

INFRARED PANORAMIC MONITORING SYSTEM

[0001] This application claims priority to Chinese Patent Application No. 201911379541.9, titled "INFRARED PANORAMIC MONITORING SYSTEM" and filed with the National Intellectual Property Administration, PRC on December 27, 2019, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the technical field of infrared panorama, and in particular to an infrared panoramic monitoring system.

BACKGROUND

[0003] Infrared panoramic systems in conventional art are divided into two categories. One category is to complete a panoramic image by performing stitching with multiple infrared cores, since infrared cores are expensive, manufacturing and maintenance costs of such system are extremely high. The other type is to use a single infrared core and multiple optical lenses to achieve large-angle imaging, the imaging angle is not 360 degrees, there is a blind area of the field of view, and setting of multiple optical lenses makes optical debugging complicated and difficult for mass production.

[0004] In summary, how to reduce the production cost and debugging time of the infrared panoramic system is an urgent problem to be solved by those skilled in the art.

SUMMARY

[0005] In view of this, an object of the present disclosure is to provide an infrared panoramic monitoring system, 360-degree imaging of the infrared core in an axial direction can be realized by using a rotating control device, so only one infrared core is required, which is low in cost, simple in optical path and convenient for debugging. In addition, a fast-reflection mirror image stabilization device ensures a precision of an obtained infrared panoramic image.

[0006] In order to achieve the above object, the present disclosure provides following technical solutions.

[0007] An infrared panoramic monitoring system includes: an infrared core configured to

respond to an external synchronization signal and output image information; a rotation control device configured to drive the infrared core to rotate in a circumferential direction; a fast-reflection mirror image stabilization device configured to output the external synchronization signal to control the infrared core to output the image information, so as to maintain a stable field of view of the infrared core; a signal processing device, which is connected with the infrared core and is configured to receive the image information and perform image processing on the image information; and a host computer display control device, which is in signal connection with the signal processing device and is configured to display image information obtained by the image processing, and acquire a detection target and display the detection target according to the image information obtained by the image processing. The host computer display control device is in signal connection with the rotation control device and the fast-reflection mirror image stabilization device.

[0008] Preferably, the rotation control device is a shooting turntable, and the shooting turntable includes: a base; an optical load chamber for mounting the infrared core and the fast-reflection mirror image stabilization device; a mounting bracket for mounting the optical load chamber; an azimuth shafting and a pitching shafting. The azimuth shafting is connected with the mounting bracket and the base, and is configured to drive the mounting bracket to rotate at a constant speed relative to the base in a horizontal plane. The pitching shafting is connected with the optical load chamber and the mounting bracket, and is configured to adjust a pitch angle of the optical load chamber relative to the mounting bracket.

[0009] Preferably, the azimuth shafting includes: an azimuth spindle for driving the mounting bracket to rotate relative to the base; a torque motor for driving the azimuth spindle; an azimuth encoder for feeding back rotation angle information of the azimuth spindle; and an azimuth control board connected with the host computer display control device. Both the azimuth encoder and the torque motor are connected with the azimuth control board, and the azimuth control board is configured to control rotation of the torque motor according to an instruction from the host computer display control device and the rotation angle information.

[0010] Preferably, the torque motor is installed in an azimuth motor fixing seat, and the azimuth motor fixing seat is connected with the base. The azimuth spindle is mounted in the azimuth motor fixing seat through an azimuth bearing, and the azimuth spindle is connected with the mounting bracket to make the torque motor directly drive the azimuth spindle.

[0011] Preferably, the azimuth control board is configured to receive an image frame frequency signal outputted by the fast-reflection mirror image stabilization device, and output image clipping

information of a panoramic image according to the image frame frequency signal and the rotation angle information.

[0012] Preferably, the azimuth control board is in signal connection with the fast-reflection mirror image stabilization device, and the azimuth control board is configured to receive the synchronization signal outputted from the fast-reflection mirror image stabilization device, and adjust a position step of a next rotation according to the synchronization signal.

[0013] Preferably, an end face of the azimuth spindle close to the mounting bracket is provided with an azimuth spindle flange, and the azimuth spindle flange is provided with multiple threaded holes for connecting with the mounting bracket, and the threaded holes are uniformly arranged in a circumferential direction of the azimuth spindle flange.

[0014] Preferably, the base is provided with a base cavity for mounting the azimuth encoder, and the azimuth encoder is sleeved outside the azimuth spindle.

[0015] Preferably, the pitching shafting includes: a first pitching shaft; a second pitching shaft; a worm gear device connected with the first pitching shaft; a pitch motor for driving the worm gear device; a pitch encoder for feeding back pitch angle information; and a pitch control board connected with the host computer display control device. Both the pitch encoder and the pitch motor are connected with the pitch control board, and the pitch control board is configured to control rotation of the pitch motor according to an instruction from the host computer display control device and the pitch angle information. The first pitching shaft and the second pitching shaft are vertically installed between the mounting bracket and the optical load chamber, and are respectively fixedly connected with two opposite sides of the optical load chamber, and are rotatably connected with the mounting bracket.

[0016] Preferably, an axis of the first pitching shaft is collinear with an axis of the second pitching shaft, and an intersection between the first pitching shaft and the optical load chamber is located at a point corresponding to half of a height of the optical load chamber.

[0017] Preferably, the worm gear device includes: a worm gear coaxially arranged with the first pitching shaft; and a worm coaxially arranged with an output shaft of the pitch motor. An axis of the worm is perpendicular to a bottom surface of the mounting bracket.

[0018] Preferably, the pitch encoder is sleeved on the first pitching shaft, or the pitch encoder is arranged on the worm gear.

[0019] Preferably, the pitching shafting further includes a brake connected with the pitch control board, and the brake is sleeved on the second pitching shaft.

[0020] Preferably, the fast-reflection mirror image stabilization device includes a laser, a reflection mirror, a voice coil motor, a position collector, an oscillating mirror control board and a potentiometer. The voice coil motor is connected with the oscillating mirror control board and the reflection mirror, and is configured to receive position information sent by the oscillating mirror control board and drive the reflection mirror to a control position. The oscillating mirror control board is connected with the position collector, and the oscillating mirror control board is configured to receive multiple position signals of the reflection mirror acquired by the position collector in a preset time period, to acquire a linearity in the preset time period. The oscillating mirror control board is configured to, in a case that the linearity does not meet a precision requirement, send an adjusting signal to the potentiometer to increase a power supply voltage, and then receive multiple position signals to calculate a linearity for judgment again.

