

BLACKBODY RADIATION DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The disclosure is based on and claims priority to Chinese Patent Application No. 202020844621.9, filed on May 19, 2020, the disclosure of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The disclosure relates to the technical field of thermal imager calibrations, and particularly to a blackbody radiation device.

BACKGROUND

[0003] In recent years, with the development of infrared thermal imaging technologies and the updating of software algorithms, a design and manufacturing demand for a high-precision infrared thermal imager is more and more urgent, particularly in the field of human body non-contact temperature measurement. In a scene with a high precision requirement such as human body temperature measurement, and the like, high-precision calibration or standardization needs to be performed on an infrared thermal imager product during a production process. For thermal imager products, a blackbody generally selected for calibration or standardization requires a planar blackbody radiation source; however, the stability of conventional planar blackbody is relatively low.

SUMMARY

[0004] In a first aspect, the disclosure provides a blackbody radiation device, which includes a housing, a blackbody and a control element. The housing has an accommodation

space therein, a through hole is provided on a side wall of the hosing, the blackbody is arranged on an inner wall of the side wall of the hosing provided with the through hole, the blackbody covers the through hole and is exposed to an outside of the housing through the through hole. A temperature-adjusting liquid is accommodated in the accommodation space. The control element is arranged on the hosing. The control element adjusts a temperature of the temperature-adjusting liquid to a set temperature of the blackbody according to the set temperature. Through arrangement of the hosing, the temperature-adjusting liquid is arranged in the hosing, the control element adjusts the temperature of the temperature-adjusting liquid to the set temperature, and the temperature of the temperature-adjusting liquid is conducted to the blackbody, so that the temperature of the blackbody reaches the set temperature. The temperature-adjusting liquid has a relatively high temperature stability, and a temperature change of the temperature-adjusting within a certain period of time can be kept not to exceed an allowable value, so that the blackbody is always at the set temperature, the temperature stability is high, and a calibration demand of an infrared thermal imager is met.

[0005] In one embodiment, a first heating element and a stirring element which are electrically connected with the control element may be provided in the hosing. When the temperature of the temperature-adjusting liquid is lower than the set temperature, the control element controls the first heating element to heat the temperature-adjusting liquid, and the control element controls the stirring element to stir the temperature-adjusting liquid to make the temperature of the temperature-adjusting liquid uniform.

[0006] In one embodiment, a second heating element electrically connected with the control element may further be provided in the hosing. The first heating element is arranged at the bottom of the hosing, and the second heating element is arranged on a side of the hosing. The control element controls the first heating element and/or the second heating element to be turned on to adjust the temperature of the temperature-adjusting liquid. Both the second heating element and the first heating element are controlled in a pulse width modulation mode. The first heating element and the second heating element are controlled in the pulse width modulation mode to output different heating powers, so that different heating effects may be achieved on the temperature-adjusting liquid at different moments according to a need.

[0007] In one embodiment, the stirring element may include a first stirring element and a second stirring element. Axes of the first stirring element and the second stirring element are not parallel. Flowing directions of the temperature-adjusting liquid stirred by the first stirring element and the second stirring element are different, so that the flowing and uniform mixing speed of the temperature-adjusting liquid can be accelerated.

[0008] In one embodiment, the hosing may be provided with an air-cooled component electrically connected with the control element. When the temperature of the temperature-adjusting liquid is higher than the set temperature, the control element controls the first heating element to be turned off and to reduce the temperature of the temperature-adjusting liquid. When the temperature of the temperature-adjusting liquid needs to be reduced, the air-cooled component is turned on, and the air-cooled component cools the temperature-adjusting liquid, so that the temperature of the temperature-adjusting liquid is reduced to a new set temperature.

[0009] In one embodiment, a plurality of first temperature sensors electrically connected with the control element may be provided in the hosing, and the plurality of first temperature sensors are respectively located at different locations to detect a respective temperature of each part of the temperature-adjusting liquid. When the control element receives a signal indicating that temperatures detected by the plurality of first temperature sensors are different, the control element controls the stirring element to be turned on. When the control element receives a signal indicating that all temperatures detected by the plurality of first temperature sensors are lower than the set temperature, the control element controls the first heating element to be turned on. When the control element receives a signal indicating that all temperatures detected by the plurality of first temperature sensors are higher than the set temperature, the control element controls the air-cooled component to be turned on.

