

LIVENESS DETECTION METHOD AND APPARATUS, COMPUTER DEVICE, AND STORAGE MEDIUM

RELATED APPLICATION

[0001] This application claims priority to Chinese Patent Application No. 202311292964.3, filed on October 8, 2023 and entitled "LIVING-BODY DETECTION METHOD AND APPARATUS, COMPUTER DEVICE, AND STORAGE MEDIUM", which is incorporated herein by reference in its entirety.

FIELD OF THE TECHNOLOGY

[0002] Embodiments of the present disclosure relate to the field of computer technologies, and in particular, to a living-body detection method and apparatus, a computer device, and a storage medium.

BACKGROUND OF THE DISCLOSURE

[0003] Palm recognition is a technology for performing identity recognition based on palm features and is increasingly applied in daily life. For the security of palm recognition technology, living-body detection may be performed on a palm during palm recognition to ensure that the recognized palm is a living-body palm.

SUMMARY

[0004] Embodiments of the present disclosure provide a living-body detection method and apparatus, a computer device, and a storage medium, which can improve the accuracy of living-body detection. Technical solutions may include the following.

[0005] According to one aspect, a living-body detection method is provided, the method including:

acquiring, by a computer device, a first palm bone and joint image, the first palm bone and joint image including palm bones and joint soft tissues between the palm bones;

performing, by the computer device, super-resolution processing on the first palm bone and joint image to obtain a second palm bone and joint image, resolution of the second palm bone and joint image being greater than that of the first palm bone and joint image;

acquiring, by the computer device, a palm feature corresponding to the second palm bone and joint image; and

determining, by the computer device, a discrimination result based on the palm feature, the discrimination result indicating whether the first palm bone and joint image is a living-body palm bone and joint image, and the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

[0006] According to another aspect, a living-body detection apparatus is provided, the apparatus including:

an image acquisition module, configured to acquire a first palm bone and joint image, the first palm bone and joint image including palm bones and joint soft tissues between the palm bones;

a super-resolution processing module, configured to perform super-resolution processing on the first palm bone and joint image to obtain a second palm bone and joint image, resolution of the second palm bone and joint image being greater than that of the first palm bone and joint image; and

a living-body detection module, configured to acquire a palm feature corresponding to the second palm bone and joint image;

the living-body detection module being further configured to determine a discrimination result based on the palm feature, the discrimination result indicating whether the first palm bone and joint image is a living-body palm bone and joint image, and the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

[0007] According to another aspect, a computer device is provided, the computer device including a processor and a memory, the memory having at least one computer program stored therein, the at least one computer program being loaded and executed by the processor to implement operations performed in the living-body detection method as described in the above aspects.

[0008] According to another aspect, a computer-readable storage medium is provided, the computer-readable storage medium having at least one computer program stored therein, and the at least one computer program being loaded and executed by a processor to implement operations performed in the living-body detection method as described in the above aspects.

[0009] According to another aspect, a computer program product is provided, including a computer program, the computer program being loaded and executed by a processor to implement operations performed in the living-body detection method as described in the above aspects.

[0010] According to another aspect, a palm scanning device is provided, the palm scanning device including:

an X-ray camera, a magnetic resonance imaging device, or an ultrasonic imaging device, configured to acquire a palm bone and joint image; and

a radio frequency (RF) circuit, configured to transmit the palm bone and joint image to a server, the server being configured to perform living-body detection based on the palm bone and joint image.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] To describe the technical solutions in the embodiments of the present disclosure more clearly, the following briefly introduces the accompanying drawings required for describing the embodiments. It is clear that the accompanying drawings in the following description are merely some embodiments of the present disclosure, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

[0012] FIG. 1 is a schematic diagram of an implementation environment according to an embodiment of the present disclosure.

[0013] FIG. 2 is a flowchart of a living-body detection method according to an embodiment of the present disclosure.

[0014] FIG. 3 is a flowchart of another living-body detection method according to an embodiment of the present disclosure.

[0015] FIG. 4 is a schematic diagram of a palm scanning device according to an embodiment of the present disclosure.

[0016] FIG. 5 is a schematic flowchart of a super-resolution processing method according to an embodiment of the present disclosure.

[0017] FIG. 6 is a schematic flowchart of a convolution method according to an embodiment of the present disclosure.

[0018] FIG. 7 is a flowchart of a training method for a super-resolution model according to an embodiment of the present disclosure.

[0019] FIG. 8 is a flowchart of a training method for a living-body detection model according to an embodiment of the present disclosure.

[0020] FIG. 9 is an architectural diagram of a living-body detection method according to an embodiment of the present disclosure.

[0021] FIG. 10 is a schematic structural diagram of a living-body detection apparatus according to an embodiment of the present disclosure.

[0022] FIG. 11 is a schematic structural diagram of another living-body detection apparatus according to an embodiment of the present disclosure.

[0023] FIG. 12 is a schematic structural diagram of a terminal according to an embodiment of the present disclosure.

[0024] FIG. 13 is a schematic structural diagram of a server according to an embodiment of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0025] To make the objectives, technical solutions, and advantages of embodiments of the present disclosure clearer, implementations of the present disclosure will be described in further detail below with reference to the accompanying drawings.

[0026] The terms "first", "second", and the like used in the present disclosure may be used for describing various concepts herein. However, the concepts are not limited by the terms unless otherwise specified. The terms are merely used for distinguishing one concept from another concept. For example, without departing from the scope of the present disclosure, a first palm bone and joint image may be referred to as a second palm bone and joint image, and similarly, the second palm bone and joint image may be referred to as the first palm bone and joint image.

[0027] "At least one" means one or more. For example, at least one image may be any integer number of images greater than or equal to one, such as one image, two images, or three images. "A plurality of" means two or more. For example, a plurality of images may be any integer number of images greater than or equal to two, such as two images or three images. "Each" means each of at least one. For example, each image refers to each of a plurality of images. If the plurality of images are 3 images, each image refers to each of the 3 images.

[0028] For a biometric recognition technology such as a palm recognition technology as referred to in the present disclosure, when the foregoing embodiments of the present disclosure are applied to a specific product or technology, the process of collection, use, and processing of relevant data needs to comply with requirements of national laws and regulations. Before palm bone and joint images or other biological feature images are collected, an information processing rule needs

to be notified and separate consent of a target object needs to be obtained, face information is processed in strict accordance with the requirements of laws and regulations and a personal information processing rule, and technical measures are taken to ensure security of the relevant data.

[0029] Artificial intelligence (AI) involves a theory, a method, a technology, and an application system that use a digital computer or a machine controlled by the digital computer to simulate, extend, and expand human intelligence, perceive an environment, acquire knowledge, and use knowledge to obtain an optimal result. In other words, AI is a comprehensive technology in computer science and attempts to understand essence of intelligence and produce a new intelligent machine that can react in a manner similar to human intelligence. AI is to study design principles and implementation methods of various intelligent machines, to enable the machines to have functions of perception, reasoning, and decision-making.

[0030] An AI technology is a comprehensive discipline, and relates to a wide range of fields including both hardware-level technologies and software-level technologies. Basic AI technologies generally include a sensor, a dedicated AI chip, cloud computing, distributed storage, a big data processing technology, a pre-trained model technology, an operating/interaction system, electromechanical integration, and the like. A pre-trained model is also referred to as a large model or a basic model, and may be widely applied to downstream tasks in various directions of AI after fine tuning. AI software technologies mainly include several major directions such as a computer vision (CV) technology, a speech processing technology, a natural language processing technology, and machine learning (ML)/deep learning.

[0031] ML is a multi-field interdisciplinary, and relates to a plurality of disciplines such as the probability theory, statistics, the approximation theory, convex analysis, and the algorithm complexity theory. ML specializes in studying how a computer simulates or implements a human learning behavior to acquire new knowledge or skills, and reorganize an existing knowledge structure, so as to keep improving its performance. ML is the core of AI, is a basic way to make the computer intelligent, and is applied to various fields of AI. ML and deep learning generally include technologies such as an artificial neural network, a belief network, reinforcement learning, transfer learning, inductive learning, and learning from demonstrations. The pre-trained model is the latest development achievement in deep learning, incorporating the foregoing technologies.

[0032] The CV technology is a field of science that studies how to use a machine to "see", and furthermore, that uses a camera and a computer to replace human eyes to perform machine vision such as recognition and measurement on a target, and further perform graphic processing, so

that the computer processes the target into an image more suitable for human eyes to observe, or an image transmitted to an instrument for detection. As a scientific discipline, CV studies related theories and technologies and attempts to establish an AI system that can acquire information from images or multidimensional data. Large model technologies bring significant transformations to development of the CV technology. Pre-trained models in vision fields such as a Swin-Transformer, a vision transformer (ViT), a vision MoE (V-MoE), and a masked auto encoder (MAE) may be rapidly and widely applied to specific downstream tasks after fine tuning. The CV technology generally includes technologies such as image processing, image recognition, image semantic understanding, image retrieval, optical character recognition (OCR), video processing, video semantic understanding, video content/behavior recognition, three-dimensional (3D) object reconstruction, a 3D technology, virtual reality, augmented reality, simultaneous localization and mapping, and further include common biometric recognition technologies.

[0033] A living-body detection method provided in the embodiments of the present disclosure will be described below based on an AI technology and a CV technology.

[0034] The living-body detection method provided in the embodiments of the present disclosure can be used in a computer device. In some embodiments, the computer device is a terminal or a server. In some embodiments, the server may be a standalone physical server, a server cluster or a distributed system including a plurality of physical servers, or a cloud server that provides basic cloud computing services such as a cloud service, a cloud database, cloud computing, a cloud function, cloud storage, a network service, cloud communication, a middleware service, a domain name service, a security service, a content delivery network (CDN), a big data platform, and an AI platform. In some embodiments, the terminal may be a smartphone, a tablet computer, a notebook computer, a desktop computer, a smart speaker, a smartwatch, a smart terminal, or the like, but is not limited thereto.

[0035] In a possible implementation, computer programs as referred to in the embodiments of the present disclosure may be deployed on a computer device for execution, or may be executed on a plurality of computer devices at one location, or may be executed on a plurality of computer devices distributed at a plurality of locations and connected by a communication network. The plurality of computer devices distributed at the plurality of locations and connected by the communication network can form a blockchain system.

