

LIVING BODY DETECTION METHOD, APPARATUS AND DEVICE

Cross Reference to Related Application

[01]This patent application claims priority to the Chinese Patent Application No. 201810159297.4, filed on February 26, 2018 and entitled “LIVING BODY DETECTION METHOD, APPARATUS AND DEVICE,” which is incorporated by reference herein in its entirety.

Technical Field

[02]The present specification relates to the field of computer technologies, and in particular, to a liveness detection method, apparatus, and device.

Background

[03]At present, biometric recognition manners such as facial recognition, voice recognition, and fingerprint recognition are gradually being applied to identity authentication in various service scenarios. Compared with a traditional identity authentication manner such as password authentication, these authentication manners can authenticate and recognize a user with higher accuracy, thus further strengthening user information security.

[04]Liveness detection is of particular importance during a facial recognition process. Detecting whether a face is a genuine face rather than a falsified face image such as a picture of a face is usually achieved by using a liveness detection technology, so as to effectively prevent people from using falsified faces to spoof facial recognition. However, the current liveness detection manners may bring discomfort to users during the facial recognition process.

[05]Based on the current technologies, a more effective liveness detection manner is desirable.

Summary

[06]The present specification provides a liveness detection method for resolving the problem in the current technologies that the liveness detection brings discomfort to users.

[07]The present specification provides a liveness detection method, comprising:

[08]displaying a preset image, and capturing a face image of a user;

[09]determining an eye image of the user based on the face image; and

[10]performing liveness detection on the user based on the preset image and a to-be-verified image included in the eye image.

5 [11]The present specification provides a liveness detection apparatus for resolving the problem in the current technologies that liveness detection brings discomfort to users.

[12]The present specification provides a liveness detection apparatus, comprising:

[13]a display module, configured to display a preset image and capture a face image of a user;

10 [14]a determination module, configured to determine an eye image of the user based on the face image; and

[15]a detection module, configured to perform liveness detection on the user based on the preset image and a to-be-verified image included in the eye image.

[16]The present specification provides a liveness detection device for resolving the problem in the current technologies that liveness detection brings discomfort to users.

15 [17]The present specification provides a liveness detection device, comprising one or more memories and processors, wherein the one or more memories storing a program configured to cause the one or more processors to execute the following steps:

[18]displaying a preset image, and capturing a face image of a user;

[19]determining an eye image of the user based on the face image; and

20 [20]performing liveness detection on the user based on the preset image and a to-be-verified image included in the eye image.

[21]At least one of the above-described technical solutions used in the present specification can achieve the following beneficial effects:

25 [22]In one or more embodiments of the present specification, after a preset image is displayed to a user, a face image of the user may be captured, and a to-be-verified image included in an eye image of the user may be determined from the face image, so that liveness detection may be performed on the user based on the preset image and the to-be-verified image. In other words, the image reflected in the user's eyeball may be captured by using the high reflectivity feature of the eyeball; the captured reflection image is then matched with the displayed image,
30 so as to perform liveness detection on the user. In this way, natural liveness detection may be

performed on the user by using characteristics of a human body when the user looks at the preset image without feeling the detection, thereby bringing great convenience to the user.

Brief Description of the Drawings

[23]The accompanying drawings described herein are intended to facilitate further understanding of the present specification, and constitute a part of the present specification. The illustrative embodiments of the present specification and the descriptions thereof are used to explain the present specification, and are not intended to constitute an improper limitation on the present specification. In the accompanying drawings:

[24]FIG. 1 is a schematic diagram of a liveness detection process according to the present specification;

[25]FIG. 2 is a schematic diagram of a terminal device performing liveness detection on a user by comparing a to-be-verified image with a preset image according to the present specification;

[26]FIG. 3 is a schematic diagram of a terminal device performing liveness detection on a user by using a plurality of displayed preset images and a plurality of captured face images according to the present specification;

[27]FIG. 4 is a schematic diagram of a liveness detection apparatus according to the present specification; and

[28]FIG. 5 is a schematic diagram of a liveness detection device according to the present specification.

Detailed Description

[29]To ensure information security of a user, a terminal device may perform identity authentication on the user when the user makes a transaction. If the terminal device performs identity authentication on the user by using facial recognition, liveness detection is to be performed on an captured face image when facial recognition is being performed on the user.