[0021] Preferably, the host computer display control device includes an arithmetic unit, a displayer and a receiver. The arithmetic unit is in signal connection with the signal processing device, and is configured to receive the image information obtained by the image processing and acquire the detection target. The displayer is connected with the arithmetic unit, and is configured to display the image information obtained by the image processing and the detection target. The receiver is configured to receive an adjustment instruction for parameters including an azimuth angle and a rotation angle from a user. The receiver is in signal connection with the shooting turntable, the infrared core and the fast-reflection mirror image stabilization device, to output the adjustment instruction.

[0022] When the infrared panoramic monitoring system provided by the present disclosure works, the host computer display control device outputs a control instruction to the rotation control device to set parameters such as an azimuth angle, and the rotation control device receives the control instruction to control the infrared core to rotate and take images. In the process of rotation, the fast-reflection mirror image stabilization device is used to keep an instantaneous field of view of the infrared core still.

[0023] As the rotation control device can drive the infrared core to rotate 360 degrees in the circumferential direction, the infrared panoramic monitoring system provided by the present disclosure can only include one infrared core, and the production cost is greatly reduced compared with the existing system including multiple infrared detectors.

[0024] In addition, compared with the system including multiple lens, since the rotation control device can drive the infrared core to rotate 360 degrees in the circumferential direction, there is no need to set multiple lenses for changing the optical path. In the infrared panoramic monitoring

system provided by the present disclosure, the number of optical elements between the target and the infrared core is reduced, the optical path is simple, the difficulty and time required for optical path debugging are greatly reduced, and mass production is convenient.

[0025] Considering the setting of the rotation control device, in order to stabilize the field of view of the infrared core in the process of rotation, the precision of the panoramic image is guaranteed by the fast-reflection mirror image stabilization device, so as to avoid the problem of image blurring.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] For more clearly illustrating embodiments of the present disclosure or technical solutions in the conventional technology, the drawings referred to for describing the embodiments or the conventional technology will be briefly described hereinafter. Apparently, the drawings in the following descriptions show only some embodiments of the present disclosure, and for those skilled in the art, other drawings may be obtained based on the provided drawings without any creative efforts.

[0027] Figure 1 is a schematic structural diagram of an infrared panoramic monitoring system according to an embodiment of the present disclosure;

[0028] Figure 2 is a schematic sectional view of the shooting turntable in Figure 1 in the front view direction;

[0029] Figure 3 is a partial enlarged view of the shooting turntable in Figure 2 in area A;

[0030] Figure 4 is a schematic sectional view of the shooting turntable in Figure 2 in the B-B direction;

[0031] Figure 5 is a schematic flow chart of driving performed by the fast-reflection mirror image stabilization device according to the present disclosure.

[0032] In Figures 1 to 5:

1 optical load chamber

2 pitching shafting

21 first pitching shaft

22 second pitching shaft

23 worm gear

24 worm

25 pitch motor

26 pitch encoder

27 brake

3 mounting bracket

4 azimuth shafting

41 azimuth spindle

42 torque motor

43 azimuth motor fixing seat

44 azimuth bearing

45 azimuth encoder

5 base

5

DETAILED DESCRIPTION

[0033] Technical solutions of embodiments of the present disclosure will be clearly and completely described hereinafter in conjunction with the drawings of the embodiments according to the present disclosure. Apparently, the embodiments described are only some embodiments of the present disclosure, rather than all embodiments. Any other embodiments obtained by those skilled in the art and based on the embodiments of the present disclosure without any creative work fall in the scope of protection of the present disclosure.

[0034] A core of the present disclosure is to provide an infrared panoramic monitoring system, 360-degree imaging of the infrared core in an axial direction can be realized by using a rotating control device, so only one infrared core is required, which is low in cost, simple in optical path and convenient for debugging. In addition, a fast-reflection mirror image stabilization device ensures a precision of an obtained infrared panoramic image.

[0035] Referring to Figures 1 to 5, Figure 1 is a schematic structural diagram of an infrared panoramic monitoring system according to an embodiment of the present disclosure; Figure 2 is a schematic sectional view of the shooting turntable in Figure 1 in the front view direction; Figure 3 is a partial enlarged view of the shooting turntable in Figure 2 in area A; Figure 4 is a schematic sectional view of the shooting turntable in Figure 2 in the B-B direction; and Figure 5 is a schematic flow chart of driving performed by the fast-reflection mirror image stabilization device according to the present disclosure.

[0036] An infrared panoramic monitoring system provided by the present disclosure includes: an infrared core configured to respond to an external synchronization signal and output image information; a rotation control device configured to drive the infrared core to rotate in a circumferential direction; a fast-reflection mirror image stabilization device configured to output the external synchronization signal to control the infrared core to output the image information, so as to maintain a stable field of view of the infrared core; a signal processing device, which is connected with the infrared core and is configured to receive the image information and perform

image processing on the image information; and a host computer display control device, which is in signal connection with the signal processing device and is configured to display image information obtained by the image processing, and acquire a detection target and display the detection target according to the image information obtained by the image processing. The host computer display control device is in signal connection with the rotation control device and the fast-reflection mirror image stabilization device.

[0037] The infrared core is a kind of infrared thermal imaging module with long-wave uncooled focal plane, which has an external power interface, a BNC standard video output interface, an LVDS 16-bit digital output interface, a RS232 control interface and so on. Rich interfaces make the infrared core very suitable for OEM assembly and integration, so it is widely used in various infrared thermal imaging fields such as night vision, monitoring and security. Please refer to the conventional art for the specific structure and model of the infrared core, which will not be repeated here.

[0038] The rotation control device is used for driving the infrared core to rotate circumferentially, so as to realize the rotation and image taking of the infrared core within the range of 360 degrees in the circumferential direction, so as to synthesize the infrared panoramic image by acquiring single frames of images at different angles.