[0036] In a possible implementation, in the embodiments of the present disclosure, a computer device configured to train a super-resolution model and a living-body detection model is a node in the blockchain system. The node can store the trained super-resolution model and

living-body detection model in a blockchain, and then the node or a node corresponding to another device in the blockchain may perform super-resolution processing on an image by using the super-resolution model, or perform living-body detection on the image by using the living-body detection model.

[0037] In a possible implementation, in this embodiment of the present disclosure, the computer device configured to perform living-body detection on the image is a node in the blockchain system. The node can store the image and a discrimination result of the image in a blockchain, and then the node or a node corresponding to another device in the blockchain may query for the image or the discrimination result of the image stored in the blockchain.

[0038] FIG. 1 is a schematic diagram of an implementation environment according to an embodiment of the present disclosure. As shown in FIG. 1, the implementation environment includes: a palm scanning device 101 and a server 102. The palm scanning device 101 may communicate with the server 102 by using a wireless or wired network. The palm scanning device 101 captures a first palm bone and joint image and transmits the first palm bone and joint image to the server 102. The server 102 receives the first palm bone and joint image, performs super-resolution processing on the first palm bone and joint image by using the method provided in this embodiment of the present disclosure to obtain a second palm bone and joint image, and performs living-body detection based on the second palm bone and joint image to obtain a discrimination result. The discrimination result indicates whether the first palm bone and joint image is a living-body palm bone and joint image.

[0039] In some embodiments, when the discrimination result indicates that the first palm bone and joint image is a non-living-body palm bone and joint image, the server 102 transmits a recognition error message to the palm scanning device 101, and the palm scanning device 101 displays the recognition error message to a user, to prompt the user that palm recognition fails. When the discrimination result indicates that the first palm bone and joint image is a living-body palm bone and joint image, the server 102 may further perform identity recognition based on the first palm bone and joint image, if the recognition succeeds, return a recognition success message to the palm scanning device 101, and if the recognition fails, return a recognition error message to the palm scanning device 101.

[0040] The living-body detection method provided in this embodiment of the present disclosure may be applied to any scenario in which a living-body palm is detected.

[0041] For example, in a scenario of palm payment, to determine true identity of a user performing payment, a palm recognition technology is used, and living-body detection is performed

during palm recognition. Firstly, the user places a palm in a scanning region on the palm scanning device. The palm scanning device captures a palm bone and joint image, and then performs living-body detection on the palm bone and joint image by using the method provided in this embodiment of the present disclosure. If it is determined, according to a living-body detection result, that the palm bone and joint image is a living-body palm bone and joint image, identity recognition may be further performed based on the palm bone and joint image, and after the recognition succeeds, a to-be-paid fee may be automatically deducted, to complete palm payment. If it is determined, according to the living-body detection result, that the palm bone and joint image is a non-living-body palm bone and joint image, palm payment fails.

[0042] In the scenario of palm payment, the palm scanning device is a device that performs payment by scanning a palm. The palm scanning device has a function of capturing a palm bone and joint image, a function of performing living-body detection on the palm bone and joint image, a function of performing payment based on the palm bone and joint image, and the like. The palm scanning device may be configured in any position where payment is required, such as shops, supermarkets, and tourist attractions, for use by users. In some embodiments, the palm scanning device may further have a function of capturing another biometric image other than the palm bone and joint image, a function of performing living-body detection on the biometric image, a function of performing payment based on the biometric image, and the like. The biometric image may include a face image, a fingerprint image, an iris image, and the like, which is not limited in this embodiment of the present disclosure.

[0043] In addition, the living-body detection method provided in this embodiment of the present disclosure may further be applied to an access control system, a security authentication system, an intelligent transportation system, another system in which user identity authentication is required, and the like, to ensure security during palm recognition.

[0044] FIG. 2 is a flowchart of a living-body detection method according to an embodiment of the present disclosure. This embodiment of the present disclosure is performed by a computer device. Referring to FIG. 2, the method includes the following operations.

[0045] 201: A computer device acquires a first palm bone and joint image, the first palm bone and joint image including palm bones and joint soft tissues between the palm bones.

[0046] The computer device acquires the first palm bone and joint image. The first palm bone and joint image is obtained by capturing a palm of a user. In this embodiment of the present disclosure, living-body detection needs to be performed on the first palm bone and joint image. Living-body detection is a biometric recognition technology, and is intended to verify whether the

captured first palm bone and joint image is a living-body palm bone and joint image. The living-body palm bone and joint image refers to a palm bone and joint image obtained by photographing a real palm. To be specific, it is detected whether a palm used by the user is a real palm, to distinguish the real palm from a palm model or an imitation such as a palm photograph.

[0047] The first palm bone and joint image includes palm bones and joint soft tissues between the palm bones, and features such as shapes, sizes, and textures of the palm bones and the joint soft tissues may be configured for living-body detection.

[0048] 202: The computer device performs super-resolution processing on the first palm bone and joint image to obtain a second palm bone and joint image, resolution of the second palm bone and joint image being greater than that of the first palm bone and joint image.

[0049] After acquiring the first palm bone and joint image, the computer device performs super-resolution processing on the first palm bone and joint image. The super-resolution processing refers to a technology of reconstructing a low-resolution image into a high-resolution image, which can improve definition and details of an image. Therefore, resolution of the second palm bone and joint image obtained by super-resolution processing is greater than that of the first palm bone and joint image. Content of the second palm bone and joint image is the same as that of the first palm bone and joint image except for the resolution.

[0050] In a possible implementation, the computer device may perform super-resolution processing on the first palm bone and joint image by using a super-resolution model. For example, the super-resolution model may be a super-resolution convolutional neural network (SRCNN), a convolutional neural network (CNN), a ViT, or the like. For a process of performing super-resolution processing by using the super-resolution model, refer to the following embodiment shown in FIG. 3. Details are not described herein. In another possible implementation, the computer device may alternatively perform super-resolution processing by using a reconstruction-based super-resolution algorithm or an edge-enhanced super-resolution algorithm, which is not limited in this embodiment of the present disclosure.

[0051] 203: The computer device acquires a palm feature corresponding to the second palm bone and joint image.

[0052] Since the content of the second palm bone and joint image is the same as that of the first palm bone and joint image, a result of performing living-body detection on the second palm bone and joint image may represent a result of performing living-body detection on the first palm bone and joint image. Moreover, since the resolution of the second palm bone and joint image is

greater than that of the first palm bone and joint image, the computer device can more easily capture detailed information in the second palm bone and joint image. Therefore, in this embodiment of the present disclosure, whether the first palm bone and joint image is a living-body palm bone and joint image is determined by performing living-body detection on the second palm bone and joint image.

[0053] The computer device acquires a palm feature corresponding to the second palm bone and joint image. The palm feature represents features of palm bones and joint soft tissues in the second palm bone and joint image, for example, shapes, sizes, or textures of the palm bones and the joint soft tissues.

[0054] 204: The computer device determines a discrimination result based on the palm feature, the discrimination result indicating whether the first palm bone and joint image is a living-body palm bone and joint image, and the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

[0055] Since the palm feature can represent features of palm bones and joint soft tissues in a palm bone and joint image and there are differences between features of palm bones and joint soft tissues in a living-body palm bone and joint image and features of palm bones and joint soft tissues in a non-living-body palm bone and joint image, the computer device may determine a discrimination result based on the palm feature. The discrimination result indicates whether the first palm bone and joint image is a living-body palm bone and joint image. That is, whether the first palm bone and joint image is a palm bone and joint image obtained by photographing a real palm can be determined according to the discrimination result.

[0056] Since the second palm bone and joint image is an image obtained by performing super-resolution processing on the first palm bone and joint image and the content of the second palm bone and joint image is the same as that of the first palm bone and joint image, a discrimination result obtained based on the palm feature of the second palm bone and joint image can indicate whether the first palm bone and joint image is a living-body palm bone and joint image.

[0057] In a related technology, living-body detection is performed by using features such as a palm outline or a palm print. However, it is very easy to imitate a palm outline and a palm print that are similar to those of a real palm by using a high-precision palm image. Consequently, it is difficult to distinguish a living-body palm from a non-living-body palm, leading to insufficient accuracy of living-body detection.

[0058] According to the method provided in this embodiment of the present disclosure, living-body detection is performed on a palm by using palm bones and joint soft tissues in a palm bone and joint image. Palm bones and joint soft tissues of a real palm have extremely high complexity, causing high difficulty in imitating the palm bones and the joint soft tissues and a large difference between a non-living-body palm bone and joint image obtained by imitation and a real living-body palm bone and joint image. Therefore, living-body detection performed by using the palm bone and joint image has higher accuracy. In addition, considering that the palm bone and joint image includes a large amount of detailed information, super-resolution processing is additionally performed on the palm bone and joint image, to obtain a palm bone and joint image with higher resolution, and living-body detection is performed by using the palm bone and joint image with higher resolution, so that detailed information may not be ignored during living-body detection, thereby further improving the accuracy of living-body detection.

[0059] The embodiment of FIG. 2 is merely a brief description of the living-body detection method. For a more detailed process of the living-body detection method, refer to the following embodiment shown in FIG. 3.

[0060] FIG. 3 is a flowchart of another living-body detection method according to an embodiment of the present disclosure. This embodiment of the present disclosure is performed by a computer device. Referring to FIG. 3, the method includes the following operations.

[0061] 301: A computer device acquires a first palm bone and joint image, the first palm bone and joint image including palm bones and joint soft tissues between the palm bones.

[0062] The computer device acquires the first palm bone and joint image. In a possible implementation, the computer device is a palm scanning device, and the first palm bone and joint image is a palm joint image acquired by the computer device by scanning a palm of a user. In another possible implementation, the computer device is a server. There is a communication connection between the server and the palm scanning device. After capturing the first palm bone and joint image, the palm scanning device transmits the first palm bone and joint image to the computer device (i.e., the server).

[0063] In some embodiments, the palm scanning device may be an X-ray camera, a magnetic resonance imaging device, an ultrasonic imaging device, or the like. Using the X-ray camera as an example, the X-ray camera performs imaging on bones and joint soft tissues of the palm of the user, to obtain a palm bone and joint image. In addition, hardware such as an infrared camera or a depth sensor may be built in the palm scanning device to capture the palm bone and joint image.