[30]In the current technologies, the terminal device may shine light of different colors and intensities on the user's face by virtue of a screen, so as to perform liveness detection by capturing light reflected by the face. Although such a manner may detect to some extent whether a current face image is a face image of a living body, the terminal device is required to shine relatively strong light onto the user's face so that the light reflected by the face may

be captured. The relatively strong light used in this method brings discomfort to the user. Additionally, such a manner relies heavily on the surrounding environment in that if relatively strong ambient light is present in the user's environment, the terminal device will not be able to effectively capture the light reflected by the face, and thus cannot perform liveness detection on the user.

[31]To resolve the above-described problem, in the present specification, the terminal device may display a preset image and capture a face image of the user looking at the preset image. Then the terminal device may determine, from the face image, a to-be-verified image included in an eye image of the user, so that liveness detection may be performed on the user based on the preset image and the to-be-verified image.

[32]Since human eyes can reflect light very easily, the terminal device is not required to display, by means of a screen, to the user an image with relatively strong light. Instead, the terminal device may capture the to-be-verified image reflected in the user's eyeball. By matching the to-be-verified image with the displayed preset image, the terminal device may perform natural liveness detection on the user without the user noticing the detection, which brings great convenience to the user.

[33]To enable those skilled in the art to better understand the technical solutions in one or more embodiments of the present specification, the technical solutions in the one or more embodiments of the present specification will be clearly and completely described below in combination with the accompanying drawings of the one or more embodiments of the present specification. Apparently, the embodiments described below are merely a part, but not all, of the embodiments of the present specification. All of other embodiments, obtained by those of ordinary skill in the art based on the embodiments of the present specification without any creative efforts, fall into the protection scope of the present specification.

[34]FIG. 1 is a schematic diagram of a liveness detection process according to the present specification. The process comprises the following steps:

[35]S100: displaying a preset image, and capturing a face image of a user.

[36]When performing liveness detection on a user, a terminal device may display a preset image to the user. The preset image may be a default fixed image, or may be an image different from those used for previous liveness detection. In other words, during each liveness detection, the terminal device may display to the user the same preset image or a different preset image.

[37]In the present specification, the preset image may include information in a character form, such as a number or a word, or may include information in a pattern form. A size, shape, color, location, and the like of such information in the preset image may constitute characteristic information of the preset image. Since different preset images comprise different characters and patterns, and the characters and patterns in the preset images have different sizes, shapes, colors and the like, different characteristic information may be used to effectively identify different preset images. As a result, the terminal device may subsequently perform liveness detection on the user based on the characteristic information of the preset image. The terminal device described herein may be a device such as a smart phone, a tablet computer, or a notebook computer capable of performing liveness detection on the user.

[38]After displaying the preset image, the terminal device may capture, by using a preset image acquisition apparatus (such as a camera), a face image of the user looking at the preset image.

[39]S102: determining an eye image of the user based on the face image.

[40]After capturing the face image of the user looking at the preset image, the terminal device may recognize, from the face image, a to-be-verified image reflected in the user's eyeball, and then perform liveness detection on the user based on the to-be-verified image and the preset image in a subsequent process.

[41]In the present specification, after capturing the face image of the user, the terminal device may first determine whether the captured face image meets a preset condition by using a preset recognition manner; and after determining that the face image meets the preset condition, the terminal device may further determine, from the face image, an eye image of the user's eye in the face image as an eye image corresponding to the face image; and then the terminal device may extract the to-be-verified image from the eye image.

[42]The preset condition described herein may be in different forms. For example, when it is determined that the image captured when the user looks at the preset image is a face image, it is determined that the face image meets the preset condition. In another example, when it is determined that the captured face image has a sharpness or clarity that reaches a set sharpness or clarity, it is determined that the face image meets the preset condition.

[43]S104: performing liveness detection on the user based on the preset image and the to-be-verified image included in the eye image.

[44]After determining the to-be-verified image from the captured face image, the terminal

device may compare the captured to-be-verified image with the preset image that the terminal device has displayed to the user, and perform liveness detection on the user based on an obtained comparison result. For example, if the to-be-verified image is an image reflected in the user's eyeball when the user looks at the preset image, the content included in the two images should be the same. Based on this, the terminal device may compare characters and patterns comprised in the two images, and characteristic information including the shapes, sizes, colors, locations, and the like of the characters and patterns, and combination thereof, in the two images, so as to determine whether the two images are the same. If the two images are the same, it is determined that the currently captured face image is a face image of a living body; if the two images are different, it is determined that the face image is a face image of a non-living body, as shown in FIG. 2.