[0010] In one embodiment, the blackbody may be provided with a plurality of second temperature sensors electrically connected with the control element. The plurality of second temperature sensors are evenly distributed on the blackbody. The plurality of second temperature sensors are configured to detect whether the temperature of the blackbody reaches the set temperature. Through acquisition of the respective temperature

of each part of the blackbody, setting of the temperature of the temperature-adjusting liquid is facilitated. Through heat conduction of the temperature-adjusting liquid, the respective temperature of each part of the blackbody is uniform and reaches the set temperature.

[0011] In one embodiment, the accuracy of the first temperature sensor and the second temperature sensor may be 0.005 degrees centigrade (°C), that is, both the first temperature sensor and the second temperature sensor are PT1000 high-precision sensors. Compared with a traditional PT100 sensor, the PT1000 high-precision sensor has the advantages that the resolution to the temperature is relatively high, the temperature of the temperature-adjusting liquid and the temperature of the blackbody can be measured more accurately, the temperature is closer to the set temperature, and excessive deviation from the set temperature is avoided.

[0012] In one embodiment, the hosing may be further provided with an ambient temperature sensor and an ambient humidity sensor which are respectively electrically connected with the control element. The ambient temperature sensor acquires ambient temperature, the ambient humidity sensor acquires ambient humidity, and the ambient temperature and the ambient humidity are used for temperature compensation.

[0013] In one embodiment, the hosing may be further provided with a user interaction component and an alarm component. The user interaction component is configured to display a current state of the blackbody radiation device and receive a control instruction input by a user, and the alarm component sends an alarm prompt when the current state of the blackbody radiation device is unavailable.

[0014] In one embodiment, a shape of blackbody may be a circle. The diameter of the circle is 5-25 centimeters (cm). The blackbody can be tightly connected with an inner wall of the hosing, so that sealing of the accommodation space is guaranteed. The area of the blackbody exposed through the through hole also can be large enough, so that calibration of a plurality of infrared thermal imagers may be performed simultaneously.

[0015] In one embodiment, the hosing may include an inner hosing and an outer hosing. The outer hosing wraps the inner hosing. Heat insulation material is arranged

between the outer hosing and the inner hosing, so that the influence of the ambient temperature on the inner hosing can be reduced, and the temperature stability is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] In order to describe embodiments of the disclosure or technical solutions in the traditional art more clearly, the drawings needed to be used in descriptions about the embodiments or the technical solutions will be simply introduced below. Apparently, the drawings in the following descriptions are only some embodiments of the disclosure. Those of ordinary skill in the art may further obtain other drawings according to these drawings without creative work.

[0017] FIG. 1 is a schematic perspective view of a blackbody radiation device according to one embodiment.

[0018] FIG. 2 is a schematic exploded view of a front plate and a blackbody according to one embodiment.

[0019] FIG. 3 is a schematic plan view that a blackbody is arranged on a front plate according to one embodiment.

[0020] FIG. 4 is a schematic perspective view of a blackbody radiation device viewed from a top plate according to one embodiment.

[0021] FIG. 5 is a schematic cross-sectional view of a blackbody radiation device according to one embodiment, in which a top plate is not shown.

[0022] FIG. 6 is a schematic view of a control portion of a blackbody radiation device according to one embodiment.

[0023] FIG. 7 is a flowchart of use of a blackbody radiation device according to one embodiment.

DETAILED DESCRIPTION

[0024] The technical solutions in the embodiments of the disclosure will be clearly and completely described below in combination with the drawings in the embodiments of the disclosure. Apparently, the described embodiments are only some embodiments of the disclosure and not all the embodiments. Based on the embodiments in the disclosure, all other embodiments obtained by those of ordinary skill in the art without creative work fall within the scope of protection of the disclosure.

[0025] Referring to FIG. 1, the disclosure provides a blackbody radiation device 100. The blackbody radiation device 100 includes a hosing 10, a blackbody 20, and a control element (not shown in the figure). In combination with FIG. 4 and FIG. 5, in one embodiment, the hosing 10 may be a rectangular parallelepiped and may include a bottom plate 11, a front plate 12, a left plate 13, a rear plate 14, a right plate 15, and a top plate 16. The bottom plate 11 is opposite to the top plate 16, the front plate 12 is opposite to the rear plate 14, and the left plate 13 is opposite to the right plate 15. In other embodiments, the hosing 10 may also be ellipsoidal, spheroidal, and the like. Furthermore, in other embodiments, the hosing 10 may include an inner hosing and an outer hosing. The outer hosing wraps the inner hosing. Heat insulation material is arranged between the outer hosing and the inner hosing, so that the influence of the ambient temperature on the inner hosing can be reduced, and the temperature stability is improved.