[0064] For example, the palm scanning device is an X-ray camera. FIG. 4 is a schematic diagram of a palm scanning device according to an embodiment of the present disclosure. As shown in FIG. 4, the palm scanning device includes a light-emitting component and an imaging component. The light-emitting component is located above, and the imaging component is located below. A space exists between the light-emitting component and the imaging component. The user extends a palm into the space between the light-emitting component and the imaging component. The light-emitting component emits an X-ray downwards to penetrate the palm of the user, and the imaging component below receives the X-ray that penetrates the palm and forms an image, so as to obtain a palm bone and joint image. An X-ray imaging principle is to pass an X-ray through an object to generate a transmission image to acquire an internal structure and information of the object. Propagation and absorption of X-rays in human tissues vary according to different density of the tissues. For example, bones and joint soft tissues have a greater ability to absorb the X-rays. Therefore, in an X-ray image, the bones and the joint soft tissues appear white or gray, so images of the bones and joint soft tissues can be clearly captured. In addition, the palm bones and the joint soft tissues have different morphological changes at different angles and postures, and in addition, the palm bones and the joint soft tissues may also be affected by factors such as a shooting angle, light, and hand occlusion. Therefore, after a palm bone and joint image is captured, quality of the palm bone and joint image may further be determined to determine whether the palm bone and joint image is clear and complete. If the quality of the palm bone and joint image does not meet a standard, the user may further be prompted to adjust a palm angle and re-capture a palm bone and joint image.

[0065] In this embodiment of the present disclosure, a palm is captured by using an X-ray camera, a magnetic resonance imaging device, or an ultrasonic imaging device, to obtain a first palm bone and joint image, so as to perform living-body detection on the first palm bone and joint image. The X-ray camera, the magnetic resonance imaging device, or the ultrasonic imaging device is successfully applied to the field of living-body detection, thereby implementing a novel living-body detection manner.

[0066] In this embodiment of the present disclosure, living-body detection is performed by using a palm bone and joint image. Compared with features such as a palm print or a blood vessel of the palm, bones and joint soft tissues in a real palm are extremely complex and non-replicable, especially the joint soft tissues, which are almost impossible to imitate, and it is very difficult to make a palm model with bones and joint soft tissues similar to those in the real palm. On the one hand, due to great difficulty in imitation, imitation costs of the palm model are increased, which reduces a possibility of launching an attack by an attacker. On the other hand, due to the great

difficulty in imitation, the bones and the joint soft tissues in the made palm model are also quite different from the bones and the joint soft tissues in the real palm. This reduces difficulty in distinguishing a living-body palm bone and joint image from a non-living-body palm bone and joint image, thereby improving accuracy of living-body detection.

[0067] 302: The computer device performs super-resolution processing on the first palm bone and joint image by using a super-resolution model, to obtain a second palm bone and joint image, resolution of the second palm bone and joint image being greater than that of the first palm bone and joint image.

[0068] In this embodiment of the present disclosure, the computer device performs super-resolution processing by using the super-resolution model and inputs the first palm bone and joint image into the super-resolution model, and the super-resolution model outputs the second palm bone and joint image. For example, the super-resolution model is an SRCNN. The SRCNN is an algorithm model constructed based on a CNN and configured to perform super-resolution processing on an image. For a training process of the super-resolution model, refer to the following embodiment shown in FIG. 7. Details are not described herein.

[0069] In a possible implementation, the super-resolution model includes a first feature extraction network, a feature mapping network, and an image reconstruction network. A process in which the computer device performs super-resolution processing by using the super-resolution model includes operation 3021 to operation 3023 below.

[0070] 3021: The computer device acquires a first image feature corresponding to the first palm bone and joint image by using the first feature extraction network.

[0071] The first feature extraction network is configured to extract an image feature corresponding to an input image, to describe the image by using the image feature.

[0072] In some embodiments, the first feature extraction network includes a convolutional network, and the convolutional network may be considered as a filter. The first feature extraction network may include one or more filters. 1 filter is 1 two-dimensional matrix. A quantity of the filters is equal to the quantity of dimensions of the first palm bone and joint image. A quantity of dimensions of an image is a quantity of dimensions included in a pixel value at each position in the image. In some embodiments, the first palm bone and joint image is a one-dimensional image. To be specific, a pixel value at each position in the first palm bone and joint image includes a pixel value in one dimension. For example, in a grayscale image, a pixel value of each pixel includes a grayscale value of the pixel, so the first feature extraction network includes 1 two-dimensional

matrix. In some embodiments, the first palm bone and joint image is a 3D image. To be specific, a pixel value at each position in the first palm bone and joint image includes pixel values in three dimensions. For example, in an RGB image, a pixel value of each pixel includes a red brightness value, a green brightness value, and a blue brightness value, so the first feature extraction network includes 3 two-dimensional matrices. In some embodiments, each filter further corresponds to a bias matrix. The computer device performs convolution processing on the first palm bone and joint image by using the filter, and fuses a convolution processing result with the bias matrix, to obtain the first image feature.

[0073] For example, when the first feature extraction network includes a plurality of filters, each filter corresponds to a pixel value of one dimension in the first palm bone and joint image, and then convolution processing is separately performed on the pixel value in the corresponding dimension in the first palm bone and joint image by using each filter, a convolution processing result is fused with the bias matrix corresponding to the filter, to obtain an image feature in the dimension, and image features in a plurality of dimensions form the first image feature.

[0074] For example, referring to FIG. 5, a first palm bone and joint image 501 has a size of $f1 \times f1 \times n1$, indicating that the first palm bone and joint image 501 includes $f1 \times f1$ pixels and each pixel includes pixel values in $n1$ dimensions. The filter in the first feature extraction network has a size of $f2 \times f2 \times n1$, and the filter further corresponds to a bias matrix with a size of $f2 \times f2 \times n1$, which indicates that the first feature extraction network has $n1$ filters and $n1$ bias matrices and each filter and each bias matrix have a size of $f2 \times f2$. The computer device convolves the first palm bone and joint image 501 by using the filter, and adds a convolution result to the bias matrix, to obtain a first image feature 502. The first image feature 502 has a size of $f3 \times f3 \times n1$. A value of $f3$ depends on the size of the first palm bone and joint image 501, the size of the filter, and a convolution stride.

[0075] In some embodiments, a process in which the computer device acquires the first image feature corresponding to the first palm bone and joint image by using the first feature extraction network may be expressed by Formula (1) below.

$$F1(Y) = \max(0, W1 * Y + B1); \text{ Formula (1)}$$

[0076] where $F1(Y)$ denotes the first image feature, $W1$ denotes the filter in the first feature extraction network, Y denotes the first palm bone and joint image, $B1$ denotes the bias matrix in the first feature extraction network, $\max(\cdot)$ denotes taking a maximum value, and an objective of taking a maximum value of 0 and $W1 * Y + B1$ is to ensure that the feature in the first image feature is no less than 0.

[0077] 3022: The computer device maps the first image feature to a second image feature by using the feature mapping network, a quantity of dimensions of the second image feature being greater than that of the first image feature.

[0078] The feature mapping network is configured to map an image feature having a smaller quantity of dimensions to an image feature having a larger quantity of dimensions, so as to increase the quantity of dimensions of the image feature, enabling an image reconstructed based on the image feature having an increased quantity of dimensions includes more detailed information.

[0079] In some embodiments, the feature mapping network includes a convolutional network, and the convolutional network may be considered as a filter. 1 filter is 1 two-dimensional matrix. The feature mapping network may include a plurality of groups of filters, and a quantity of the filters is equal to the quantity of dimensions of the first image feature. In some embodiments, the first image feature is a one-dimensional image feature, that is, a quantity of features at each position in the first image feature is one, so each group of filters includes 1 two-dimensional matrix. In some embodiments, the first image feature is a 3D image feature, that is, a quantity of features at each position in the first image feature is three, so each group of filters includes 3 two-dimensional matrices. In some embodiments, each filter further corresponds to a bias matrix. The computer device performs convolution processing on the first image feature by using the filter, and fuses a convolution processing result with the bias matrix, to obtain the second image feature.

[0080] For example, when the feature mapping network includes a plurality of groups of filters, each group of filters corresponds to one dimension in the first palm bone and joint image, and thus corresponds to a feature in one dimension in the first image feature. Then, convolution processing is separately performed on the feature in the corresponding dimension in the first image feature by using each group of filters, a convolution processing result is fused with the bias matrix corresponding to the filter, to obtain an image feature in the dimension, and image features in a plurality of dimensions form the second image feature.

[0081] For example, referring to FIG. 5, the first image feature 502 has a size of $f3 \times f3 \times n1$, indicating that the first image feature includes $f3 \times f3$ positions and each position includes features in $n1$ dimensions. The filter in the feature mapping network has a size of $f4 \times f4 \times n1 \times n2$, and the filter further corresponds to a bias matrix with a size of $f4 \times f4 \times n1 \times n2$, which indicates that the feature mapping network has $n1 \times n2$ filters and $n1 \times n2$ bias matrices and each filter and each bias matrix have a size of $f4 \times f4$. The computer device convolves the first image feature 502 by using the filter, and adds a convolution result to the bias matrix, to obtain a second image feature 503. The second

image feature 503 has a size of $f5 \times f5 \times n1 \times n2$. A value of $f5$ depends on the size of the first image feature 502, the size of the filter, and a convolution stride.

[0082] In some embodiments, a process in which the computer device maps the first image feature to the second image feature by using the feature mapping network may be expressed by Formula (2) below.

$$F2(Y) = \max(0, W2 * F1(Y) + B2); \text{ Formula (2)}$$

[0083] where $F2(Y)$ denotes the second image feature, $W2$ denotes the filter in the feature mapping network, $F1(Y)$ denotes the first image feature, $B2$ denotes the bias matrix in the feature mapping network, $\max(\cdot)$ denotes taking a maximum value, and an objective of taking a maximum value of 0 and $W2 * F1(Y) + B2$ is to ensure that the feature in the second image feature is no less than 0.

[0084] 3023: The computer device reconstructs the second palm bone and joint image based on the second image feature by using the image reconstruction network.