[45]FIG. 2 is a schematic diagram of a terminal device performing liveness detection on a user by comparing a to-be-verified image with a preset image according to the present specification.

[46]The terminal device may display to the user the preset image as shown in FIG. 2, and capture a face image of the user looking at the preset image. Then the terminal device may determine an eye image of the user's eye from the face image, so as to extract, from the eye image, a to-be-verified image reflected in the eyeball.

[47]The to-be-verified image captured by the terminal device is in a mirror image relationship with the preset image. Therefore, the terminal device may horizontally flip the to-be-verified image, and then compare the flipped to-be-verified image with the preset image, so as to perform liveness detection on the user.

[48]As can be seen from FIG. 2, the sizes and locations of the two five-pointed stars in the preset image are the same as those of the two five-pointed stars included in the flipped to-be-verified image. Therefore, it may be determined that the to-be-verified image matches the preset image, and it may be further determined that the face image currently captured by the terminal device is a face image of a living body.

[49]During liveness detection, the terminal device may display a static preset image to the user, or may display dynamically changing preset images to the user, i.e., display a plurality of preset images. Therefore, in the present specification, the terminal device may sequentially display a plurality of preset images in a specified order within a preset time, and may continuously capture face images of the user at least within the preset time.

[50]For example, the terminal device may periodically display the preset images that change

in a specified order in every three seconds. Then the terminal device may continuously capture a plurality of face images of the user looking at the continuously changed preset images, extract a plurality of to-be-verified images from the face images, and then compare the plurality of to-be-verified images with the plurality of preset images displayed by the terminal device, so as to perform liveness detection on the user, which is shown in FIG. 3.

[51]FIG. 3 is a schematic diagram of a terminal device performing liveness detection on a user by using a plurality of displayed preset images and a plurality of captured face images according to the present specification.

[52]During liveness detection, the terminal device may, within three seconds, display three preset images to the user in a specified order, and capture face images of the user looking at the three preset images. Then the terminal device may extract, from the captured face images, to-be-verified images reflected in the user's eyeball. Since the to-be-verified images captured by the terminal device are in a mirror image relationship with the preset images respectively, the terminal device may horizontally flip the determined to-be-verified images to obtain all flipped to-be-verified images; and then each of the flipped to-be-verified images is compared with the respective preset image displayed by the terminal device.

[53]When it is determined that each of the flipped to-be-verified images matches the respective preset images displayed by the terminal device, it may be determined that the face images currently captured by the terminal device are face images of a living body.

[54]In the present specification, the terminal device may compare a plurality of captured face images with a plurality of displayed preset images, determine designated preset images from the plurality of preset images, and then perform liveness detection on the user based on the quantity of the preset images. The designated preset image described herein may be a preset image matching at least one to-be-verified image.

[55]For example, assuming that the terminal device determines a plurality of to-be-verified images from a plurality of captured face images, and compares the plurality of to-be-verified images with S displayed preset images. It is found through comparison that the quantity of the designated preset images, among the plurality of preset images, that match the to-be-verified images is A. Therefore, a ratio of the quantity A of the designated preset images to the total quantity S of displayed preset images may be determined. The terminal device may further determine whether the ratio reaches a set ratio; and if it is determined that the ratio reaches the set ratio, the terminal device may determine that the captured face image is a face image of a living body; if it is determined that the ratio does not reach the set ratio, the terminal device

may determine that the captured face image is a face image of a non-living body.

[56]The terminal device may further compare a plurality of captured face images with a plurality of displayed preset images, determine designated face images from the plurality of captured preset images, and then perform liveness detection on the user based on the quantity of the designated face images. The designated face image described herein is a face image matching at least one preset image displayed by the terminal device. For details, reference may be made to the above-described examples, which are not repeated herein.

[57]Certainly, there may be many manners in which the terminal device performs liveness detection on the user based on the determined to-be-verified images and the displayed preset images, which will not be illustrated herein one by one.

[58]It may be seen from the above-described method that, since human eyes can reflect light very easily, the terminal device is not required to display, by means of a screen, to the user an image with relatively strong light. Instead, the terminal device may capture the to-be-verified image reflected in the user's eyeball. By matching the to-be-verified image with the displayed preset image, the terminal device may perform natural liveness detection on the user without the user noticing the detection, which brings great convenience to the user.