[0039] The rotating shaft of the rotation control device may be set to one or two. Preferably, two rotating shafts of the rotation control device may be set, and the directions of the two rotating shafts are perpendicular to each other, so that the infrared core can rotate in the horizontal plane and adjust a pitch angle relative to the horizontal plane, thus meeting the adjustment needs in the field of monitoring and security.

[0040] The fast-reflection mirror image stabilization device compensates an optical axis offset on the rotation control device caused by the oscillating of a reflection mirror, so as to maintain the stability of the visual field of the infrared core, thereby eliminating the image blur caused by the optical axis jitter and ensuring the imaging quality of a single frame image.

[0041] Preferably, the fast-reflection mirror image stabilization device may be connected to the rotation control device together with the infrared core to save installation space and optimize the spatial layout of the infrared panoramic monitoring system.

[0042] The signal processing device is in signal connection with the infrared core, and is used for processing the received single frame image information into panoramic image information.

[0043] It should be noted here that the signal connection may mean that a physical connection

structure between the two, an electrical connection between the two, or a wireless connection such as wifi to realize information transmission between the two.

[0044] In a specific embodiment, the signal processing device may be a ZYNQ chip. The image signal of the infrared core is transmitted to the ZYNQ chip through a conductive slip ring, and the ZYNQ chip performs precise image processing on RGB signals in the received LVDS signals. Because ZYNQ chip combines the capabilities of PS and PL, it can support both high-speed parallel computing and software-based algorithms. In addition, the ZYNQ chip can transmit servo control information with the rotation control device to adjust the operation of the rotation control device.

[0045] The host computer display control device is in signal connection with the signal processing device to receive and display the processed image information, and acquire the detection target and display the detection target according to the processed image information. Preferably, the host computer display control device may include a warning component, and the warning component is used for warning the user after the detection target is obtained.

[0046] Preferably, the warning component may be LED or the like, after the host computer display control device obtains the detection target, the LED prompts the user through continuous flashing. The blinking time of LED is controlled by timer, and the blinking time interval of LED is determined according to the actual needs.

[0047] Preferably, the color of LED may be set to red to make it more conspicuous and convenient for users to pay attention to warning information.

[0048] Of course, the warning component may also include a buzzer, and after the host computer display control device acquires the detection target, the buzzer buzzes to warn.

[0049] When the infrared panoramic monitoring system works, the host computer display control device outputs a control instruction to the rotation control device to set parameters such as an azimuth angle, and the rotation control device receives the control instruction to control the infrared core to rotate and take images. In the process of rotation, the fast-reflection mirror image stabilization device is used to keep an instantaneous field of view of the infrared core still.

[0050] In this embodiment, as the rotation control device can drive the infrared core to rotate 360 degrees in the circumferential direction, the infrared panoramic monitoring system can only include one infrared core, and the production cost is greatly reduced compared with the existing system including multiple infrared detectors.

[0051] In addition, since the rotation control device can drive the infrared core to rotate 360

degrees in the circumferential direction, there is no need to set multiple lenses for changing the optical path in the infrared panoramic monitoring system according to the embodiment. Compared with the system including multiple lens, the number of optical elements is reduced, the optical path is simple, the difficulty and time required for optical path debugging are greatly reduced, and mass production is convenient.

[0052] Considering the setting of the rotation control device, in order to stabilize the field of view of the infrared core in the process of rotation, the precision of the panoramic image is guaranteed by the fast-reflection mirror image stabilization device, so as to avoid the problem of image blurring.

[0053] On the basis of the above embodiment, the structure of the rotation control device that drives the infrared core to rotate in the circumferential direction is limited. The rotation control device may be a shooting turntable. The shooting turntable includes: a base 5; an optical load chamber 1 for mounting the infrared core and the fast-reflection mirror image stabilization device; a mounting bracket 3 for mounting the optical load chamber 1; an azimuth shafting 4 and a pitching shafting 2. The azimuth shafting 4 is connected with the mounting bracket 3 and the base 5, and is configured to drive the mounting bracket 3 to rotate at a constant speed relative to the base 5 in a horizontal plane. The pitching shafting 2 is connected with the optical load chamber 1 and the mounting bracket 3, and is configured to adjust a pitch angle of the optical load chamber 1 relative to the mounting bracket 3.

[0054] The optical load chamber 1 is used to install the infrared core and the fast-reflection mirror image stabilization device. Preferably, referring to Figure 1, the optical load chamber 1 may include a bottom plate and a rectangular frame connected to the edge of the bottom plate. The bottom plate and the rectangular frame are connected perpendicularly. Therefore, the rectangular frame and the bottom plate enclose a chamber of the optical load chamber 1, and the infrared core and the fast-reflection mirror image stabilization device are installed in the chamber.

[0055] One end of the pitching shafting 2 is connected with the optical load chamber 1, and the other end of the pitching shafting 2 is connected with the mounting bracket 3. The pitching shafting 2 is used to drive the optical load chamber 1 to rotate relative to a vertical plane where the mounting bracket 3 is located, so as to change the pitch angle of the optical load chamber 1.

[0056] The mounting bracket 3 is connected with the base 5 through the azimuth shafting 4. Since the optical load chamber 1 is installed in the mounting bracket 3, when the mounting bracket 3 rotates relative to the base 5 in the horizontal plane, the mounting bracket 3 can drive the optical load chamber 1 to rotate simultaneously.

[0057] The mounting bracket 3 may be a rectangular frame, and it may also be set in other geometric shapes that meet the requirements.

[0058] Preferably, in order to reduce an overall mass of the shooting turntable and facilitate the installation of the infrared core in the optical load chamber 1, the mounting bracket 3 may be set as a U-shaped bracket, and the U-shaped bracket is symmetrical about an extending direction of the azimuth shafting.

[0059] The size of the U-shaped bracket is determined according to the size of the optical load chamber 1, so as to leave enough space for the installation of the optical load chamber 1. The size of the optical load chamber 1 is determined according to the size of the infrared core in the optical load chamber 1.

[0060] A height from a bottom surface of the mounting bracket 3 to a bottom surface of the optical load chamber 1 is determined according to a width of the optical load chamber 1 and a pitch angle range of the optical load chamber 1, so as to avoid mutual wear between the optical load chamber 1 and the mounting bracket 3 due to a jamming problem in a pitch angle adjustment process.