[0085] The image reconstruction network is configured to reconstruct, based on an inputted image feature, an image having the image feature.

[0086] The quantity of dimensions of the first image feature is equal to that of the first palm bone and joint image, and the quantity of dimensions of the second image feature is greater than that of the first image feature. That is, the quantity of dimensions of the second image feature is greater than that of the first palm bone and joint image. Therefore, the second palm bone and joint image reconstructed based on the second image feature includes more detailed information than the first palm bone and joint image, and has higher resolution.

[0087] In a possible implementation, by setting the size of the filter and the convolution stride, a size of the second image feature in each dimension can be equal to a size of the first palm bone and joint image in each dimension, that is, $f5=f1$. In another possible implementation, by setting the size of the filter and the convolution stride, the size of the second image feature in each dimension can be greater than the size of the first palm bone and joint image in each dimension, that is, $f5>f1$.

[0088] In some embodiments, operation 3023 includes: merging features in a plurality of dimensions in the second image feature, to obtain the second palm bone and joint image, so that the quantity of dimensions of the second palm bone and joint image is equal to that of the first palm bone and joint image. For example, referring to FIG. 5, the first palm bone and joint image 501 has a size of $f1 \times f1 \times n1$, the second image feature 503 has a size of $f5 \times f5 \times n1 \times n2$, and each $n2$ features of

features in $n1 \times n2$ dimensions in the second image feature 503 are merged into one feature, so that a quantity of dimensions after merging is $n1$. In addition, a pixel value in each dimension of the second palm bone and joint image is obtained by merging the features in the plurality of dimensions in the second image feature, and more features are fused, so the pixel value is more accurate, thereby achieving an effect of higher resolution of the second palm bone and joint image.

[0089] In some embodiments, the image reconstruction network may determine the feature in each dimension after merging based on the features in the plurality of dimensions by averaging. Alternatively, the image reconstruction network may determine the feature in each dimension after merging based on the features in the plurality of dimensions by convolution processing. For example, the image reconstruction network includes a convolutional network, and the convolutional network may be considered as a filter. 1 filter is 1 two-dimensional matrix. Referring to FIG. 5, the second image feature 503 has a size of $f5 \times f5 \times n1 \times n2$, the filter of the image reconstruction network has a size of $f6 \times f6 \times n1 \times n2$, and the filter further corresponds to a bias matrix with a size of $f6 \times f6 \times n1 \times n2$. The computer device convolves the second image feature 503 by using the filter, and adds a convolution result to the bias matrix, to obtain a second palm bone and joint image 504. The second palm bone and joint image 504 has a size of $f7 \times f7 \times n1$, achieving an effect of merging features in $n1 \times n2$ dimensions in the second image feature 503 to obtain features in $n1$ dimensions. A value of $f7$ depends on the size of the second image feature 503, the size of the filter, and a convolution stride. In some embodiments, by setting the size of the filter and the convolution stride, the size of the second palm bone and joint image 504 in each dimension (such as $f7 \times f7$) can be equal to the size of the first palm bone and joint image 501 in each dimension (such as $f1 \times f1$). When $n1$ is equal to 1, the second palm bone and joint image is a 1-dimensional image. When $n1$ is equal to 3, the second palm bone and joint image is a 3D image.

[0090] In some embodiments, a process in which the computer device reconstructs the second palm bone and joint image based on the second image feature by using the image reconstruction network may be expressed by Formula (3) below.

$$F3(Y) = W3 * F2(Y) + B3; \text{ Formula (3)}$$

[0091] where $F3(Y)$ denotes the second palm bone and joint image, $W3$ denotes the filter in the image reconstruction network, $F2(Y)$ denotes the second image feature, and $B3$ denotes the bias matrix in the image reconstruction network.

[0092] In conclusion, a convolution operation is used in operation 3021 to operation 3023. For an operation process of the convolution operation, refer to FIG. 6. FIG. 6 is a schematic diagram of a convolution method according to an embodiment of the present disclosure. As shown

in FIG. 6, a large matrix on the left is input data 601 (for example, the first palm bone and joint image, the first image feature, or the second image feature), and each value in the input data 601 represents a pixel value of a pixel. A small matrix on the right is a filter 602, and each value in the filter 602 represents a parameter of the filter. The filter 602 convolves a region that is in the input data 601 and has the same size as that of the filter 602, to obtain a value 6. The value 6 represents a pixel value of a pixel in a convolution result. Different convolution strides are set, the filter 602 is moved sequentially on the input data 601, and regions having the same size as the filter 602 are selected, so that the input data 601 is divided into different quantities of regions. Each region obtained by division and the filter 602 are separately convolved according to the convolution stride, and convolution results of the regions form a convolution result of the entire input data 601 and the filter 602.

[0093] In this embodiment of the present disclosure, on the one hand, to reduce a requirement for a palm scanning environment, reduce costs of the palm scanning device, and reduce a network transmission load, the palm scanning device captures a first palm bone and joint image with lower resolution. On the other hand, considering that more detailed information in an image may be ignored when living-body detection is performed directly by using the first palm bone and joint image with lower resolution, after the first palm bone and joint image is obtained, super-resolution processing is performed on the first palm bone and joint image to obtain a second palm bone and joint image with higher resolution, and subsequently, living-body detection is performed by using the second palm bone and joint image. This enables a living-body detection process to rely on more detailed information, helping to improve accuracy of living-body detection.

[0094] 303: The computer device acquires a palm feature corresponding to the second palm bone and joint image by using a living-body detection model.

[0095] In this embodiment of the present disclosure, the computer device performs living-body detection by using the living-body detection model, inputs the second palm bone and joint image into the living-body detection model, and the living-body detection model outputs a discrimination result. For example, the living-body detection model is a CNN. For a training process of the living-body detection model, refer to the following embodiment shown in FIG. 8. Details are not described herein.

[0096] The living-body detection model includes a second feature extraction network. After the computer device inputs the second palm bone and joint image into the living-body detection model, the second feature extraction network in the living-body detection model acquires the palm feature corresponding to the second palm bone and joint image.

[0097] In a possible implementation, the second feature extraction network includes a convolutional layer and a pooling layer. The convolutional layer performs convolution processing on the second palm bone and joint image to obtain a convolution result, and then the pooling layer performs pooling processing on the convolution result to reduce a quantity of dimensions, thereby obtaining the palm feature. The palm feature represents features of the palm bones and the joint soft tissues in the second palm bone and joint image, for example, shapes, sizes, or textures of the palm bones and the joint soft tissues.

[0098] 304: The computer device determines a discrimination result based on the palm feature by using the living-body detection model, the discrimination result indicating whether the first palm bone and joint image is a living-body palm bone and joint image, and the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

[0099] The living-body detection model includes a classification network. After obtaining the palm feature, the second feature extraction network in the living-body detection model inputs the palm feature into the classification network, and the computer device determines the discrimination result based on the palm feature by using the classification network. Since the palm feature can represent features of palm bones and joint soft tissues in a palm bone and joint image and there are differences between features of palm bones and joint soft tissues in a living-body palm bone and joint image and features of palm bones and joint soft tissues in a non-living-body palm bone and joint image, the classification network can determine the discrimination result based on the palm feature.

[00100] In a possible implementation, the classification network is a softmax (an activation function) classifier, which is not limited in this embodiment of the present disclosure.

[00101] In a possible implementation, the discrimination result is a value ranging from 0 to 1, indicating a probability that the first palm bone and joint image is a living-body palm bone and joint image. When the discrimination result is greater than a target threshold, it may be considered that the first palm bone and joint image is a living-body palm bone and joint image. When the discrimination result is no greater than the target threshold, it may be considered that the first palm bone and joint image is a non-living-body palm bone and joint image. The target threshold is a value ranging from 0 to 1. For example, the target threshold is 0.5, 0.6, 0.7, or the like.

[00102] In a possible implementation, the classification network is a binary classification network. The discrimination result is 0 or 1. When the discrimination result is 0, it indicates that the first palm bone and joint image is a non-living-body palm bone and joint image. When the

discrimination result is 1, it indicates that the first palm bone and joint image is a living-body palm bone and joint image.

[00103] 305: The computer device acquires a label result of the first palm bone and joint image. The label result represents a true result of whether the first palm bone and joint image is a living-body palm bone and joint image.

[00104] The first palm bone and joint image is an image captured by the palm scanning device. Operation 301 to operation 304 are a process in which the computer device performs living-body detection on the first palm bone and joint image and are also a process in which the living-body detection model performs living-body detection on the second palm bone and joint image. In addition to using the living-body detection model to perform living-body detection on the second palm bone and joint image to determine whether the first palm bone and joint image is a living-body palm bone and joint image, whether the first palm bone and joint image is a living-body palm bone and joint image may also be determined by manual determination. A result determined by manual determination may be referred to as a label result of the first palm bone and joint image. The label result represents a true result of whether the first palm bone and joint image is a living-body palm bone and joint image. That is, the label result is accurate and error-free.

[00105] 306: The computer device determines the first palm bone and joint image and the label result as training samples or determines the second palm bone and joint image and the label result as training samples when the discrimination result is inconsistent with the label result.

[00106] The computer device compares the discrimination result obtained by the living-body detection model with an accurate label result. If the discrimination result is inconsistent with the label result, indicating that an error occurs during living-body detection of the living-body detection model, the computer device determines the first palm bone and joint image and the label result as training samples or determines the second palm bone and joint image and the label result as training samples.

[00107] "The discrimination result is inconsistent with the label result" means that a situation indicated by the discrimination result is different from that indicated by the label result. For example, the discrimination result indicates that the first palm bone and joint image is a living-body palm bone and joint image, but the label result indicates that the first palm bone and joint image is a non-living-body palm bone and joint image. Alternatively, the discrimination result indicates that the first palm bone and joint image is a non-living-body palm bone and joint image, but the label result indicates that the first palm bone and joint image is a living-body palm bone and joint image.

[00108] 307: The computer device trains the living-body detection model based on the training samples.