[59]It should be noted that in the present specification, after capturing the face image, the terminal device may first determine whether the captured image of the user is an image of a genuine face by using a preset recognition manner. After determining that the captured image is an image of a genuine face, the terminal device may further capture a current eye image of the user by using an image acquisition apparatus, and then extract, from the captured eye image, a to-be-verified image reflected in the user's eyeball.

[60]The liveness detection method according to the one or more embodiments of the present specification is described. Based on the same concept, the present specification further provides a corresponding liveness detection apparatus, as shown in FIG. 4.

[61]FIG. 4 is a schematic diagram of a liveness detection apparatus according to the present specification. The apparatus comprises:

[62]a display module 401, configured to display a preset image, and capture a face image of a user;

[63]a determination module 402, configured to determine an eye image of the user based on the face image; and

[64]a detection module 403, configured to perform liveness detection on the user based on the

preset image and a to-be-verified image included in the eye image.

[65]The determination module 402 is configured to determine whether the face image meets a preset condition; if it is determined that the face image meets the preset condition, extract the eye image of the user from the face image.

5 [66]The preset image comprises a character and/or a pattern, and the to-be-verified image comprises a character and/or a pattern; and

[67]the detection module 403 is configured to perform liveness detection on the user based on characteristic information in the preset image and characteristic information in the to-be-verified image, wherein if the preset image or the to-be-verified image comprises a
10 character, the characteristic information comprises at least one of a size, color, and location of the character in the preset image or the to-be-verified image; if the preset image or the to-be-verified image comprises a pattern, the characteristic information comprises at least one of a shape, size, color, and location of the pattern in the preset image or the to-be-verified image.

15 [68]The to-be-verified image is reflection of the preset image in the user's eye; and

[69]the detection module 403 is configured to compare the preset image with the to-be-verified image, and perform liveness detection on the user based on an obtained comparison result.

[70]The display module 401 is configured to sequentially display a plurality of preset images
20 in a specified order within a preset time; and

[71]the display module 401 is further configured to continuously capture face images of the user at least within the preset time.

[72]The determination module 402 is configured to: for each of the continuously captured face images, determine an eye image of the user based on the face image as an eye image
25 corresponding to the face image; and

[73]the detection module 403 is configured to determine designated preset images from a plurality of displayed preset images, and perform liveness detection on the user based on the quantity of the designated preset images; and/or determine designated face images from the continuously captured face images, and perform liveness detection on the user based on the
30 quantity of the designated face images, wherein each of the designated preset images is a preset image matching a to-be-verified image included in the eye image corresponding to at least one face image; and each of the designated face images is a face image for which a

to-be-verified image included in the corresponding eye image matches at least one preset image.

[74]Based on the above-described liveness detection method, accordingly, the present specification further provides a liveness detection device, as shown in FIG. 5. The device comprises one or more memories and processors, wherein the memory storing a program configured to cause the one or more processors to execute the following steps:

[75]displaying a preset image to a user, and capturing a face image of the user;

[76]determining an eye image of the user based on the face image; and

[77]performing liveness detection on the user based on the preset image and a to-be-verified image included in the eye image.

[78]In one or more embodiments of the present specification, after a preset image is displayed to a user, a face image of the user may be captured; and a to-be-verified image included in an eye image of the user may be determined from the face image, so that liveness detection can be performed on the user based on the preset image and the to-be-verified image.

[79]The image reflected in the user's eyeball may be captured by using the high reflectivity feature of the eyeball; the captured reflection image is matched with the displayed image, so as to perform liveness detection on the user. In this way, natural liveness detection may be performed on the user by using characteristics of a human body when the user looks at the preset image without feeling the detection, thereby bringing great convenience to the user.

[80]In the 1990s, an improvement in technology can be clearly identified as a hardware improvement (for example, an improvement in a diode, a transistor, a switch, and other circuit structures), or a software improvement (for example, an improvement in a method flow). However, with the development of various technologies, an improvement in many method flows nowadays can be considered as a direct improvement in a hardware circuit structure.