[0061] In this embodiment, since the azimuth shafting 4 can make the mounting bracket 3 move at a constant speed relative to the base 5 in the horizontal plane, a rotation speed of the infrared core remains unchanged within a rotation range of 360 degrees in the circumferential direction, and the image taking speed for all positions is the same, thus effectively improving the precision of the synthesized panoramic image.

[0062] On the basis of the above embodiment, in order to realize a uniform rotation of the mounting bracket 3 relative to the base 5 in the horizontal plane, the azimuth shafting 4 may include: an azimuth spindle 41 for driving the mounting bracket 3 to rotate relative to the base 5; a torque motor 42 for driving the azimuth spindle 41; an azimuth encoder 45 for feeding back rotation angle information of the azimuth spindle 41; and an azimuth control board connected with the host computer display control device. Both the azimuth encoder 45 and the torque motor 42 are connected with the azimuth control board, and the azimuth control board is configured to control rotation of the torque motor 42 according to an instruction from the host computer display control device and the rotation angle information.

[0063] In operation, the host computer display control device transmits information about an azimuth angle instruction to the azimuth control board, and the azimuth control board adjusts an output torque of the torque motor 42 according to the azimuth angle instruction to make a rotation

speed of the azimuth spindle 41 meet the requirements of the azimuth angle instruction. The torque motor 42 drives the azimuth spindle 41 to rotate, thereby driving the mounting bracket 3 to rotate relative to the base 5.

[0064] In addition, the azimuth encoder 45 collects rotation angle information of the azimuth spindle 41 and feeds it back to the azimuth control board. The azimuth control board adjusts the output torque of the torque motor 42 by comparing a preset rotation angle with an actual rotation angle.

[0065] By adopting a control mode of azimuth step tracking, a rotation precision of the azimuth shafting 4 can be up to ± 0.012 degrees. Because of the high azimuth precision, the imaging quality of the panoramic image is effectively improved.

[0066] In this embodiment, the torque motor 42 is used as the azimuth motor to drive the azimuth shafting 4. Since the output torque of the torque motor 42 is constant, the driving torque received by the azimuth spindle 41 remains constant, thus realizing the uniform rotation of the azimuth spindle 41.

[0067] In practice, due to the influence of wind and other external factors, there is a certain gap between an actual azimuth of the infrared core when receiving the external synchronization signal from the fast-reflection mirror image stabilization device to output the image information and a set azimuth of the external synchronization signal, which results in shaking of the stitched panoramic image.

[0068] Preferably, the azimuth control board may receive an image frame frequency signal outputted by the fast-reflection mirror image stabilization device, and output image clipping information of a panoramic image according to the image frame frequency signal and the rotation angle information.

[0069] It should be noted that, the image clipping information of the panoramic image may specifically be pixel values that need to be clipped when two adjacent single-frame images are stitched, and of course the image clipping information may be set to other values.

[0070] Since the azimuth control board can receive the image frame frequency signal outputted by the fast-reflection mirror image stabilization device, the azimuth control board can obtain the set azimuth when the infrared core outputs the image information, and because the azimuth encoder 45 is connected with the azimuth control board, the azimuth control board can obtain the actual azimuth when the infrared core outputs the image information. Therefore, the azimuth control board can calculate a difference between the set azimuth and the actual azimuth and

convert the difference into image clipping information such as pixel value, so that single frame images are clipped to avoid shaking of the panoramic image during stitching.

[0071] For example, when the shooting turntable rotates 360 degrees in 2s and the panoramic image is formed by stitching 60 images, the fast-reflection mirror image stabilization device outputs 60 external synchronous signals uniformly within 2s to control the infrared core to shoot, that is, the infrared core shoots once every 6 degrees of rotation of the shooting turntable. Affected by external factors such as rotating speed fluctuation of the shooting turntable and wind, there may be situations where the shooting turntable does not reach or exceed the set azimuth when the infrared core shoots. In order to avoid image shaking, the azimuth control board calculates the difference between the actual azimuth and the set azimuth and converts the difference into the image clipping information such as pixel values, so as to clip single frame images during stitching.

[0072] For the types and specifications of the torque motor 42, please refer to the conventional art, which will not be repeated here. Preferably, a direct current brushless torque motor may be selected as a driving motor of the azimuth spindle 41. Because of the brushless structure, the required installation space is small, there is no brush wear problem, and the service life is longer.

[0073] For the types and specifications of the azimuth encoder 45, please refer to the conventional art, which will not be repeated here. In a specific embodiment of the present disclosure, the azimuth encoder 45 adopts a 20-bit absolute encoder with a high resolution and a high precision, which is beneficial to realize azimuth synchronization of azimuth adjustment.

[0074] Preferably, the azimuth control board may be in signal connection with the fast-reflection mirror image stabilization device, and the azimuth control board receives the synchronization signal outputted from the fast-reflection mirror image stabilization device, and adjusts a position step of a next rotation according to the synchronization signal, thereby realizing the 0 azimuth synchronization between the rotation control device and the fast-reflection mirror image stabilization device and avoiding the problem of zero drift of images in the conventional art.

[0075] It should be noted that, 0 azimuth refers to the 0 point on the azimuth, and the specific azimuth represented by the "0 azimuth" may be determined according to the actual needs.

[0076] Based on the above embodiment, the torque motor 42 is installed in an azimuth motor fixing seat 43, and the azimuth motor fixing seat 43 is connected with the base 5. The azimuth spindle 41 is mounted in the azimuth motor fixing seat 43 through an azimuth bearing 44, and the azimuth spindle 41 is connected with the mounting bracket 3 to make the torque motor 42 directly drive the azimuth spindle 41 through the azimuth bearing 44.

[0077] In this embodiment, the azimuth spindle 41 is directly driven by the torque motor 42, which reduces the load of the torque motor 42. The torque motor 42 has low driving power and low power consumption, which prolongs the service life and reliability of the torque motor 42 under the condition of long-term continuous rotation and reduces the maintenance times. The current of the torque motor 42 is reduced, and the influence on an image signal is reduced.

[0078] Meanwhile, this connection method improves the space utilization rate, makes the azimuth shafting 4 compact to install, and reduces the mass of the azimuth shafting 4 and the required installation space.