[00109] In this embodiment of the present disclosure, since it is impossible to predict all possible attack manners and types of imitated palms, the trained living-body detection model is at risk of overfitting, further leading to a situation in which the living-body detection model makes an error in a discrimination result of a palm bone and joint image. However, when the living-body detection model makes an error in the discrimination result of the palm bone and joint image, some features in the palm bone and joint image have not been learned by the living-body detection model. Therefore, the palm bone and joint image and the corresponding label result are used as training samples, and the living-body detection model continues to be trained by using training samples collected in a real environment, so as to continuously train and optimize the living-body detection model, thereby improving a generalization capability and accuracy of the living-body detection model. For a process of training the living-body detection model based on training samples, refer to the following embodiment shown in FIG. 8.

[00110] According to the method provided in this embodiment of the present disclosure, living-body detection is performed on a palm by using palm bones and joint soft tissues in a palm bone and joint image. Palm bones and joint soft tissues of a real palm have extremely high complexity, causing high difficulty in imitating the palm bones and the joint soft tissues and a large difference between a non-living-body palm bone and joint image obtained by imitation and a real living-body palm bone and joint image. Therefore, living-body detection performed by using the palm bone and joint image has higher accuracy. In addition, considering that the palm bone and joint image includes a large amount of detailed information, super-resolution processing is additionally performed on the palm bone and joint image, to obtain a palm bone and joint image with higher resolution, and living-body detection is performed by using the palm bone and joint image with higher resolution, so that detailed information may not be ignored during living-body detection, thereby further improving the accuracy of living-body detection.

[00111] In addition, in this embodiment of the present disclosure, compared with performing living-body detection based on features such as a palm print, living-body detection performed based on palm bones and joint soft tissues is less likely to be forged and cracked, which can effectively prevent a risk that a biological recognition technology is stolen or cracked, thereby improving reliability and security of the biological recognition technology.

[00112] In addition, in this embodiment of the present disclosure, super-resolution processing is performed on the first palm bone and joint image by using the super-resolution model including

the first feature extraction network, the feature mapping network, and the image reconstruction network, to obtain the second palm bone and joint image. The super-resolution model has a simple network architecture, improving processing efficiency, and it is ensured that the second palm bone and joint image includes more detailed information, thereby improving an effect of super-resolution processing and further improving the accuracy of living-body detection.

[00113] In addition, in this embodiment of the present disclosure, living-body detection is performed on the second palm bone and joint image by using the living-body detection model including the second feature extraction network and the classification network. The living-body detection model has a simple network architecture, and a discrimination result can be quickly obtained without complex operations, thereby improving processing efficiency.

[00114] FIG. 7 is a flowchart of a training method for a super-resolution model according to an embodiment of the present disclosure. This embodiment of the present disclosure is performed by a computer device. Referring to FIG. 7, the method includes the following operations.

[00115] 701: A computer device acquires a first sample palm bone and joint image and a second sample palm bone and joint image, content of the first sample palm bone and joint image being the same as that of the second sample palm bone and joint image, and resolution of the second sample palm bone and joint image being greater than that of the first sample palm bone and joint image.

[00116] The first sample palm bone and joint image and the second sample palm bone and joint image differ in resolution but have the same content. Therefore, supervised training may be performed on the super-resolution model by using the first sample palm bone and joint image and the second sample palm bone and joint image.

[00117] The first sample palm bone and joint image and the second sample palm bone and joint image may be living-body palm bone and joint images or may be non-living-body palm bone and joint images, which is not limited in this embodiment of the present disclosure.

[00118] 702: The computer device acquires a first sample image feature corresponding to the first sample palm bone and joint image by using a first feature extraction network in a super-resolution model.

[00119] 703: The computer device maps a first sample image feature to a second sample image feature by using a feature mapping network in the super-resolution model, a quantity of dimensions of the second sample image feature being greater than that of the first sample image feature.

[00120] 704: The computer device reconstructs a predicted palm bone and joint image based on the second sample image feature by using an image reconstruction network in the super-resolution model.

[00121] A process of processing the first sample palm bone and joint image to obtain the predicted palm bone and joint image in operation 702 to operation 704 is similar to the process of processing the first palm bone and joint image to obtain the second palm bone and joint image in operation 3021 to operation 3023, and details are not described herein again.

[00122] 705: The computer device trains the super-resolution model based on the predicted palm bone and joint image and the second sample palm bone and joint image.

[00123] The predicted palm bone and joint image is an image with higher resolution predicted by the super-resolution model, and the second sample palm bone and joint image is a real image with higher resolution. Therefore, a smaller difference between the predicted palm bone and joint image and the second sample palm bone and joint image indicates a more accurate predicted palm bone and joint image, that is, a more accurate super-resolution model. Therefore, the computer device trains the super-resolution model based on the predicted palm bone and joint image and the second sample palm bone and joint image, so that the difference between the predicted palm bone and joint image obtained based on the super-resolution model and the second sample palm bone and joint image is reduced.

[00124] In some embodiments, the computer device trains the super-resolution model based on the difference between the predicted palm bone and joint image and the second sample palm bone and joint image, so that the difference between the predicted palm bone and joint image obtained based on the super-resolution model and the second sample palm bone and joint image is reduced.

[00125] In a possible implementation, the computer device determines a first loss value based on the difference between the predicted palm bone and joint image and the second sample palm bone and joint image, and trains the super-resolution model based on the first loss value, so that the first loss value obtained by using the trained super-resolution model is reduced. The first loss value is positively correlated with the difference. The super-resolution model is trained with a goal of reducing the first loss value, so that the difference between the predicted palm bone and joint image obtained based on the trained super-resolution model and the second sample palm bone and joint image can be reduced.

[00126] To train the super-resolution model, the computer device first acquires a training sample set. The training sample set includes a plurality of pairs of sample palm bone and joint images. Each pair of sample palm bone and joint images includes two sample palm bone and joint images having the same content and differing in resolution. A process of training the super-resolution model based on the training sample set includes a plurality of iteration processes. In each iteration process, training is performed based on at least one pair of sample palm bone and joint images. In this embodiment of the present disclosure, only the first sample palm bone and joint image and the second sample palm bone and joint image are used as an example for description.

[00127] In a process of training the super-resolution model, multiple iterations are required. In a possible implementation, training of the super-resolution model is stopped in response to an iteration round reaching a first threshold; or training of the super-resolution model is stopped in response to a first loss value obtained in a current iteration is no greater than a second threshold. The first threshold and the second threshold are both arbitrary values.

[00128] According to the method provided in this embodiment of the present disclosure, in a process of training the super-resolution model, the first sample palm bone and joint image and the second sample palm bone and joint image are used as training samples for supervised learning, and the super-resolution model is trained based on the predicted palm bone and joint image predicted by the super-resolution model and the second sample palm bone and joint image, so that the super-resolution model learns how to reconstruct a palm bone and joint image with higher resolution according to a palm bone and joint image with lower resolution, thereby improving accuracy of the super-resolution model. Further, subsequently, in practical applications, super-resolution processing is performed by using the trained super-resolution model, thereby improving convenience and efficiency of performing super-resolution processing on the palm bone and joint image.

[00129] Moreover, a first loss value is determined based on the difference between the predicted palm bone and joint image and the second sample palm bone and joint image, the first loss value is positively correlated with the difference, and the super-resolution model is trained based on the first loss value, so that the first loss value obtained by using the trained super-resolution model is reduced, thereby enabling training of the super-resolution model with a goal of reducing the first loss value, which can rapidly and effectively improve accuracy of the super-resolution model and speeds up the training.

[00130] FIG. 8 is a flowchart of a living-body detection model according to an embodiment of the present disclosure. This embodiment of the present disclosure is performed by a computer device. Referring to FIG. 8, the method includes the following operations.

[00131] 801: A computer device acquires a third sample palm bone and joint image and a sample label result. The sample label result represents a true result of whether the third sample palm bone and joint image is a living-body palm bone and joint image.

[00132] The computer device acquires the third sample palm bone and joint image and the corresponding sample label result. The third sample palm bone and joint image may be a living-body sample palm bone and joint image, and the sample label result indicates that the third sample palm bone and joint image is a living-body palm bone and joint image. For example, the value 1 is determined as the sample label result. The third sample palm bone and joint image may be a non-living-body sample palm bone and joint image, and the sample label result indicates that the third sample palm bone and joint image is a non-living-body palm bone and joint image. For example, the value 0 is determined as the sample label result.

[00133] For example, when the third sample palm bone and joint image is a non-living-body sample palm bone and joint image, a high-precision palm model, a palm model without bones and joints, a palm model with simple built-in bones, and a palm model using another material (such as metal or wood) as bones may be photographed, to obtain the third sample palm bone and joint image, which forms a training sample of the non-living-body palm bone and joint image, so that the living-body detection model learns features of the non-living-body palm bone and joint image.

[00134] For example, when the third sample palm bone and joint image is a living-body sample palm bone and joint image, real palms of persons of different genders, different ages, and different sizes may be photographed, to obtain the third sample palm bone and joint image, which forms a training sample of the living-body palm bone and joint image, so that the living-body detection model learns features of the living-body palm bone and joint image.

[00135] In a possible implementation, the computer device acquires an original palm bone and joint image, and the original palm bone and joint image is an image on which super-resolution processing has not been performed. The computer device determines the original palm bone and joint image as the third sample palm bone and joint image. Alternatively, the computer device performs super-resolution processing on the original palm bone and joint image to obtain the third sample palm bone and joint image.

[00136] That is, the training sample of the living-body detection model may be a palm bone and joint image on which super-resolution processing has been performed, or may be a palm bone and joint image on which super-resolution processing has not been performed.

[00137] In a possible implementation, the third sample palm bone and joint image and the sample label result may alternatively be training samples acquired in operation 305 to operation 307.

[00138] 802: The computer device acquires a sample palm feature corresponding to the third sample palm bone and joint image using a second feature extraction network.

[00139] 803: The computer device determines a predicted discrimination result based on the sample palm feature using a classification network. The predicted discrimination result represents a prediction result of whether the third sample palm bone and joint image is a living-body palm bone and joint image.

[00140] A process of processing the third sample palm bone and joint image to obtain the predicted discrimination result in operation 802 to operation 803 is similar to the process of processing the second palm bone and joint image to obtain the discrimination result in operation 303 to operation 304, and details are not described herein again.

[00141] 804: The computer device trains a living-body detection model based on the predicted discrimination result and the sample label result.