Most of design engineers obtain a corresponding hardware circuit structure by programming an improved method flow into a hardware circuit. Therefore, one cannot make the statement that an improvement in a method flow cannot be implemented in a physical hardware module. For example, a programmable logic device (PLD) (for example, a field programmable gate array, FPGA) is such an integrated circuit that the logic functions thereof are determined by programming the device by users. Design engineers can program and "integrate" a digital system in a PLD without having a manufacturer to design and manufacture a dedicated integrated circuit chip. Moreover, at present, instead of manually manufacturing an integrated

circuit chip, the programming in most cases is achieved by using “logic compiler” software. The logic compiler is similar to a software compiler used for developing and compiling a program; and before compilation, the raw codes may also need to be complied in some programming language, which is called hardware description language (HDL); furthermore, there are many types rather than only one type of HDL, such as Advanced Boolean Expression Language (ABEL), Altera Hardware Description Language (AHDL), Confluence, Cornell University Programming Language (CUPL), HDCal, Java Hardware Description Language (JHDL), Lava, Lola, MyHDL, PALASM, Ruby Hardware Description Language (RHDL), and the like, among which VHDL (Very-High-Speed Integrated Circuit Hardware Description Language) and Verilog are most commonly used at present. Those skilled in the art should understand that simply by performing logic programming on a method flow by using the above-described hardware description languages and by programming the method flow into an integrated circuit, a hardware circuit for implementing the logic method flow can be obtained easily.

[81]A controller can be implemented in any appropriate form; for example, the controller can be in the form of a microprocessor or a processor, a computer-readable medium storing a computer-readable program code (for example, software or hardware) which can be executed by the microprocessor/processor, a logic gate, a switch, an application specific integrated circuit (ASIC), a programmable logic controller, and an embedded micro-controller; the examples of controllers include, but are not limited to, the following micro-controllers: ARC 625D, Atmel AT91SAM, Microchip PIC18F26K20, and Silicone Labs C8051F320. A memory controller can also be implemented as a part of a memory control logic. Those skilled in the art should appreciate that besides the controller being implemented by using only computer-readable program codes, it is completely acceptable to perform logic programming on method steps to enable the controller to realize the same functions in the form of a logic gate, a switch, a dedicated integrated circuit, a programmable logic controller, and an embedded micro-controller. Therefore, the controller can be considered as a hardware component; and an apparatus for implementing various functions included in the controller can also be considered as a structure in the hardware component. Alternatively, an apparatus for implementing various functions can be even considered as both a software module for implementing a method and a structure in the hardware component.

[82]Systems, apparatus, modules, or units described in the above-described embodiments may be implemented by computer chips or entities, or by products with some function. A typical implementation device is a computer. For example, the computer, can be a personal

computer, a laptop computer, a cellular phone, a camera phone, a smart phone, a personal digital assistant, a media player, a navigation device, an e-mail device, a game console, a tablet computer, a wearable device, or a combination of any of these devices.

[83]For ease of description, the above apparatus are described on the basis of respective function of each unit thereof. Naturally, when the present specification is implemented, the functions of the units can be implemented in the same one or more software and/or hardware.

[84]Those skilled in the art should appreciate that the embodiments of the present specification can be embodied as a method, a system, or a computer program product. Therefore, the present application can take the form of an entire hardware embodiment, an entire software embodiment or an embodiment combining hardware and software elements. Furthermore, the present specification can take the form of a computer program product embodied in one or more computer usable storage media including computer usable program codes (including, but not limited to, a magnetic disk storage, a CD-ROM, an optical memory, and the like).

[85]The present specification is described with reference to the flow charts and/or block diagrams of the method, device (system), and computer program product according to the one or more embodiments of the present specification. It should be understood that each flow and/or block in the flow charts and/or the block diagrams, and a combination of the flows and/or the blocks in the flow charts and/or the block diagrams can be implemented via computer program instructions. The computer program instructions may be loaded onto a general-purpose computer, a specialized computer, an embedded processor, or a processor of any other programmable data processing device to produce a computer such that the instructions which are executed on the computer or the processor of any other programmable data processing device generate an apparatus for implementing the functions specified in one or more flows in a flow chart and/or one or more blocks in a block diagram.

[86]The computer program instructions can also be stored in a computer readable memory which can boot a computer or other programmable data processing devices to operate in a specific manner, such that the instructions stored in the computer readable memory generate a product comprising an instruction apparatus, wherein the instruction apparatus is configured to implement the functions specified in one or more flows in a flow chart and/or one or more blocks in a block diagram.