[0026] The hosing 10 has an accommodation space 102 therein, and a through hole 101 is provided on a side wall (for example, the front plate 12) of one side of the hosing. The blackbody 20 is arranged on the inner wall of the side wall (for example, the front plate 12) of the hosing 10 provided with the through hole 101, the blackbody 20 covers the through hole 101 and is exposed to an outside of the hosing 10 through the through hole 101. Temperature-adjusting liquid (not shown in the figure) is accommodated in the accommodation space 102. The temperature-adjusting liquid is in contact with the blackbody 20, and the temperature of the temperature-adjusting liquid is conducted to the blackbody 20, thereby adjusting the temperature of the blackbody 20.

[0027] The temperature stability of the temperature-adjusting liquid may be 0.01 °C,

that is, the temperature of the temperature-adjusting liquid is stabilized within 0.01°C. The temperature-adjusting liquid may be water, an organic solvent, and the like. In some embodiments, water may be selected as the temperature-adjusting liquid, which is characterized by low cost, the temperature stability up to 0.01°C, and the like.

[0028] The hosing 10 further includes a control portion 17. The control portion 17 is protruded from the top plate 16, and the control element is provided in the control portion 17. In other embodiments, the control portion 17 may be arranged at other locations. The control element adjusts the temperature of the temperature-adjusting liquid to a set temperature of the blackbody 20 according to the set temperature of the blackbody 20.

[0029] When calibrating an infrared thermal imager, the blackbody 20 serves as a radiation source, and the infrared thermal imager is calibrated by detecting the temperature of the blackbody 20. Through arrangement of the hosing 10, the temperature-adjusting liquid is arranged in the hosing 10, the control element adjusts the temperature of the temperature-adjusting liquid to the set temperature, and the temperature of the temperature-adjusting liquid is conducted to the blackbody 20, so that the temperature of the blackbody 20 reaches the set temperature. The temperature stability of the temperature-adjusting liquid is 0.01°C and has relatively high temperature stability. A temperature change within a certain period of time can be kept not to exceed an allowable value, so that the blackbody 20 is always at the set temperature, the temperature stability is high, and a calibration demand of the infrared thermal imager is met.

[0030] The control portion 17 is further provided with a user interaction component. The user interaction component may be, for example, a display screen 80, a key 90, and the like. The display screen 80 is configured to display a current state of the blackbody radiation device 100. The current state includes a temperature value of the temperature-adjusting liquid, a temperature value of the blackbody 20, and the like. The display screen 80 may also display information such as a calendar, a user name, and the like. The size of the display screen 80 may be 7 inches, and the size is relatively large, so that a great deal of information may be displayed. The key 90 is configured to receive a control instruction (such as key-in, modify a value of the set temperature of the blackbody 20)

input by a user. The key 90 may also perform operations such as turning on, turning off, controlling other parameters, and the like, and the other parameters are not limited.

[0031] Referring to FIG. 2 to FIG. 4, the blackbody 20 arranged on the inner wall of the front plate 12 is taken as an example. A shape of the blackbody 20 is a circle, and the diameter of the circle is 5-25 cm. A shape of the through hole 101 is also a circle, the diameter D of the blackbody 20 is greater than that of the through hole 101, and the diameter of the through hole 101 may be 3-20 cm. In some embodiments of the disclosure, the diameter D of the blackbody 20 is 25 cm. The diameter of the through hole 101 is 20 cm. The blackbody 20 can be tightly connected with the inner wall of the front plate 12, so that sealing of the accommodation space 102 is guaranteed. The area of the blackbody 20 exposed through the through hole 101 also can be large enough, so that calibration of a plurality of infrared thermal imagers may be performed simultaneously. In one embodiment, the diameter D of the blackbody 20 is 5 cm, and the diameter of the through hole 101 is 3 cm, so that a whole structure of the blackbody radiation device may be compact, and convenient to carry and use at any time.