[0079] Preferably, the azimuth encoder 45 may be installed in an inner cavity of the base 5, and the azimuth encoder 45 is sleeved with the azimuth spindle 41, so as to reasonably utilize the installation space and improve the space utilization rate in the azimuth shafting 4.

[0080] Preferably, an end face of the azimuth spindle 41 close to the mounting bracket 3 is provided with an azimuth spindle flange. The azimuth spindle flange is provided with multiple threaded holes for connecting with the mounting bracket 3, and the threaded holes are uniformly arranged in a circumferential direction of the azimuth spindle flange.

[0081] The size of the threaded holes on the azimuth spindle flange and the specific number of threaded holes are determined according to the actual needs.

[0082] Of course, it is also possible to replace the bolt connection with a connection method such as a pin connection.

[0083] Preferably, in order to eliminate radial runout and axial runout between the azimuth motor fixing seat 43 and the azimuth spindle 41, the azimuth bearing 44 may be set as a pair of angular contact ball bearings.

[0084] The specific specifications of angular contact ball bearings are determined according to actual needs.

[0085] On the basis of the above embodiment, in order to adjust the pitch angle of the optical load chamber 1 relative to the mounting bracket 3, the structure of the pitching shafting 2 is defined. The pitching shafting 2 may include a first pitching shaft 21; a second pitching shaft 22; a worm gear device connected with the first pitching shaft 21; a pitch motor 25 for driving the worm gear device; a pitch encoder 26 for feeding back pitch angle information; and a pitch control board connected with the host computer display control device. Both the pitch encoder 26 and the pitch motor 25 are connected with the pitch control board, and the pitch control board is configured to control rotation of the pitch motor 25 according to an instruction from the host computer display

control device and the pitch angle information. The first pitching shaft 21 and the second pitching shaft 22 are vertically installed between the mounting bracket 3 and the optical load chamber 1, and are respectively fixedly connected with two opposite sides of the optical load chamber 1, and are rotatably connected with the mounting bracket 3.

5 **[0086]** The axis of the first pitching shaft 21 and the axis of the second pitching shaft 22 may be collinear or may not be collinear. Preferably, the axis of the first pitching shaft 21 and the axis of the second pitching shaft 22 may be set to be collinear to facilitate the disassembly and manufacture of the pitching shafting 2.

10 **[0087]** The diameter and length of the first pitching shaft 21 may be same as or different from the diameter and length of the second pitching shaft 22 respectively. Preferably, in order to facilitate manufacturing and assembly, and improve the interchangeability of parts, the first pitching shaft 21 and the second pitching shaft 22 are set as rotating shafts with the same diameter and the same length.

15 **[0088]** Preferably, it may be set that an axis of the first pitching shaft 21 is collinear with an axis of the second pitching shaft 22, and an intersection between the first pitching shaft 21 and the optical load chamber 1 is located at a point corresponding to half of a height of the optical load chamber 1. In this way, the torque provided by the first pitching shaft 21 acts on the geometric rotating shaft of the optical load chamber 1.

20 **[0089]** Preferably, referring to Figure 3, the worm gear device may includes: a worm gear 23 coaxially arranged with the first pitching shaft 21; and a worm 24 coaxially arranged with an output shaft of the pitch motor 25. An axis of the worm 24 is perpendicular to a bottom surface of the mounting bracket 3.

25 **[0090]** Since the output shafts of the worm 24 and the pitch motor 25 are perpendicular to the bottom surface of the mounting bracket 3, the worm 24 and the pitch motor 25 may be arranged in the side wall of the mounting bracket 3, which saves the installation space and makes the spatial layout of the shooting turntable more compact and reasonable.

30 **[0091]** It should be noted that, the coaxial arrangement may be that the two are connected to the same rotating shaft, or the axes of the two are collinear and connected by a coupling. Referring to Figure 3 and Figure 4, the worm gear 23 is mounted on the first pitching shaft 21, and the worm 24 is connected with the output shaft of the pitch motor 25 through a coupling.

[0092] Preferably, considering that the first pitching shaft 21 and the worm gear 23 are coaxially arranged and have the same rotation speed, the pitch encoder 26 may be sleeved on the first

pitching shaft 21, or the pitch encoder 26 may be arranged on the worm gear 23.

[0093] In operation, the host computer display control device transmits information about a pitch angle instruction to the pitch control board, and the pitch control board controls the pitch motor 25 to drive the worm gear device to rotate according to the pitch angle instruction, thereby driving the first pitching shaft 21 and the second pitching shaft 22 to rotate. Since the first pitching shaft 21 and the second pitching shaft 22 are both fixedly connected with the optical load chamber 1 and rotatably connected with the mounting bracket 3, the optical load chamber 1 rotates relative to the mounting bracket 3.

[0094] In addition, the pitch encoder 26 detects the pitch angle information and transmits the pitch angle information to the pitch motor 25. The pitch control board compares a preset pitch angle with an actual pitch angle, and adjusts a rotation angle of the pitch motor 25 until the preset pitch angle and the actual pitch angle are equal, and then controls the pitch motor 25 to stop rotating.

[0095] Preferably, the pitch motor 25 may be set as a stepping motor, and the rotation speed of the stepping motor is slow, and the rotation angle can be accurately controlled, which is beneficial to improve the precision of the pitch angle adjustment. In a specific embodiment, an adjustment range of the pitch angle of the stepping motor ranges from -40 degrees to +40 degrees, and an adjustment precision of the pitch angle is 0.05 degrees. It should be noted that, the above values are only for reference, and the adjustment range of the pitch angle and the adjustment precision of the pitch angle may be set to other values according to the actual needs.

[0096] In this embodiment, since the worm gear device has a reverse self-locking function, it is avoided that the first pitching shaft 21 and the second pitching shaft 22 rotate reversely under the action of external force after the pitch motor 25 stops rotating and the pitch angle is fixed, thereby avoid making the actual pitch angle deviates from the preset pitch angle. In this way, the precision of panoramic shooting is improved.

[0097] Preferably, referring to Figure 3, the pitch encoder 26 may be sleeved outside the first pitching shaft 21.

[0098] On the basis of the above embodiment, in order to further lock the pitch angle, a locking member may include a brake 27 connected with the pitch control board, and the brake 27 is sleeved on the second pitching shaft 22.