[87]The computer program instructions can also be loaded to a computer or other programmable data processing devices, so as to perform a series of operation steps on the

computer or the other programmable devices to generate a computer-implemented process, such that the instructions executed on the computer or the other programmable devices can provide steps for implementing the functions specified in one or more flows in a flow chart and/or one or more blocks in a block diagram.

5 [88]In a typical configuration, a computing device comprises one or more processors (CPU), an input/output interface, a network interface, and an internal memory.

[89]The internal memory may comprise a volatile memory on a computer readable medium, a random access memory (RAM), a non-volatile memory, and/or a non-volatile memory, such as a read-only memory (ROM) or a flash random access memory (flash RAM). The internal
10 memory is an example of the computer readable medium.

[90]The computer readable medium includes non-volatile, volatile, removable, and non-removable media which can store information by using any methods or technologies. The information can be a computer-readable instruction, a data structure, a program module, or other data. Examples of the computer storage medium include, but are not limited to, a
15 phase-change random access memory (PRAM), a static random access memory (SRAM), a dynamic random access memory (DRAM), other types of random access memories (RAM), a read-only memory (ROM), an electrically erasable programmable read-only memory (EEPROM), a flash memory or other memory technologies, a compact disc read-only memory (CD-ROM), a digital versatile disc (DVD) or other optical memories, a cassette tape,
20 and a magnetic tape disk storage, other magnetic storage devices or any other non-transmitting media, which can be used to store information that can be accessed by the computing device. As described herein, the computer-readable media do not include transitory computer-readable media (transitory media), such as modulated data signals and carriers.

[91]It should also be noted that the terms “comprising,” “including” or any other variants
25 thereof are intended to cover non-exclusive inclusion, such that a process, method, a product, or device comprising a series of elements comprises not only those elements but also other elements not explicitly listed, or further comprises inherent elements of such process, method, product or device. Unless more limitations are stated, the element defined by the sentence “comprising a ...” does not exclude the situation that the process, method, commodity, or
30 device comprising the element further comprises another same element.

[92]The present specification can be described in a general context of a computer executable instruction executed by a computer, for example, a program module. Generally, the program module comprises a routine, a program, an object, an assembly, a data structure, and the like

for executing a task or for implementing an abstract data type. The one or more embodiments of the present specification can also be implemented in a distributed computing environment where a task is executed by a remote processing device connected via a communication network. In the distributed computing environment, the program module can be located in a local and a remote computer storage media comprising a storage device.

[93]The embodiments of the present specification are all described in a progressive manner. The same or similar parts in the embodiments may be mutually referenced. Each embodiment emphasizes content different from that in other embodiments. Particularly, the system embodiments are basically similar to the method embodiments, and are thus described in a more concise manner. For relevant content, reference may be made to the content in the method embodiments.

[94]The embodiments of the present specification are described above. Other embodiments fall within the scope of the attached claims. In some situations, actions or steps stated in the claims may be performed in a sequence different from those in the embodiments and the desired results can still be achieved. In addition, the desired results can still be achieved if the processes described in the drawings are not necessarily performed in the illustrated particular or continuous sequence. In some implementation manners, multitasking and parallel processing are also feasible or may be advantageous.

[95]Although one or more embodiments of the present specification are described above, they shall not be construed as limiting the present specification. For those skilled in the art, one or more embodiments of the present specification may have various modifications and variations. Any modification, equivalent replacement, or improvement made within the spirit and principle of the one or more embodiments of the present specification shall fall within the protection scope of the claims of the present specification.

CLAIMS

1. A liveness detection method, comprising:

periodically displaying a plurality of preset images, comprising displaying, in each period, the preset images of the plurality of preset images in a specific order;

continuously capturing face images of a user looking at the periodically displayed preset images, the continuously captured face images of the user forming a plurality of face images;

for each of the plurality of face images, determining an eye image of the user based on the face image; and performing liveness detection on the user based on the plurality of preset images and a plurality of to-be-verified images included in the plurality of eye images of the plurality of face images, wherein each to-be-verified image of the plurality of to-be-verified images is formed by reflection of a corresponding displayed preset image of the plurality of preset images in an eye of the user, wherein the performing liveness detection on the user based on the plurality of preset images and the plurality of to-be-verified images comprises:

extracting the plurality of to-be-verified images from the plurality of eye images,

comparing the plurality of to-be-verified images with the plurality of preset images,

determining, through comparison of the plurality of to-be-verified images with the plurality of preset images, a quantity of designated preset images among the plurality of preset images, wherein the designated preset images are the preset images of the plurality of preset images which match at least a to-be-verified image in the plurality of to-be-verified images,

determining a ratio of the quantity of designated preset images to the total quantity of preset images in the plurality of preset images,

if it is determined that the ratio reaches a set ratio, determining that the plurality of face images are face images of a living body, and

if it is determined that the ratio does not reach the set ratio, determining that the plurality of face images are face images of a non-living body.