[0032] Referring to FIG. 1, FIG. 4 and FIG. 5, a first heating element 41 and a stirring element (31/32) which are electrically connected with the control element are arranged in the housing 10. When the temperature of the temperature-adjusting liquid is lower than the set temperature, the control element controls the first heating element 41 to heat the temperature-adjusting liquid, and the control element controls the stirring element (31/32) to stir the temperature-adjusting liquid, so that the temperature of each part of the temperature-adjusting liquid is uniform.

[0033] In one embodiment, a second heating element 42 which is electrically connected with the control element is further provided in the housing 10. The first heating element 41 is arranged at the bottom of the housing 10, that is, the first heating element 41 is arranged at a location close to the bottom plate 11, and for example, is fixed on the bottom plate 11 through a holder. The second heating element 42 is arranged on a side of the housing 10, that is, the second heating element 42 is arranged at a location close to any one of the front plate 12, the left plate 13, the rear plate 14, or the right plate 15, and for example, is fixed to any one of the plates by a holder. The temperature-adjusting liquid

surrounds the first heating element 41 and the second heating element 42, so that the temperature-adjusting liquid can be sufficiently heated.

[0034] The control element controls the first heating element 41 and/or the second heating element 42 to be turned on to adjust the temperature of the temperature-adjusting liquid.

[0035] In some embodiment, the first heating element 41 and the second heating element 42 are simultaneously turned on to rapidly rise the temperature of the temperature-adjusting liquid. One of the first heating element 41 or the second heating element 42 is turned on to precisely adjust the temperature of the temperature-adjusting liquid. For example, when the blackbody radiation device 100 is just turned on, the temperature of the temperature-adjusting liquid is relatively low, for example, the difference between the temperature of the temperature-adjusting liquid and the set temperature is greater than 3°C, and the temperature of the temperature-adjusting liquid is much lower than the set temperature of the blackbody 20. At this time, the first heating element 41 and the second heating element 42 are simultaneously turned on to rapidly rise the temperature of the temperature-adjusting liquid. When the temperature of the temperature-adjusting liquid is risen to be close to the set temperature, for example, the difference between the temperature of the temperature-adjusting liquid and the set temperature is 0°C-3°C, one of the first heating element 41 or the second heating element 42 is turned off, and only one of the first heating element 41 or the second heating element 42 is left to continue heating. Since one heating element is turned off, the magnitude of the temperature rise is reduced, the temperature of the temperature-adjusting liquid can be precisely controlled, and the temperature of the temperature-adjusting liquid is ensured to reach the set temperature. The first heating element 41 and the second heating element 42 may be resistive heaters, or may be other types of heaters, which are not limited.

[0036] Both the first heating element 41 and the second heating element 42 are controlled in a pulse width modulation mode, and the duty ratio is 0%-100%. A pulse width is, for example, 100 Hertz (Hz)-800 KHz, and in some embodiments, 200 Hz to 500 KHz. Both the first heating element 41 and the second heating element 42 are

controlled in the pulse width modulation mode, different heating powers can be output, for example, the heating power of 0-100 watts (W), and different heating effects may be achieved on the temperature-adjusting liquid at different moments according to a need.

[0037] In one embodiment, the stirring element includes a first stirring element 31 and a second stirring element 32, and axes of the first stirring element 31 and the second stirring element 32 are not parallel. That is, flowing directions of the temperature-adjusting liquid stirred by the first stirring element 31 and the second stirring element 32 are different, so that the flowing and uniform mixing speed of the temperature-adjusting liquid can be accelerated. In some embodiments, the axes of first stirring element 31 and second stirring element 32 are perpendicular to each other. For example, the axis of the first stirring element 31 is in the vertical direction, and the axis of the second stirring element 32 is in the horizontal direction. Both the first stirring element 31 and the second stirring element 32 may be of an impeller structure and are driven to rotate by a motor. The motor is electrically connected with the control element. The control element controls different rotating directions and speeds of the motor, which can change rotating directions and rotating speeds of the first stirring element 31 and the second stirring element 32, so that the diversity in the flowing direction and speed of the temperature-adjusting liquid is achieved, and the temperature uniformizing speed of the temperature-adjusting liquid is accelerated.