[00142] The predicted discrimination result is a result predicted by the living-body detection model, and the sample label result is a true result. Therefore, a smaller difference between the predicted discrimination result and the sample label result indicates a more accurate predicted discrimination result, that is, a more accurate living-body detection model. Therefore, the computer device trains the living-body detection model based on the predicted discrimination result and the sample label result, so that the difference between the predicted discrimination result obtained based on the living-body detection model and the sample label result is reduced.

[00143] In some embodiments, the computer device trains the living-body detection model based on a difference between the predicted discrimination result and the sample label result, so that the difference between the predicted discrimination result obtained based on the living-body detection model and the sample label result is reduced.

[00144] In a possible implementation, the computer device determines a first value as a second loss value when the predicted discrimination result is consistent with the sample label result, and determines a second value as the second loss value when the predicted discrimination result is

inconsistent with the sample label result. The second value is greater than the first value. The computer device trains the living-body detection model based on the second loss value, so that the second loss value obtained by using the trained living-body detection model is reduced.

[00145] "The predicted discrimination result is consistent with the sample label result" means that a situation indicated by the discrimination result is the same as that indicated by the label result. "The predicted discrimination result is inconsistent with the sample label result" means that the situation indicated by the discrimination result is different from that indicated by the label result.

[00146] For example, the first value is 0, and the second value is 1. When the predicted discrimination result is consistent with the sample label result, the second loss value is equal to 0. When the predicted discrimination result is inconsistent with the sample label result, the second loss value is equal to 1.

[00147] A second loss value of a positive sample is set to a smaller first value, and a second loss value of a negative sample is set to a larger second value, so that the living-body detection model can be trained with a goal of reducing the second loss value, and the living-body detection model can learn correct knowledge included in the positive sample and incorrect knowledge included in the negative sample, thereby rapidly and effectively improving the accuracy of the living-body detection model and speeding up the training.

[00148] To train the living-body detection model, the computer device first acquires a training sample set. The training sample set includes a plurality of groups of samples, and each group of samples includes a sample palm bone and joint image and a corresponding sample label result. A process of training the living-body detection model based on the training sample set includes a plurality of iteration processes. In each iteration process, training is performed based on at least one group of samples. In this embodiment of the present disclosure, only a group of samples is used as an example for description.

[00149] In a process of training the living-body detection model, multiple iterations are required. In a possible implementation, training of the living-body detection model is stopped in response to an iteration round reaching a first threshold.

[00150] According to the method provided in this embodiment of the present disclosure, in a process of training the living-body detection model, the third sample palm bone and joint image and the sample label result are used as training samples for supervised learning, and the living-body detection model is trained based on the predicted discrimination result predicted by the living-body detection model and the sample label result, so that the living-body detection model learns how to

distinguish, according to features in a palm bone and joint image, whether the palm bone and joint image is a living-body palm bone and joint image, thereby improving accuracy of the living-body detection model. Further, subsequently, in practical applications, living-body detection is performed by using the trained living-body detection model, thereby improving convenience and efficiency of performing living-body detection on the palm bone and joint image.

[00151] FIG. 9 is an architectural diagram of a living-body detection method according to an embodiment of the present disclosure. As shown in FIG. 9, the living-body detection method provided in this embodiment of the present disclosure may be divided into three stages from the perspective of an entire architecture, which are respectively a model training stage, a model use stage, and a model optimization stage.

[00152] The model training stage includes a training process of the super-resolution model and a training process of the living-body detection model. The training process of the super-resolution model is implemented based on a data set of a low-resolution palm bone and joint image and a high-resolution palm bone and joint image. After a network structure and a network parameter of the super-resolution model are initialized, the super-resolution model is trained by using the data set, and the network parameter of the super-resolution model is adjusted by using a method such as a back propagation algorithm or a stochastic gradient descent. The training process of the living-body detection model is implemented based on a data set of a palm bone and joint image and a corresponding label result. After a network structure and a network parameter of the living-body detection model are initialized, the living-body detection model is trained by using the data set, and the network parameter of the living-body detection model is adjusted by using a method such as a back propagation algorithm or a stochastic gradient descent.

[00153] In the model use stage, a palm of a user is scanned on a palm scanning device. The palm scanning device captures a palm bone and joint image. The palm scanning device transmits the captured palm bone and joint image to a backend server by using a network. A super-resolution model and a living-body detection model that are trained are deployed in the server. The server inputs the palm bone and joint image into the super-resolution model, the super-resolution model outputs a palm bone and joint image with higher resolution and then inputs the palm bone and joint image with higher resolution into the living-body detection model, and the living-body detection model outputs a discrimination result.

[00154] In the model optimization stage, if it is found that the discrimination result outputted by the living-body detection model is inconsistent with a true label result of the palm bone and joint image, that is, the living-body detection model makes an error in detection, a new data set may be

formed by the palm bone and joint image with an error in detection and the corresponding label result, and the living-body detection model continues to be trained and optimized by using the new data set, to improve a generalization capability and accuracy of the living-body detection model.

[00155] FIG. 10 is a schematic structural diagram of a living-body detection apparatus according to an embodiment of the present disclosure. Referring to FIG. 10, the apparatus includes:

[00156] an image acquisition module 1001, configured to acquire a first palm bone and joint image, the first palm bone and joint image including palm bones and joint soft tissues between the palm bones;

[00157] a super-resolution processing module 1002, configured to perform super-resolution processing on the first palm bone and joint image to obtain a second palm bone and joint image, resolution of the second palm bone and joint image being greater than that of the first palm bone and joint image; and

[00158] a living-body detection module 1003, configured to acquire a palm feature corresponding to the second palm bone and joint image;

[00159] the living-body detection module 1003 being further configured to determine a discrimination result based on the palm feature, the discrimination result indicating whether the first palm bone and joint image is a living-body palm bone and joint image, and the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

[00160] According to the living-body detection apparatus provided in this embodiment of the present disclosure, living-body detection is performed on a palm by using palm bones and joint soft tissues in a palm bone and joint image. Palm bones and joint soft tissues of a real palm have extremely high complexity, causing high difficulty in imitating the palm bones and the joint soft tissues and a large difference between a non-living-body palm bone and joint image obtained by imitation and a real living-body palm bone and joint image. Therefore, living-body detection performed by using the palm bone and joint image has higher accuracy. In addition, considering that the palm bone and joint image includes a large amount of detailed information, super-resolution processing is additionally performed on the palm bone and joint image, to obtain a palm bone and joint image with higher resolution, and living-body detection is performed by using the palm bone and joint image with higher resolution, so that detailed information may not be ignored during living-body detection, thereby further improving the accuracy of living-body detection.

[00161] In some embodiments, the super-resolution model includes a first feature extraction network, a feature mapping network, and an image reconstruction network; and the super-resolution processing module 1002 is configured to:

[00162] acquire a first image feature corresponding to the first palm bone and joint image by using the first feature extraction network;

[00163] map the first image feature to a second image feature by using the feature mapping network, a quantity of dimensions of the second image feature being greater than that of the first image feature; and

[00164] reconstruct the second palm bone and joint image based on the second image feature by using the image reconstruction network.

[00165] In some embodiments, referring to FIG. 11, the apparatus further includes a first training module 1004, configured to:

[00166] acquire a first sample palm bone and joint image and a second sample palm bone and joint image, content of the first sample palm bone and joint image being the same as that of the second sample palm bone and joint image, and resolution of the second sample palm bone and joint image being greater than that of the first sample palm bone and joint image;

[00167] acquire a first sample image feature corresponding to the first sample palm bone and joint image by using the first feature extraction network;

[00168] map the first sample image feature to a second sample image feature by using the feature mapping network, a quantity of dimensions of the second sample image feature being greater than that of the first sample image feature;

[00169] reconstruct a predicted palm bone and joint image based on the second sample image feature by using the image reconstruction network; and

[00170] train the super-resolution model based on the predicted palm bone and joint image and the second sample palm bone and joint image.

[00171] In some embodiments, the first training module 1004 is configured to:

[00172] determine a first loss value based on a difference between the predicted palm bone and joint image and the second sample palm bone and joint image, the first loss value being positively correlated with the difference; and

[00173] train the super-resolution model based on the first loss value, so that the first loss value obtained by using the trained super-resolution model is reduced.

- [00174] In some embodiments, the living-body detection model includes a second feature extraction network and a classification network;
- [00175] the operation of acquiring a palm feature corresponding to the second palm bone and joint image is performed by using the second feature extraction network; and
- [00176] the operation of determining a discrimination result based on the palm feature is performed by using the classification network.
- [00177] In some embodiments, referring to FIG. 11, the apparatus further includes a second training module 1005, configured to:
- [00178] acquire a third sample palm bone and joint image and a sample label result, where the sample label result represents a true result of whether the third sample palm bone and joint image is a living-body palm bone and joint image;
- [00179] acquire a sample palm feature corresponding to the third sample palm bone and joint image using the second feature extraction network;
- [00180] determine a predicted discrimination result based on the sample palm feature using the classification network, where the predicted discrimination result represents a prediction result of whether the third sample palm bone and joint image is a living-body palm bone and joint image; and
- [00181] train the living-body detection model based on the predicted discrimination result and the sample label result.
- [00182] In some embodiments, the second training module 1005 is configured to:
- [00183] acquire an original palm bone and joint image, the original palm bone and joint image being an image on which super-resolution processing has not been performed; and
- [00184] determine the original palm bone and joint image as the third sample palm bone and joint image; or perform super-resolution processing on the original palm bone and joint image to obtain the third sample palm bone and joint image.
- [00185] In some embodiments, the second training module 1005 is configured to:
- [00186] determine a first value as a second loss value when the predicted discrimination result is consistent with the sample label result, and determine a second value as the second loss value when the predicted discrimination result is inconsistent with the sample label result, the second value being greater than the first value; and

[00187] train the living-body detection model based on the second loss value, so that the second loss value obtained by using the trained living-body detection model is reduced.

[00188] In some embodiments, referring to FIG. 11, the apparatus further includes:

[00189] a label result acquisition module 1006, configured to acquire a label result of the first palm bone and joint image, where the label result represents a true result of whether the first palm bone and joint image is a living-body palm bone and joint image;

[00190] a training sample determination module 1007, configured to determine the first palm bone and joint image and the label result as training samples or determine the second palm bone and joint image and the label result as training samples when the discrimination result is inconsistent with the label result; and

[00191] a second training module 1005, configured to train the living-body detection model based on the training samples.