[0099] When the pitch angle needs to be adjusted, the pitch control board controls the brake 27 to release the second pitching shaft 22. Since the second pitching shaft can rotate relative to the

mounting bracket 3, the first pitching axis 21 connected with the second pitching shaft can be driven by the pitch motor 25 to rotate relative to the mounting bracket 3.

[0100] After the optical load chamber 1 reaches the required pitch angle, the pitch control board controls the brake 27 to hold the second pitching shaft 22. Therefore, the second pitching shaft can no longer rotate relative to the mounting bracket 3, so that the first pitching shaft 21 connected with the second pitching shaft can not be driven by the pitch motor 25 to rotate relative to the mounting bracket 3.

[0101] In this embodiment, the brake 27 sleeved on the second pitching shaft 22 can eliminate the looseness of the pitching axis caused by the backlash of the worm gear device and keep the pitch angle unchanged during shooting.

[0102] In addition, this locking method is reliable and stable, and the pitch motor 25 does not need to be electrified for a long time to keep the locking state, so the power consumption of the equipment is low.

[0103] On the basis of the above embodiment, the structure of the fast-reflection mirror image stabilization device is limited. The fast-reflection mirror image stabilization device may include a laser, a reflection mirror, a voice coil motor, a position collector, an oscillating mirror control board and a potentiometer. The voice coil motor is connected with the oscillating mirror control board and the reflection mirror, and is configured to receive position information sent by the oscillating mirror control board and drive the reflection mirror to a control position. The oscillating mirror control board is connected with the position collector, and the oscillating mirror control board is configured to receive multiple position signals of the reflection mirror acquired by the position collector in a preset time period, to acquire a linearity in the preset time period. The oscillating mirror control board is configured to, in a case that the linearity does not meet a precision requirement, send an adjusting signal to the potentiometer to increase a power supply voltage, and then receive multiple position signals to calculate a linearity for judgment again.

[0104] For the operation principle and type of the position collector, please refer to the conventional art, which will not be repeated here. Preferably, a PSD displacement sensor may be selected as the position collector.

[0105] During the rotation of the infrared core, a laser emitted by the laser is reflected by the reflection mirror and then the reflected laser shines on the position collector, and a spot position collected by the position collector may be used to judge a deflection angle of the reflection mirror. The position collector feeds back the position signal of the reflection mirror to the oscillating

mirror control board. The oscillating mirror control board outputs a control signal to the voice coil motor according to the detected deflection angle of the reflection mirror, and the reflection mirror is controlled by the voice coil motor to swing at a speed which is equal to the speed of the rotation of the rotation control device and to swing in a direction opposite to the direction of the rotation of the the rotation control device. In addition, an external synchronization signal is outputted to control the infrared core to output image information, so as to compensate the optical axis offset caused by the rotation of the rotation control device and maintain the instantaneous visual field of the infrared core to be still when shooting.

[0106] Therefore, the imaging effect of a single frame image is related to the speed matching degree between the fast-reflection mirror image stabilization device and the rotation control device. The higher the matching degree, the better the imaging effect of the single frame image of the infrared core and the clearer the image.

[0107] The oscillating mirror control board may include a processor, a data converter and a power amplifier. The data converter is specifically an analog-to-digital converter or a digital-to-analog converter, and the processor is specifically a digital processor.

[0108] In the above process, the position signal of the reflection mirror collected by the position collector is an analog signal, the analog signal is sent to the analog-to-digital converter and then converted into a digital signal, and the digital signal is sent to the digital processor. A preset position signal sent by the digital processor is a digital signal, the digital signal is converted into an analog signal by the analog-to-digital converter and the analog signal is sent to the power amplifier. The power amplifier generates a high power output to drive the voice coil motor to work, so that the mirror surface of the reflection mirror swings at a certain frequency.

[0109] The driving method for the above fast-reflection mirror image stabilization device may include following steps S11 to S14.

[0110] Step S11, receiving multiple position signals of the reflection mirror sent by the position collector within a preset time period.

[0111] It should be noted that in step S11, the position collector collects and transmits the position signals of the reflection mirror. Further, multiple position signals sent by the position collector within a preset time period may be received. The preset time period may be a time period in which the drive system is in a stable state. When the reflection mirror swings at a fixed frequency in accordance with a certain requirement, the drive system may be considered to be in a stable state. Specifically, multiple position signals may be received at equal intervals within a

preset time period, for example, 100 position signals are received in one minute.

[0112] Step S12, calculating, according to the multiple position signals, a linearity of the reflection mirror in the preset time period.

5 [0113] Step S13, determining whether the linearity meets a precision requirement, proceeding to step S14 in a case that the linearity does not meet the precision requirement.

[0114] Step S14, sending an adjusting signal to the potentiometer to increase a power supply voltage, and then receiving multiple position signals to calculate a linearity for judgment again.

10 [0115] It should be noted that in step S12, the received position signals within the preset time period may be converted into a voltage signal, and the linearity of the voltage value corresponding to the multiple voltage signals may be calculated according to the voltage signals converted from the position signals.

[0116] Preferably, the multiple obtained voltage values form an array $a[x]$, where x represents the number of obtained voltage values; the linearity of multiple voltage values is calculated by the linearity formula as follows:

15
$$\text{Linearity} = \text{MAX}|a[x] - b[x]| / (a[\text{max}] - a[\text{min}]) * 100\%; b[x] = K * x;$$

[0117] $b[x]$ represents an ideal value, K represents a value obtained by dividing a difference between the maximum value $a[\text{max}]$ and the minimum value $a[\text{min}]$ in the array by the number of values in the array; $\text{MAX}|a[x] - b[x]|$ represents the maximum of an absolute value of the difference between $a[x]$ and $b[x]$.

20 [0118] It should be noted that in step S13, the calculated linearity is compared with the precision requirement of the reflection mirror to determine whether the linearity meets the precision requirement of the fast-reflection mirror. If the linearity meets the precision requirement of the fast-reflection mirror, it means that the current supply voltage meets the requirement of the fast-reflection mirror image stabilization device. If the linearity does not meet the precision
25 requirement of the fast-reflection mirror, it means that the current supply voltage does not meet the precision requirement of the fast-reflection mirror image stabilization device, and the supply voltage needs to be increased.