[0038] In one embodiment, the hosing 10 is provided with an air-cooled component (not shown in the figure) electrically connected to the control element. When the temperature of the temperature-adjusting liquid is higher than the set temperature, the control element controls the first heating element 41 and the second heating element 42 to be turned off and turns on the air-cooled component so as to reduce the temperature of the temperature-adjusting liquid. Since calibrated infrared thermal imagers may be various, some infrared thermal imagers are high in calibration temperature and some are low in calibration temperature, for example, when calibrating a high-temperature infrared thermal imager and then calibrating a low-temperature infrared thermal imager, since the set temperature of the blackbody 20 is relatively high when calibrating a high-temperature infrared thermal imager, the temperature of the temperature-adjusting liquid is also relatively high, while the set temperature of the blackbody 20 is relatively low

when calibrating a low-temperature infrared thermal imager, the temperature of the temperature-adjusting liquid needs to be lowered. Therefore, the air-cooled component is arranged. When the temperature of the temperature-adjusting liquid needs to be lowered, the air-cooled component is turned on, the air-cooled component cools the temperature-adjusting liquid, so that the temperature of the temperature-adjusting liquid is reduced to a new set temperature. The air-cooled component may include a structure such as a fan, a heat sink, a heat dissipation hole, and the like. The air-cooled component may be arranged near the top plate 16 and above a liquid level of the temperature-adjusting liquid.

[0039] In one embodiment, a plurality of first temperature sensors 50 electrically connected to the control element are provided in the housing 10, and the plurality of first temperature sensors 50 are respectively located at different locations to detect a respective temperature of each part of the temperature-adjusting liquid. For example, the number of the first temperature sensors 50 is five, and the bottom plate 11, the front plate 12, the left plate 13, the rear plate 14, and the right plate 15 are each provided with one first temperature sensor 50. The first temperature sensor 50 is arranged in a mode of staggering from the first heating element 41 and the second heating element 42. Of course, the number of the first temperature sensors 50 is not limited to five, and may be less or more.

[0040] When the control element receives a signal indicating that temperatures detected by the plurality of first temperature sensors 50 are different, that is, the temperature of each part of the temperature-adjusting liquid is different (non-uniform), the control element controls the stirring element (31/32) to be turned on, so that the flowing of the temperature-adjusting liquid is accelerated, and the temperature of each part of the temperature-adjusting liquid is the same (uniform).

[0041] When the control element receives a signal indicating that temperatures detected by the plurality of first temperature sensors 50 are all lower than the set temperature, the control element controls the first heating element 41 and/or the second heating element 42 to be turned on to heat the temperature-adjusting liquid, so that the temperature of the temperature-adjusting liquid is risen to the set temperature.

[0042] When the control element receives a signal indicating that temperatures

detected by the plurality of first temperature sensors 50 are all higher than the set temperature, the control element controls the air-cooled component to be turned on so as to cool the temperature-adjusting liquid, so that the temperature of the temperature-adjusting liquid is reduced to the set temperature.

[0043] In one embodiment, referring to FIG. 3, a plurality of second temperature sensors 60 electrically connected to the control element are provided on the blackbody 20. The plurality of second temperature sensors 60 are evenly distributed on the blackbody 20, and are configured to detect whether the temperature of the blackbody 20 reaches the set temperature. For example, the number of the second temperature sensors 60 is four, and one second temperature sensor 60 is arranged at each of the upper, lower, left and right edge locations of the blackbody 20, so that temperatures at the upper, lower, left and right edge locations of the blackbody 20 can be detected. Of course, the number of the second temperature sensors 60 is not limited to four, and may be less or more. Through acquisition of the temperature of each part of the blackbody 20, setting of the temperature of the temperature-adjusting liquid is facilitated. Through heat conduction of the temperature-adjusting liquid, temperatures of all parts of the blackbody 20 are uniform and reach the set temperature.

[0044] In one embodiment, referring to FIG. 3 to FIG. 5, the accuracy of each of the first temperature sensor 50 and the second temperature sensor 60 may be 0.005°C , that is, both the first temperature sensor 50 and the second temperature sensor 60 are PT1000 high-precision sensors. Compared with a traditional PT100 sensor, the PT1000 high-precision sensor has higher temperature resolution and can more accurately measure the temperature of the temperature-adjusting liquid and the temperature of the blackbody 20, such that the detected temperatures are closer to the set temperature, and excessive deviation from the set temperature is avoided. In other embodiments, the accuracy of each of the first temperature sensor 50 and the second temperature sensor 60 may also be 0.01°C , which can meet a requirement for accurately distinguishing a temperature change of the temperature-adjusting liquid.