[00192] In some embodiments, the image acquisition module 1001 is configured to capture a palm by using an X-ray camera, a magnetic resonance imaging device, or an ultrasonic imaging device, to obtain the first palm bone and joint image.

[00193] The living-body detection apparatus provided in the foregoing embodiment is illustrated only with an example of division of the foregoing function modules. In practical applications, the foregoing functions may be allocated to and completed by different function modules according to requirements. That is, an internal structure of the computer device is divided into different function modules to complete all or some of the functions described above. In addition, the embodiments of the living-body detection apparatus and the living-body detection method provided in the foregoing embodiments belong to the same conception. For the specific implementation process thereof, refer to the method embodiments. Details are not described herein again.

[00194] An embodiment of the present disclosure further provides a computer device. The computer device including a processor and a memory. The memory has at least one computer program stored therein, and the at least one computer program is loaded and executed by the processor, to implement operations performed in the living-body detection method in the foregoing embodiments.

[00195] In some embodiments, the computer device is provided as a terminal. FIG. 12 is a schematic structural diagram of a terminal 1200 according to an exemplary embodiment of the present disclosure. The terminal 1200 includes: a processor 1201 and a memory 1202.

[00196] The processor 1201 may include one or more processing cores, for example, a 4-core processor or an 8-core processor. The processor 1201 may be implemented in at least one hardware form of a digital signal processor (DSP), a field programmable gate array (FPGA), and a programmable logic array (PLA). In some embodiments, the processor 1201 may further include an AI processor. The AI processor is configured to process computing operations related to machine learning.

[00197] The memory 1202 may include one or more computer-readable storage media. The computer-readable storage medium may be non-transient. In some embodiments, the non-transient computer-readable storage medium in the memory 1202 is configured to store at least one computer program. The at least one computer program is used by the processor 1201 to implement the living-body detection method provided in the method embodiments of the present disclosure.

[00198] In some embodiments, the terminal 1200 may alternatively include: a peripheral interface 1203 and at least one peripheral. The processor 1201, the memory 1202, and the peripheral interface 1203 may be connected by using a bus or a signal cable. Each peripheral may be connected to the peripheral interface 1203 by using a bus, a signal cable, or a circuit board. In some embodiments, the peripheral device includes: at least one of an RF circuit 1204, a display screen 1205, a camera component 1206, an audio circuit 1207, and a power supply 1208.

[00199] The peripheral interface 1203 may be configured to connect the at least one peripheral related to input/output (I/O) to the processor 1201 and the memory 1202.

[00200] The RF circuit 1204 is configured to receive and transmit an RF signal, also referred to as an electromagnetic signal. The RF circuit 1204 communicates with a communication network and another communication device by using the electromagnetic signal. The RF circuit 1204 converts an electric signal into an electromagnetic signal for transmission, or converts a received electromagnetic signal into an electric signal.

[00201] The display screen 1205 is configured to display a user interface (UI). The UI may include a graph, text, an icon, a video, and any combination thereof. When the display screen 1205 is a touch display screen, the display screen 1205 further has a capability of capturing a touch signal on or above a surface of the display screen 1205. The touch signal may be inputted to the processor 1201 as a control signal for processing. In this case, the display screen 1205 may be further configured to provide a virtual button and/or a virtual keyboard, also referred to as a soft button and/or a soft keyboard.

[00202] The camera component 1206 is configured to capture images or videos. In some embodiments, the camera component 1206 includes a front-facing camera and a rear-facing camera. The front-facing camera is provided on a front panel of the terminal 1200, and the rear-facing camera is provided on a back surface of the terminal 1200.

[00203] The audio circuit 1207 may include a microphone and a speaker. The microphone is configured to acquire sound waves of a user and an environment, and convert the sound waves into electric signals and input the electric signals into the processor 1201 for processing, or input the electric signals into the RF circuit 1204 to implement voice communication. The speaker is configured to convert electric signals from the processor 1201 or the RF circuit 1204 into sound waves. In some embodiments, the audio circuit 1207 may further include an earphone jack.

[00204] The power supply 1208 is configured to supply power to components in the terminal 1200. The power supply 1208 may be an alternating current, a direct current, a primary battery, or a rechargeable battery. When the power supply 1208 includes the rechargeable battery, the rechargeable battery may support wired charging or wireless charging. The rechargeable battery may be further configured to support a fast charging technology.

[00205] In some embodiments, the terminal 1200 further includes one or more sensors 1209. The one or more sensors 1209 include, but are not limited to, an acceleration sensor 1210, a gyroscope sensor 1211, a pressure sensor 1212, an optical sensor 1213, and a proximity sensor 1214.

[00206] The acceleration sensor 1210 may detect magnitude of acceleration on three coordinate axes of a coordinate system established with the terminal 1200. For example, the acceleration sensor 1210 may be configured to detect components of gravity acceleration on the three coordinate axes.

[00207] The gyroscope sensor 1211 may detect a body direction and a rotation angle of the terminal 1200. The gyroscope sensor 1211 may cooperate with the acceleration sensor 1210 to acquire a 3D action by the user on the terminal 1200. The processor 1201 may implement the following functions according to data acquired by the gyroscope sensor 1211: motion sensing (such as changing the UI according to a tilt operation of the user), image stabilization during shooting, game control, and inertial navigation.

[00208] The pressure sensor 1212 may be arranged at a side frame of the terminal 1200 and/or a lower layer of the display screen 1205. When the pressure sensor 1212 is disposed at the side frame of the terminal 1200, a holding signal of the user on the terminal 1200 may be detected.

The processor 1201 performs left and right hand recognition or a quick operation according to the holding signal captured by the pressure sensor 1212. When the pressure sensor 1212 is disposed at the lower layer of the display screen 1205, the processor 1201 controls, according to a pressure operation of the user on the touch display screen 1205, an operable control on the UI. The operable control includes at least one of a button control, a scroll-bar control, an icon control, and a menu control.

[00209] The optical sensor 1213 is configured to capture ambient light intensity. In an embodiment, the processor 1201 may control display brightness of the touch display screen 1205 according to the ambient light intensity captured by the optical sensor 1213. In some embodiments, when the ambient light intensity is higher, the display brightness of the touch display screen 1205 is increased. When the ambient light intensity is lower, the display brightness of the touch display screen 1205 is decreased. In another embodiment, the processor 1201 may further dynamically adjust a shooting parameter of the camera component 1206 according to the ambient light intensity captured by the optical sensor 1213.

[00210] The proximity sensor 1214, also referred to as a distance sensor, is disposed on the front panel of the terminal 1200. The proximity sensor 1214 is configured to capture a distance between the user and a front surface of the terminal 1200. In an embodiment, when the proximity sensor 1214 detects that the distance between the user and the front surface of the terminal 1200 gradually becomes smaller, the display screen 1205 is controlled by the processor 1201 to switch from a screen-on state to a screen-off state. When the proximity sensor 1214 detects that the distance between the user and the front surface of the terminal 1200 gradually becomes larger, the display screen 1205 is controlled by the processor 1201 to switch from the screen-off state to the screen-on state.

[00211] A person skilled in the art may understand that the structure shown in FIG. 12 constitutes no limitation on the terminal 1200, and the terminal may include more or fewer components than those shown in the figure, or some components may be combined, or different component layouts may be used.

[00212] In some embodiments, the computer device is provided as a server. FIG. 13 is a schematic diagram of a structure of a server according to an embodiment of the present disclosure. The server 1300 may vary greatly due to different configurations or performance, and may include one or more central processing units (CPU) 1301 and one or more memories 1302. The memory 1302 has at least one computer program stored therein. The at least one computer program is loaded and executed by the processor 1301 to implement the methods provided in the foregoing method

embodiments. It is clear that the server may further include parts such as a wired or wireless network interface, a keyboard, and an I/O interface, to perform input and output. The server may further include another part configured to implement a device function. Details are not described herein again.

[00213] An embodiment of the present disclosure further provides a computer-readable storage medium. The computer-readable storage medium has at least one computer program stored therein, and the at least one computer program is loaded and executed by a processor to implement the operations performed in the living-body detection method in the foregoing embodiments.

[00214] An embodiment of the present disclosure further provides a computer program product, including a computer program. The computer program is loaded and executed by a processor to implement the operations performed in the living-body detection method in the foregoing embodiments.

[00215] An embodiment of the present disclosure further provides a palm scanning device. The palm scanning device includes:

[00216] an X-ray camera, a magnetic resonance imaging device, or an ultrasonic imaging device, configured to acquire a palm bone and joint image; and

[00217] an RF circuit, configured to transmit the palm bone and joint image to a server, the server being configured to perform living-body detection based on the palm bone and joint image.

[00218] For details of a process in which the server performs living-body detection based on the palm bone and joint image, refer to the foregoing embodiment. Details are not described herein again.

[00219] In some embodiments, the palm scanning device includes an X-ray camera;

[00220] the X-ray camera includes: a light-emitting component and an imaging component;

[00221] the light-emitting component is located above, the imaging component is located below, and a space exists between the light-emitting component and the imaging component;

[00222] the light-emitting component is configured to emit an X-ray downwards to penetrate a palm between the light-emitting component and the imaging component; and

[00223] the imaging component is configured to receive the X-ray that penetrates the palm and form an image, to obtain the palm bone and joint image.

[00224] For example, a structure of the X-ray camera is shown in FIG. 4.

[00225] In some embodiments, this embodiment of the present disclosure is applied to a palm payment scenario, and the palm scanning device is a palm payment device. When a user needs to pay a fee, the user places a palm in the space between the light-emitting component and the imaging component. In the palm payment device, the light-emitting component emits an X-ray downwards to penetrate the palm between the light-emitting component and the imaging component. The imaging component is configured to receive the X-ray that penetrates the palm and form an image, to obtain a palm bone and joint image. Then, the palm bone and joint image is transmitted to the server by using the RF circuit. After acquiring the palm bone and joint image, the server performs super-resolution processing on the palm bone and joint image, to obtain a palm bone and joint image with higher resolution and acquire a palm feature corresponding to the palm bone and joint image with higher resolution, thereby determining a discrimination result based on the palm feature. If the discrimination result indicates that the palm bone and joint image is a living-body palm bone and joint image, identity recognition is performed based on the palm bone and joint image, an account of the user is determined, and the fee is paid from the account of the user. In some embodiments, if the discrimination result indicates that the palm bone and joint image is a non-living-body palm bone and joint image, a recognition error message is transmitted to the palm scanning device, and the palm scanning device displays the recognition error message to prompt the user that palm recognition fails.