[0119] It should be noted that in step S14, when the linearity does not meet the precision requirement, an adjusting signal is sent to the potentiometer to increase the power supply voltage.
30 Since the value of the resistance in the circuit may affect the output voltage of the circuit, the potentiometer may adjust the resistance according to the requirement of the adjustment signal, thereby completing the process of increasing the power supply voltage.

[0120] Of course, those skilled in the art can determine the adjustment mode of the potentiometer according to the actual circuit structure of the driving system, which is not limited here. It should be noted that, the detailed method, for adjusting the resistance by the potentiometer according to the received adjusting signal, may be referred to the conventional art, and the details are not described in the embodiment of the present disclosure.

[0121] Preferably, the adjusting signal may contain information of adjusting the resistance of the potentiometer by taking the minimum variable resistance value of the potentiometer as an adjustment quantity. Therefore, the potentiometer can adjust the resistance of the potentiometer according to the information contained in the received adjusting signal and by using the minimum variable resistance of the potentiometer as the adjustment quantity, thereby ensuring that the power supply voltage can increase slowly, saving resources to a greater extent and avoiding power dissipation.

[0122] Of course, those skilled in the art can also set the adjustment quantity of the potentiometer according to the actual situation, which is not limited here.

[0123] Through the driving method for the fast-reflection mirror image stabilization device described above, it is possible to ensure that a corresponding power supply voltage is provided for the difference of different reflection mirrors. Therefore, the present disclosure, for different reflection mirrors, provides a power supply voltage suitable for the reflection mirror according to position signals of the reflection mirror, avoids unnecessary power dissipation, and has strong self-adaptability to better meet the needs of users.

[0124] Preferably, the driving method for the fast-reflection mirror image stabilization device further includes steps S15 and S16.

[0125] Step S15, recording the minimum voltage value of the power supply voltage when the precision requirement is met.

[0126] Step S16, setting the minimum voltage value to a default voltage value at each startup.

[0127] In this embodiment, by recoding the power supply voltage when the precision requirement is met for the first time as the minimum voltage value of the power supply voltage, and setting the minimum voltage value as the default voltage value when starting each time, the driving steps can be simplified when the fast-reflection mirror image stabilization device is used next time, and the precision requirement can be met through less adjustments, which improves the convenience of operation and better meets the needs of users.

[0128] On the basis of the above embodiments, the structure of the host computer display control

device may be defined. The host computer display control device may include an arithmetic unit, a display and a receiver. The arithmetic unit is in signal connection with the signal processing device, and is configured to receive the image information obtained by the image processing and acquire the detection target. The display is connected with the arithmetic unit, and is configured to display the image information obtained by the image processing and the detection target. The receiver is configured to receive an adjustment instruction for parameters including an azimuth angle and a rotation angle from a user. The receiver is in signal connection with the shooting turntable, the infrared core and the fast-reflection mirror image stabilization device, to output the adjustment instruction.

[0129] Before the display displays the image information, it is necessary to set playing parameters and data sources of the display. The playing parameters include the number of stitched images and the left and right clipping parameters, etc. The specific playing parameters may be set by manually selecting preset parameters of the system, or by receiving the playing parameters through the receiver.

[0130] When the data source is network transmission, the IP address of the input device may be received by the receiver, so that the display can obtain the image data to be displayed. Of course, the network transmission of image data may also be carried out in other ways. For details, please refer to the conventional art, and will not be repeated here.

[0131] When the data source is local image reading and the data type is single frame image data, the single frame image data may be read and synthesized into panoramic image data according to playing parameters, and the synthesized panoramic image data may be displayed on the display.

[0132] Preferably, the display may be a display screen, which includes a panoramic image display area and at least one partial panoramic image display area. In a specific embodiment, the number of partial panoramic image display area is four.

[0133] Preferably, the display area of the partial panoramic image display area may be defined by the user. The method of defining the display area may specifically be frame selection in the panoramic image display area, or the receiver may receive the coordinates of boundary points of the panoramic image display area. Of course, the display area may also be defined by other means. Please refer to the conventional art and will not repeat it here.

[0134] Preferably, the size and position of the partial panoramic image display area may be adjusted according to the needs of users.

[0135] Through a target detection algorithm, the arithmetic unit may analyze the received image

information obtained by the image processing and obtain the detection target in the region. The detection area is defined according to the user's needs. Please refer to the defining method of the display area of the partial panoramic image display area and the conventional art for the way of defining the detection area, which will not be repeated here.

5 **[0136]** Preferably, in addition to displaying rectangular panoramic pictures, the displayer may also project them onto the 360-degree circular interface to restore the field scene pictures and realize a radar chart display function.

10 **[0137]** It should be noted that, the "first" and "second" in terms including the first pitching shaft 21 and the second pitching shaft 22 mentioned in this disclosure are only used to distinguish the difference in position, and do not contain the restriction on the sequence.

[0138] In the present disclosure, the embodiments are described in a progressive manner. Each embodiment mainly focuses on an aspect different from other embodiments, and reference can be made to these similar parts among the embodiments.

15 **[0139]** The infrared panoramic monitoring system according to the present disclosure is described in detail hereinbefore. The principle and embodiments of the present disclosure are described through specific examples herein. The description of the above-described embodiments is merely used to facilitate understanding the method and core idea of the present disclosure. It should be noted that, for the person skilled in the art, a few of improvements and modifications may be made to the present disclosure without departing from the principle of the present
20 disclosure, and these modifications and improvements are also deemed to fall within the protection scope of the present disclosure defined by the claims.