[0045] In one embodiment, referring to FIG. 1, FIG. 4 and FIG. 5, the housing 10 is further provided with an ambient temperature sensor 71 and an ambient humidity sensor

72 which are respectively electrically connected with the control element. The ambient temperature sensor 71 acquires ambient temperature, the ambient humidity sensor 72 acquires ambient humidity, and the ambient temperature and the ambient humidity are used for temperature compensation. The ambient temperature sensor 71 and the ambient humidity sensor 72 are arranged at the periphery of the hosing 10 and are configured to detect the ambient temperature and the ambient humidity around the blackbody radiation device 100. Since the blackbody 20 is exposed to the outside from the through hole 101 of the hosing 10, the ambient temperature and the ambient humidity have a certain influence on the blackbody 20, and the temperature compensation is required. When the ambient temperature sensor 71 detects that the ambient temperature is higher than the set temperature, the ambient high temperature may be conducted to the blackbody 20, so that the temperature of the blackbody 20 is risen, and the influence of the temperature rise of the blackbody 20 needs to be taken into account when setting the temperature-adjusting liquid to adjust the temperature. For example, the temperature of the temperature-adjusting liquid is risen or reduced to be slightly lower than the set temperature, and in combination with warming effect of the ambient high temperature on the blackbody 20, the temperature of the blackbody 20 is exactly the set temperature under comprehensive effect. In the same way, the ambient humidity also influences the temperature of the blackbody 20, and the ambient humidity is also used for temperature compensation with reference to the influence of the ambient temperature, so that the temperature of the blackbody 20 is ensured to be the set temperature.

[0046] In one embodiment, referring to FIG. 1, the hosing 10 is further provided with an alarm component (not shown in the figure). The alarm component may be an acousto-optic alarm device. The alarm component sends an alarm prompt when a current state of the blackbody radiation device 100 is unavailable. As described in the foregoing, the current state of the blackbody radiation device 100 includes the temperature value of the temperature-adjusting liquid, the temperature value of the blackbody 20, and the like. The current state is unavailable, that is, the blackbody radiation device 100 cannot be configured to calibrate an infrared thermal imager. A possible reason may be that the temperature of the blackbody 20 does not reach the set temperature, the temperature of the temperature-adjusting liquid is not uniform and is not the same as the set temperature,

and the like, and may also include a system abnormal factor such as other control elements being not ready. The alarm component alarms to remind a user that the calibration of the infrared thermal imager cannot be performed temporarily, the user needs to wait or excludes an abnormality. When the current state is available, the alarm component cancels the alarm, and the calibration of the infrared thermal imager may be performed.

[0047] Referring to FIG. 6, a block diagram of a control system of the blackbody radiation device is provided. A control structure of the blackbody radiation device of the disclosure includes: a control element 150 arranged on a hosing 10, and an air-cooled component 160, an alarm component 170, an authorization component 180, a first stirring element 31, a second stirring element 32, a first heating element 41, a second heating element 42, a plurality of first temperature sensors 50, a plurality of second temperature sensors 60, an ambient temperature sensor 71, an ambient humidity sensor 72, a display screen 80, a key 90, and the like which are electrically connected to the control element 150. The control element 150 includes a data acquisition unit 151, a data computing unit 152, a data storage unit 153, a control unit 154, a human-computer interaction unit 155, a standardization data storage unit 156, and the like. The control element 150 may adopt a Microcontroller Unit (MCU) structure, each unit in the control element 150 respectively has a function of data acquisition, data computing, data storage, control, human-computer interaction or standardization data storage, may refer to an existing MCU structure and is not limited. The function of the authorization component 180 is safety encryption. The authorization component 180 may be a structure such as password unlocking, fingerprint unlocking, face unlocking, and the like. When using the device, a user must pass the authentication of the authorization component 180 to perform operations, so that the apparatus is prevented from being damaged by the operation of irrelevant personnel. Other structures such as the air-cooled component 160, the alarm component 170, and the like have been described in detail above and will not be described in detail herein.

[0048] Referring to FIG. 7, a method for using a blackbody radiation device according to one embodiment is introduced.