[00226] In addition, this embodiment of the present disclosure is also applicable to other scenarios, and the palm scanning device may be a device configured to implement other functions in addition to palm payment. The application scenarios of the palm scanning device are not limited in this embodiment of the present disclosure. For example, in a scenario in which an access control system is unlocked by using a palm, the palm scanning device is a verification device of the access control system. When needing to open the access control system, the user scans a palm on the palm scanning device. After obtaining a palm bone and joint image, the palm scanning device transmits the palm bone and joint image to the server. After acquiring the palm bone and joint image, the server performs super-resolution processing on the palm bone and joint image, to obtain a palm bone and joint image with higher resolution and acquire a palm feature corresponding to the palm bone and joint image with higher resolution, thereby determining a discrimination result based on the palm feature. If the discrimination result indicates that the palm bone and joint image is a living-body palm bone and joint image, identity recognition is performed based on the palm bone and joint image, it is determined that the user is allowed to enter the access control system, and then the access control system is unlocked. If the discrimination result indicates that the palm bone and joint image is a non-living-body palm bone and joint image, a recognition error message is

transmitted to the palm scanning device, and the palm scanning device displays or plays the recognition error message to prompt the user that palm recognition fails.

[00227] In some embodiments, the palm scanning device may further include a display screen. After the user places the palm in the space between the light-emitting component and the imaging component, a recognition message may be displayed by using the display screen, such as a recognition success message or a recognition failure message, to facilitate the user to understand a recognition result.

[00228] In some embodiments, the palm scanning device may further include a camera component. An image, such as a face image or an iris image, of the user may be captured by using the camera component, to perform operations such as identity recognition and payment based on the captured image.

[00229] In some embodiments, the palm scanning device may further include an audio circuit. The audio circuit includes a microphone. A sound of the user may be captured by using the microphone, to perform voiceprint recognition based on the captured sound, so as to perform operations such as identity recognition and payment based on the recognized voiceprint.

[00230] In some embodiments, the palm scanning device may further include an audio circuit. The audio circuit includes a speaker. A voice message may be played by using the speaker. For example, after the palm bone and joint image of the user is recognized, a recognition message, such as a recognition success message or a recognition failure message, may be played by using the speaker.

[00231] In addition, the palm scanning device may further include other components, for example, one or more components shown in FIG. 12, which is not limited in this embodiment of the present disclosure.

[00232] A person of ordinary skill in the art may understand that all or some of the steps of the foregoing embodiments may be implemented by hardware, or may be implemented by a program instructing relevant hardware. The program may be stored in a computer-readable storage medium. The storage medium may be a read-only memory, a magnetic disk, an optical disc, or the like.

[00233] The above descriptions are merely exemplary embodiments of the embodiments of the present disclosure, and are not intended to limit the embodiments of the present disclosure. Any modification, equivalent replacement, improvement, and the like made within the spirit and

principle of the embodiments of the present disclosure fall within the protection scope of the present disclosure.

CLAIMS

1. A method for living-body detection, comprising:

acquiring, by a computer device, a first palm bone and joint image, wherein the first palm bone and joint image comprises palm bones and joint soft tissues between the palm bones;

performing, by the computer device, super-resolution processing on the first palm bone and joint image to obtain a second palm bone and joint image, wherein a resolution of the second palm bone and joint image is greater than a resolution of the first palm bone and joint image;

acquiring, by the computer device, a palm feature corresponding to the second palm bone and joint image; and

determining, by the computer device, a discrimination result based on the palm feature, wherein the discrimination result indicates whether the first palm bone and joint image is a living-body palm bone and joint image, the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

2. The method according to claim 1, wherein a super-resolution model comprises a first feature extraction network, a feature mapping network, and an image reconstruction network; and

wherein performing, by the computer device, the super-resolution processing on the first palm bone and joint image to obtain the second palm bone and joint image comprises:

acquiring, by the computer device, a first image feature corresponding to the first palm bone and joint image using the first feature extraction network;

mapping, by the computer device, the first image feature to a second image feature using the feature mapping network, wherein a quantity of dimensions of the second image feature is greater than that of the first image feature; and

reconstructing, by the computer device, the second palm bone and joint image based on the second image feature using the image reconstruction network.

3. The method according to claim 2, wherein a training process of the super-resolution model comprises:

acquiring a first sample palm bone and joint image and a second sample palm bone and joint image, wherein content of the first sample palm bone and joint image is the same as that of the second sample palm bone and joint image, and resolution of the second sample palm bone and joint image is greater than that of the first sample palm bone and joint image;

acquiring a first sample image feature corresponding to the first sample palm bone and joint image using the first feature extraction network;

mapping the first sample image feature to a second sample image feature using the feature mapping network, wherein a quantity of dimensions of the second sample image feature is greater than that of the first sample image feature;

reconstructing a predicted palm bone and joint image based on the second sample image feature using the image reconstruction network; and

training the super-resolution model based on the predicted palm bone and joint image and the second sample palm bone and joint image.

4. The method according to claim 3, wherein training the super-resolution model based on the predicted palm bone and joint image and the second sample palm bone and joint image comprises:

determining a first loss value based on a difference between the predicted palm bone and joint image and the second sample palm bone and joint image, wherein the first loss value is positively correlated with the difference; and

training the super-resolution model based on the first loss value, to reduce the first loss value obtained using a trained super-resolution model.

5. The method according to any one of claims 1 to 4, wherein a living-body detection model comprises a second feature extraction network and a classification network;

the operation of acquiring, by the computer device, the palm feature corresponding to the second palm bone and joint image is performed using the second feature extraction network; and

the operation of determining, by the computer device, the discrimination result based on the palm feature is performed using the classification network.

6. The method according to claim 5, wherein a training process of the living-body detection model comprises:

acquiring a third sample palm bone and joint image and a sample label result, wherein the sample label result represents a true result of whether the third sample palm bone and joint image is a living-body palm bone and joint image;

acquiring a sample palm feature corresponding to the third sample palm bone and joint image using the second feature extraction network;

determining a predicted discrimination result based on the sample palm feature using the

classification network, wherein the predicted discrimination result represents a prediction result of whether the third sample palm bone and joint image is a living-body palm bone and joint image; and

training the living-body detection model based on the predicted discrimination result and the sample label result.

7. The method according to claim 6, wherein acquiring the third sample palm bone and joint image comprises:

acquiring an original palm bone and joint image, wherein the original palm bone and joint image is an image on which super-resolution processing has not been performed; and

determining the original palm bone and joint image as the third sample palm bone and joint image; or performing super-resolution processing on the original palm bone and joint image to obtain the third sample palm bone and joint image.

8. The method according to claim 6 or 7, wherein training the living-body detection model based on the predicted discrimination result and the sample label result comprises:

determining a first value as a second loss value when the predicted discrimination result is consistent with the sample label result, and determining a second value as the second loss value when the predicted discrimination result is inconsistent with the sample label result, wherein the second value is greater than the first value; and

training the living-body detection model based on the second loss value, to reduce the second loss value obtained using a trained living-body detection model.

9. The method according to any one of claims 5 to 8, wherein after the determining the discrimination result based on the palm feature, the method further comprises:

acquiring a label result of the first palm bone and joint image, wherein the label result represents a true result of whether the first palm bone and joint image is a living-body palm bone and joint image;

determining the first palm bone and joint image and the label result as training samples or determining the second palm bone and joint image and the label result as training samples when the discrimination result is inconsistent with the label result; and

training the living-body detection model based on the training samples.

10. The method according to any one of claims 1 to 9, wherein acquiring, by the computer device, the first palm bone and joint image comprises:

capturing, by the computer device, a palm using an X-ray camera, a magnetic resonance imaging device, or an ultrasonic imaging device, to obtain the first palm bone and joint image.

11. An apparatus for living-body detection, comprising:

an image acquisition module, configured to acquire a first palm bone and joint image, wherein the first palm bone and joint image comprises palm bones and joint soft tissues between the palm bones;

a super-resolution processing module, configured to perform super-resolution processing on the first palm bone and joint image to obtain a second palm bone and joint image, wherein a resolution of the second palm bone and joint image is greater than a resolution of the first palm bone and joint image; and

a living-body detection module, configured to acquire a palm feature corresponding to the second palm bone and joint image;

wherein the living-body detection module is further configured to determine a discrimination result based on the palm feature, the discrimination result indicating whether the first palm bone and joint image is a living-body palm bone and joint image, and the living-body palm bone and joint image being a palm bone and joint image obtained by photographing a real palm.

12. A computer device, the computer device comprising a processor and a memory, the memory having at least one computer program stored therein, and the at least one computer program being loaded and executed by the processor to implement operations performed in the living-body detection method according to any one of claims 1 to 10.

13. A computer-readable storage medium, the computer-readable storage medium having at least one computer program stored therein, and the at least one computer program being loaded and executed by a processor to implement operations performed in the living-body detection method according to any one of claims 1 to 10.

14. A computer program product, comprising a computer program, the computer program being loaded and executed by a processor to implement operations performed in the living-body detection method according to any one of claims 1 to 10.

15. A palm scanning device, comprising:

an X-ray camera, a magnetic resonance imaging device, or an ultrasonic imaging device, configured to acquire a palm bone and joint image; and

a radio-frequency (RF) circuit, configured to transmit the palm bone and joint image to a

server, wherein the server is configured to perform living-body detection based on the palm bone and joint image.

16. The palm scanning device according to claim 15, wherein the palm scanning device comprises the X-ray camera; and

the X-ray camera comprises a light-emitting component and an imaging component;

the light-emitting component being located above, the imaging component being located below, and a space existing between the light-emitting component and the imaging component;

the light-emitting component being configured to emit an X-ray downwards to penetrate a palm between the light-emitting component and the imaging component; and

the imaging component being configured to receive the X-ray that penetrates the palm and form an image, to obtain the palm bone and joint image.