2. The method according to claim 1, wherein the determining, for each of the plurality of face images, an eye image of the user based on the face image comprises:

determining whether the face image meets a preset condition; and

if it is determined that the face image meets the preset condition, extracting the eye image of the user from the face image.

3. The method according to claim 1, wherein the plurality of preset images comprises

different preset images having different characters each characterized by respective characteristic information, wherein the different preset images comprise a first preset image having a first character and the plurality of to-be-verified images comprise a second to-be-verified image from a second face image captured during display of the first preset image, the second to-be-verified image comprising a second character;

wherein comparing the plurality of to-be-verified images with the plurality of preset images comprises:

comparing the second to-be-verified image with the first preset image by comparing characteristic information of the first character in the first preset image and characteristic information of the second character in the second to-be-verified image, comprising comparing the size of the first character in the first preset image with the size of the second character in the second to-be-verified image, comparing the color of the first character in the first preset image with the color of the second character in the second to-be-verified image, or comparing the location of the first character in the first preset image with the location of the second character in the second to-be-verified image.

4. The method according to claim 1, wherein the plurality of preset images comprises different preset images having different patterns each characterized by respective characteristic information, wherein the different preset images comprise a first preset image having a first pattern and the plurality of to-be-verified images comprise a second to-be-verified image from a second face image captured during display of the first preset image, the second to-be-verified image comprising a second pattern; and

wherein comparing the plurality of to-be-verified images with the plurality of preset images comprises:

comparing the second to-be-verified image with the first preset image by comparing characteristic information of the first pattern in the first preset image and characteristic information of the second pattern in the second to-be-verified image, comprising comparing the shape of the first pattern in the first preset image with the shape of the second pattern in the second to-be-verified image, comparing the size of the first pattern in the first preset image with the size of the second pattern in the second to-be-verified image, comparing the color of the first pattern in the first preset image with the color of the second pattern in the second to-be-verified image, or comparing the location of the first pattern in the first preset image with the location of the second pattern in the second to-be-verified image.

5. A liveness detection apparatus comprising a display module and a preset image acquisition apparatus and configured to carry out the method of any one of claims 1 to 4.

6. A liveness detection device, comprising one or more memories and processors, wherein the one or more memories storing a program configured to cause the one or more processors to execute the following steps:

5 periodically displaying a plurality of preset images, comprising displaying, in each period, the preset images of the plurality of preset images in a specific order;

continuously capturing face images of a user looking at the periodically displayed preset images, the continuously captured face images of the user a plurality of face images;

for each of the plurality of face images, determining an eye image of the user based on the face image; and

10 performing liveness detection on the user based on the plurality of preset images and a plurality of to-be-verified images included in the plurality of eye images of the plurality of face images, wherein each to-be-verified image of the plurality of to-be-verified images is formed by reflection of a corresponding displayed preset image of the plurality of preset images in an eye of the user, wherein the performing liveness detection on the user based on
15 the plurality of preset images and the plurality of to-be-verified images comprises:

extracting the plurality of to-be-verified images from the plurality of eye images,

comparing the plurality of to-be-verified images with the plurality of preset images,

20 determining, through comparison of the plurality of to-be-verified images with the plurality of preset images, a quantity of designated preset images among the plurality of preset images, wherein the designated preset images are the preset images of the plurality of preset images which match at least a to-be-verified image in the plurality of to-be-verified images,

25 determining a ratio of the quantity of designated preset images to the total quantity of preset images in the plurality of preset images,

if it is determined that the ratio reaches a set ratio, determining that the plurality of face images are face images of a living body, and

30 if it is determined that the ratio does not reach the set ratio, determining that the plurality of face images are face images of a non-living body

7. A computer program product comprising instructions, which, when executed by a liveness detection device according to claim 5, cause the liveness detection device to perform the method according to any one of claims 1 to 4.