- [0049] At S701, a system is booted.
- [0050] At S702, self-checking and authentication are performed after booting.
- [0051] The system performs self-checking after being powered on and booted, checks whether each sensor is normal, reads an authority, and performs authentication.
- [0052] When the self-checking and the authentication succeeds, S703 is performed to continue to read blackbody temperature information configured by the user. When the self-checking or the authentication fails, alarm information is displayed on a display screen, and the system automatically enters a standby mode after 5 minutes (min).
- [0053] At S703, the system is booted and reads configured temperature information.
- [0054] At S704, the user sets the blackbody temperature.
- [0055] At S705, difference between current temperature of the temperature-adjusting liquid and set temperature is checked.
- [0056] After reading the blackbody temperature information set by the user, the system checks the current temperature of the temperature-adjusting liquid, and performs step S706 when the difference between the set temperature and actual temperature of the temperature-adjusting liquid (the set temperature minus the current temperature of the temperature-adjusting liquid) $\Delta \geq 3^{\circ}\text{C}$, the system starts double-channel heating, a first heating element and a second heating element heat simultaneously, temperature rise of the system is accelerated, and the efficiency is improved. When the difference between the set temperature and the actual temperature of the temperature-adjusting liquid is $0^{\circ}\text{C} < \Delta < 3^{\circ}\text{C}$, S708 is performed, the system turns on the first heating element at the bottom for heating (or the second heating element at the middle of the system is turned on), and heating power is adjusted. When the difference between the set temperature and the actual temperature of the temperature-adjusting liquid $\Delta < 0^{\circ}\text{C}$, S707 is performed, that is, when the current temperature of the temperature-adjusting liquid is higher than the set temperature, the system turns off a heating channel and turns on an air-cooled component to adjust air-cooled intensity.

- [0057] At S708, the first heating element or the second heating element is turned on.
- [0058] At S709, an actual temperature of the blackbody is read.
- [0059] At S710, the difference between the actual temperature of the blackbody and the set temperature is determined and a heating pulse width is set to be 50%;
- [0060] When $0^{\circ}\text{C} < \Delta < 3^{\circ}\text{C}$, after reading the actual temperature of the blackbody, the system computes the difference between the set temperature and the actual temperature of the blackbody.
- [0061] 1) When the temperature difference $\Delta \geq 0.005^{\circ}\text{C}$, S711 is performed to reduce the controlled heating by 1% to 5%, the temperature of the blackbody is detected, and the system prompts the user to continue to wait. The heating power is adjusted by reducing the duty ratio of the first heating element (or the second heating element) until the system temperature reaches $0.005^{\circ}\text{C} \geq \Delta \geq -0.005^{\circ}\text{C}$.
- [0062] 2) When the temperature difference $\Delta \leq -0.005^{\circ}\text{C}$, S712 is performed to increase the controlled heating by 1% to 5%, the temperature of the blackbody is detected, and the system prompts the user to continue to wait. The heating power is increased by increasing the duty ratio of the first heating element (or the second heating element) for controlling heating. Closed-loop control is finally realized, the heating power of the first heating element (or the second heating element) of the system is constant, and the temperature of the blackbody is stabilized at $0.005^{\circ}\text{C} \geq \Delta \geq -0.005^{\circ}\text{C}$.
- [0063] 3) When the system temperature or the temperature of the blackbody is stabilized at $0.005^{\circ}\text{C} \geq \Delta \geq -0.005^{\circ}\text{C}$, S713 is performed to stabilize a heating pulse width, and the system outputs a status indication OK to indicate that the current temperature of the blackbody is stabilized and may be used by the user.
- [0064] In some embodiments, when the system is unstable ($\Delta \leq -0.005^{\circ}\text{C}$ or $\Delta \geq 0.005^{\circ}\text{C}$), the system prompts the user to continue to wait. After the system temperature is stabilized at $\pm 0.005^{\circ}\text{C}$, the heating control power of the system will fluctuate around 50% due to a fluctuation of the external ambient temperature.

[0065] In some embodiments, after the user sets a new target temperature of the blackbody, the system proceeds from S705.

[0066] In some embodiments, when a blackbody thermostatic condition does not meet $\pm 0.005^{\circ}\text{C}$ due to a sudden change of the external ambient temperature, the system sends an acousto-optic alarm.

[0067] Only a few embodiments of the disclosure are disclosed above, of course, these embodiments are not intended to limit the scope of the disclosure. It will be understood by those of ordinary skill in the art that all or part of flows for implementing the above embodiments and equivalent variations made in accordance with the claims of the disclosure still fall within the scope of the utility model.