CLAIMS

1. An infrared panoramic monitoring system, comprising:

an infrared core configured to respond to an external synchronization signal and output
5 image information;

a rotation control device configured to drive the infrared core to rotate in a circumferential direction;

a fast-reflection mirror image stabilization device configured to output the external synchronization signal to control the infrared core to output the image information, so as to
10 maintain a stable field of view of the infrared core;

a signal processing device, which is connected with the infrared core and is configured to receive the image information and perform image processing on the image information; and

a host computer display control device, which is in signal connection with the signal processing device and is configured to display image information obtained by the image
15 processing, and acquire a detection target and display the detection target according to the image information obtained by the image processing; wherein

the host computer display control device is in signal connection with the rotation control device and the fast-reflection mirror image stabilization device,

wherein, the fast-reflection mirror image stabilization device comprises a laser, a
20 reflection mirror, a voice coil motor, a position collector, an oscillating mirror control board and a potentiometer; wherein

the voice coil motor is connected with the oscillating mirror control board and the reflection mirror, and is configured to receive position information sent by the oscillating mirror control board and drive the reflection mirror to a control position; and

25 the oscillating mirror control board is connected with the position collector, and the oscillating mirror control board is configured to receive a plurality of position signals of the reflection mirror acquired by the position collector in a preset time period, to acquire a linearity in the preset time period; and

the oscillating mirror control board is configured to, in a case that the linearity does not
30 meet a precision requirement, send an adjusting signal to the potentiometer to increase a

power supply voltage, and then receive a plurality of position signals to calculate a linearity for judgment again.

2. The infrared panoramic monitoring system according to claim 1, wherein the rotation control device is a shooting turntable, and the shooting turntable comprises: a base (5); an optical load chamber (1) for mounting the infrared core and the fast-reflection mirror image stabilization device; a mounting bracket (3) for mounting the optical load chamber (1); an azimuth shafting (4) and a pitching shafting (2), wherein

the azimuth shafting (4) is connected with the mounting bracket (3) and the base (5), and is configured to drive the mounting bracket (3) to rotate at a constant speed relative to the base (5) in a horizontal plane; and

the pitching shafting (2) is connected with the optical load chamber (1) and the mounting bracket (3), and is configured to adjust a pitch angle of the optical load chamber (1) relative to the mounting bracket (3).

3. The infrared panoramic monitoring system according to claim 2, wherein, the azimuth shafting (4) comprises: an azimuth spindle (41) for driving the mounting bracket (3) to rotate relative to the base (5); a torque motor (42) for driving the azimuth spindle (41); an azimuth encoder (45) for feeding back rotation angle information of the azimuth spindle (41); and an azimuth control board connected with the host computer display control device, wherein

both the azimuth encoder (45) and the torque motor (42) are connected with the azimuth control board, and the azimuth control board is configured to control rotation of the torque motor (42) according to an instruction from the host computer display control device and the rotation angle information.

4. The infrared panoramic monitoring system according to claim 3, wherein, the torque motor (42) is installed in an azimuth motor fixing seat (43), and the azimuth motor fixing seat (43) is connected with the base (5); and

the azimuth spindle (41) is mounted in the azimuth motor fixing seat (43) through an azimuth bearing (44), and the azimuth spindle (41) is connected with the mounting bracket (3) to make the torque motor (42) directly drive the azimuth spindle (41).

5. The infrared panoramic monitoring system according to claim 3, wherein, the azimuth control board is configured to receive an image frame frequency signal outputted by the

fast-reflection mirror image stabilization device, and output image clipping information of a panoramic image according to the image frame frequency signal and the rotation angle information.

5 6. The infrared panoramic monitoring system according to claim 3, wherein, the azimuth control board is in signal connection with the fast-reflection mirror image stabilization device, and the azimuth control board is configured to receive the synchronization signal outputted from the fast-reflection mirror image stabilization device, and adjust a position step of a next rotation according to the synchronization signal.

10 7. The infrared panoramic monitoring system according to claim 3, wherein, an end face of the azimuth spindle (41) close to the mounting bracket (3) is provided with an azimuth spindle flange, and the azimuth spindle flange is provided with a plurality of threaded holes for connecting with the mounting bracket (3), and the threaded holes are uniformly arranged in a circumferential direction of the azimuth spindle flange.

15 8. The infrared panoramic monitoring system according to claim 3, wherein, the base (5) is provided with a base cavity for mounting the azimuth encoder (45), and the azimuth encoder (45) is sleeved outside the azimuth spindle (41).

20 9. The infrared panoramic monitoring system according to claim 2, wherein, the pitching shafting (2) comprises: a first pitching shaft (21); a second pitching shaft (22); a worm gear device connected with the first pitching shaft (21); a pitch motor (25) for driving the worm gear device; a pitch encoder (26) for feeding back pitch angle information; and a pitch control board connected with the host computer display control device, wherein

25 both the pitch encoder (26) and the pitch motor (25) are connected with the pitch control board, and the pitch control board is configured to control rotation of the pitch motor (25) according to an instruction from the host computer display control device and the pitch angle information; and

the first pitching shaft (21) and the second pitching shaft (22) are vertically installed between the mounting bracket (3) and the optical load chamber (1), and are respectively fixedly connected with two opposite sides of the optical load chamber (1), and are rotatably connected with the mounting bracket (3).

30 10. The infrared panoramic monitoring system according to claim 9, wherein, an axis of the first pitching shaft (21) is collinear with an axis of the second pitching shaft (22), and an

intersection between the first pitching shaft (21) and the optical load chamber (1) is located at a point corresponding to half of a height of the optical load chamber (1).

11. The infrared panoramic monitoring system according to claim 9, wherein, the worm gear device comprises: a worm gear (23) coaxially arranged with the first pitching shaft (21);
5 and a worm (24) coaxially arranged with an output shaft of the pitch motor (25), wherein an axis of the worm (24) is perpendicular to a bottom surface of the mounting bracket (3).

12. The infrared panoramic monitoring system according to claim 11, wherein, the pitch encoder (26) is sleeved on the first pitching shaft (21), or the pitch encoder (26) is arranged on the worm gear (23).

10 13. The infrared panoramic monitoring system according to claim 10, wherein, the pitching shafting (2) further comprises a brake (27) connected with the pitch control board, and the brake (27) is sleeved on the second pitching shaft (22).

14. The infrared panoramic monitoring system according to any one of claims 2 to 13, wherein, the host computer display control device comprises an arithmetic unit, a displayer
15 and a receiver, wherein

the arithmetic unit is in signal connection with the signal processing device, and is configured to receive the image information obtained by the image processing and acquire the detection target;

the displayer is connected with the arithmetic unit, and is configured to display the image
20 information obtained by the image processing and the detection target;

the receiver is configured to receive an adjustment instruction for parameters comprising an azimuth angle and a rotation angle from a user; and

the receiver is in signal connection with the shooting turntable, the infrared core and the fast-reflection mirror image stabilization device, to output the adjustment instruction.