, step thermal imaging, phase-locked thermal imaging, and vibrational thermal imaging.

7.2.3 Last image hold

Last image hold is the function of holding the current view during the operation of the infrared thermal imager.

7.3 Image display

Use the display to display the thermal image visible to human eyes, usually

7.5.6 Fusion of visible light and infrared images

The infrared thermal image and the visible light image collected at the same viewing angle are subjected to adjustments of different weight ratios according to different background settings, to achieve simultaneous display of the infrared image and the visible light image on the same screen.

7.6 Image recording

Image recording shall have at least continuous recording and single frame recording functions, and record instrument parameter settings and testing conditions related to temperature calculation. Image recording should have full dynamic range thermal image raw data recording function.

7.7 Image reading

Image reading is to comprehensively retrieve the stored image information, and at the same time, it shall be able to display the instrument parameter settings and testing conditions during the acquisition, so as to facilitate the analysis of the testing results.

8 Excitation source

8.1 General

Active infrared thermal imaging methods require an external excitation source to heat the material. The appropriate excitation source and modulation method shall be selected according to the object to be tested and the purpose of testing. Commonly used excitation sources include light heating sources, high temperature gas generators, electromagnetic induction heaters, vibration heaters, refrigeration units, or other heat sources. Commonly used modulation methods include pulse type, step type, and periodic type.

8.2 Light heating source

8.2.1 Flash

The advantage of this method is that a curve of the entire temperature as a function of time can be recorded and analyzed. The disadvantage is that the heating does not have good uniformity.

8.2.2 Laser

The advantage of this method is that the energy density is large and the supplied energy is stable and controllable. The disadvantage is that the heating area is not large, so for large-area materials, block heating is required and the

9 Integrated performance parameters and functions of infrared systems and equipment

9.1 Integrated performance parameters

9.1.1 Noise equivalent temperature difference

The noise equivalent temperature difference (NETD) represents the ability of an infrared thermal imaging system to resolve temperature differences. Observe a circular or square target with a low spatial frequency with a thermal imager, and when the signal-to-noise ratio of its video signal is 1, the temperature difference between the black body and the background is NETD. The smaller the noise equivalent temperature difference, the higher the testing sensitivity. NETD varies with the temperature, measurement range, integral (quantity detector), and average number of times of the data of the measured black body.

9.1.2 Minimum resolvable temperature difference

The minimum resolvable temperature difference (MRTD) is an indicator for evaluating the imaging quality of an infrared imaging system. It represents the integrated ability of an infrared thermal imaging system and an observer to resolve small temperature differences on small structures (compared to full field of view). The measurement of MRTD is closely related to the observer. The smaller the minimum resolvable temperature difference, the higher the testing sensitivity.

9.1.3 Minimum detectable temperature difference

The minimum detectable temperature difference (MDTD) is another indicator for evaluating the imaging quality of an infrared imaging system. It represents the integrated ability of an infrared thermal imaging system and an observer to detect another target temperature over a large uniform background. The measurement of the MDTD is also closely related to the observer. The smaller the minimum detectable temperature difference, the higher the testing sensitivity.

9.1.4 Field of view (FOV)

Field of view is the maximum opening angle of the spatial range that the thermal imager can observe in the horizontal and vertical directions. The size of the field of view and imaging of the thermal imager directly affects the resolution of the image.

9.2.1 Lens interchangeability

In order to make the infrared thermal imaging system suitable for different testing requirements, the objective lens should be replaceable.

9.2.2 Digital input/output interface

The digital input/output interface allows external input of thermal imaging system signals or thermal imaging system output signals. The input signal is typically used to control the thermal imaging system and the output signal is used for alarms or attention.

9.2.3 Data transfer interface

The data transfer interface allows real-time transmission of digital image information from a thermal imaging system to a computer or other storage devices.

9.2.4 Video output interface

Image information is allowed to be output to other display devices through the video output interface.

9.2.5 Image processing

The image processing function is shown in 7.2 ~ 7.7.

10 Auxiliary equipment

10.1 General

Auxiliary equipment is equipment other than an infrared thermal imager. When the power supply system, infrared mirror, electronic processing system, and lens are integrated into the infrared thermal imager, they are not auxiliary equipment.

10.2 Infrared mirror

An infrared mirror is mainly used to test areas that cannot be directly observed by the infrared thermal imager. Infrared thermal imaging systems extend their testing range by using infrared mirrors.

10.3 Attenuator

An attenuator is a lens that attenuates the intensity of the infrared radiation entering the camera lens to ensure that the radiant energy on the detector is within the dynamic range. The attenuator extends the temperature

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