INDUSTRIAL APPLICABILITY

[0068] In the embodiment, through arrangement of the hosing, the temperature-adjusting liquid is arranged in the hosing, the control element adjusts the temperature of the temperature-adjusting liquid to the set temperature, and the temperature of the temperature-adjusting liquid is conducted to the blackbody, so that the temperature of the blackbody reaches the set temperature. The temperature-adjusting liquid has relatively high temperature stability and a temperature change of which within a certain period of time can be kept not to exceed an allowable value, so that the blackbody is always at the set temperature, the temperature stability is high, and a calibration demand of an infrared thermal imager is met.

CLAIMS

1. A blackbody radiation device, comprising a hosing, a blackbody, and a control element, wherein

the hosing has an accommodation space therein, and a side wall of the hosing is provided with a through hole; the blackbody is arranged on an inner wall of the side wall of the hosing provided with the through hole, the blackbody covers the through hole and is exposed to an outside of the hosing through the through hole; the accommodation space contains a temperature-adjusting liquid; the control element is arranged on the hosing, and the control element adjusts a temperature of the temperature-adjusting liquid to a set temperature of the blackbody according to the set temperature of the blackbody.

2. The blackbody radiation device of claim 1, wherein a first heating element and a stirring element which are electrically connected with the control element are provided in the hosing, when the temperature of the temperature-adjusting liquid is lower than the set temperature, the control element controls the first heating element to heat the temperature-adjusting liquid, and controls the stirring element to stir the temperature-adjusting liquid, to make the temperature of the temperature-adjusting liquid uniform.

3. The blackbody radiation device of claim 2, wherein a second heating element electrically connected with the control element is further provided in the hosing; the first heating element is arranged at the bottom of the hosing, and the second heating element is arranged on a side of the hosing; the control element controls at least one of the first heating element or the second heating element to be turned on to adjust the temperature of the temperature-adjusting liquid, the second heating element and the first heating element being controlled in a pulse width modulation mode; and

the stirring element comprises a first stirring element and a second stirring element, and

axes of the first stirring element and the second stirring element being not parallel.

4. The blackbody radiation device of claim 2, wherein the hosing is provided with an air-cooled component electrically connected with the control element, when the temperature of the temperature-adjusting liquid is higher than the set temperature, the control element controls the first heating element to be turned off and turns on the air-cooled component to reduce the temperature of the temperature-adjusting liquid.

5. The blackbody radiation device of claim 4, wherein a plurality of first temperature sensors electrically connected with the control element are provided in the hosing, and the plurality of first temperature sensors are respectively located at different locations to detect a respective temperature of each part of the temperature-adjusting liquid, when the control element receives a signal indicating that temperatures detected by the plurality of first temperature sensors are different, the control element controls the stirring element to be turned on, when the control element receives a signal indicating that all temperatures detected by the plurality of first temperature sensors are lower than the set temperature, the control element controls the first heating element to be turned on, and when the control element receives a signal indicating that all temperatures detected by the plurality of first temperature sensors are higher than the set temperature, the control element controls the air-cooled component to be turned on.

6. The blackbody radiation device of claim 5, wherein the blackbody is provided with a plurality of second temperature sensors electrically connected with the control element, the plurality of second temperature sensors being evenly distributed on the blackbody, and the plurality of second temperature sensors being configured to detect whether the temperature of the blackbody reaches the set temperature.

7. The blackbody radiation device of claim 1, wherein the hosing is further provided with an ambient temperature sensor and an ambient humidity sensor which are respectively electrically connected with the control element, the ambient temperature sensor acquiring ambient temperature, the ambient humidity sensor acquiring ambient humidity, and the ambient temperature and the ambient humidity being used for temperature compensation.

8. The blackbody radiation device of claim 1, wherein the hosing is further provided with a user interaction component and an alarm component, the user interaction component being configured to display a current state of the blackbody radiation device and receive a control instruction input by a user; and

the alarm component sending an alarm prompt when the current state of the blackbody radiation device is unavailable.

9. The blackbody radiation device of claim 1, wherein a shape of the blackbody is a circle, the diameter of the circle being 5-25 cm.

10. The blackbody radiation device of claim 1, wherein the hosing comprises an inner hosing and an outer hosing, the outer hosing wrapping the inner hosing, and heat insulation material being arranged between the outer hosing and the inner hosing.