

METHOD AND DEVICE FOR DETECTING BONE AGE

[0001] The application claims the priority of the Chinese patent application No. 201811163000.8 of Chinese Patent Office, filed on September 30, 2018, and entitled "Method and Device for Detecting Bone Age", which is hereby incorporated by reference in its entirety.

Field

[0002] The present disclosure relates to the field of machine learning technology, in particular to a method and device for detecting bone age.

Background

[0003] Bone age is the developmental age obtained by comparing the bone development level of young children with the bone development standard. It can more accurately reflect the maturity of the body than the age, height and weight, and more accurately reflect the growth and development level and maturity of the individual.

[0004] Clinically, the biological age of a child is judged by detecting the bone age, and the development status of the child is evaluated by the difference between the biological age and the chronological age, then the sexual maturity trend of the child is understood, and the adult height of the child is predicted. Bone age detection is widely used in the treatment and monitoring of diseases affecting growth and development of children and is very helpful for the diagnosis of some pediatric endocrine diseases.

[0005] In the prior art, the bone age is estimated by artificially checking the bone age image after taking an image of bone. This method relies on artificial estimation of bone age based on the bone age image, and the accuracy is greatly influenced by human subjective factors and the efficiency is low.

Summary

[0006] Since the prior art relies on manual estimation of bone age based on the bone age image, the accuracy is affected by human subjective factors, and the efficiency is low, the embodiment of the application provides a method and device for detecting bone age.

[0007] In a first aspect, the embodiment of the application provides a method for detecting bone age, including:

obtaining a bone age image of a detection user;

determining positions of respective target epiphyses in the bone age image by using a

positioning model;

for each of the respective target epiphyses, determining a bone age score of the each of the respective target epiphyses according to features and the position of the each of the respective target epiphyses; and

determining a bone age of the detection user according to bone age scores of the respective target epiphyses.

[0008] Since different epiphysis shapes represent different bone age stages, and the epiphysis shapes at different positions also have certain differences, the embodiment of this application uses a positioning model to first automatically determine the position of the target epiphysis, then the bone age score is determined based on the features and the position of the target epiphysis, and finally the bone age of the user to be detected is determined based on the bone age scores without subjective judgment of bone age based on the bone age image, thus improving the accuracy of detecting bone age on one hand, and improving the efficiency of bone age detection on the other hand.

[0009] Alternatively, the positioning model includes a coarse positioning module and fine positioning modules;

determining positions of respective target epiphyses in the bone age image by using the positioning model includes:

inputting the bone age image into the coarse positioning module for determining the coordinates of respective first key points corresponding to the respective target epiphyses in the bone age image;

determining one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses, wherein one coarse segmentation region includes one or more target epiphyses;

for each coarse segmentation region, inputting bone age image in the each coarse segmentation region into corresponding fine positioning module for determining the coordinates of a second key point corresponding to each target epiphysis in the coarse segmentation region; and

determining a position of the each target epiphysis in the each coarse segmentation region according to the coordinates of the second key point corresponding to the each target epiphysis in the each coarse segmentation region.

[0010] Alternatively, the bone age image is a hand bone image; the first key points include first key points of a thumb region, first key points of a middle finger region, first key points of a little finger region and first key points of a wrist region;

determining one or a plurality of coarse segmentation regions in the bone age image

according to the coordinates of the respective first key points corresponding to the respective target epiphyses includes:

for the first key points of the each region, determining a long axis direction and a short axis direction according to the coordinates of the first key points of the each region;

5 determining a center point of the each region; and

determining a coarse segmentation region by expanding outwards by a preset distance according to the long axis direction and the short axis direction with the center point as the center.

[0011] Alternatively, before inputting the bone age image in the each coarse segmentation region into the corresponding fine positioning module, the method also includes:

adjusting the bone age image of in the each coarse segmentation region to meet requirements of the fine positioning module.

[0012] In a second aspect, the embodiment of the application provides a device for detecting bone age, including:

15 an obtaining module configured to obtain a bone age image of a detection user;

a positioning module configured to determine positions of respective target epiphyses in the bone age image by using a positioning model;

a processing module configured to, for each of the respective target epiphyses, determine a bone age score of the each of the respective target epiphyses according to features and the position of the each of the respective target epiphyses; and

20 a detecting module configured to determine a bone age of the detection user according to bone age scores of the respective target epiphyses.

[0013] Alternatively, the positioning model includes a coarse positioning module and fine positioning modules; and

25 the positioning module is specifically configured to:

input the bone age image into the coarse positioning module for determining coordinates of respective first key points corresponding to the respective target epiphyses in the bone age image;

determine one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses, wherein one coarse segmentation region includes one or more target epiphyses;

30 for each of the coarse segmentation regions, input bone age image in the each coarse segmentation region into corresponding fine positioning module for determining the coordinates of a second key point corresponding to each target epiphysis in the each of the

coarse segmentation region; and

determine a position of the each target epiphysis in the each coarse segmentation region according to the coordinates of the second key point corresponding to the each target epiphysis in the coarse segmentation region.

5 **[0014]** Alternatively, the bone age image is a hand bone film; the first key points include first key points of a thumb region, first key points of a middle finger region, first key points of a little finger region and first key points of a wrist region;

the positioning module is specifically configured to:

10 for the first key points of the each region, determine a long axis direction and a short axis direction according to the coordinates of the first key points of the each region;

determine a center point of the region; and

determine a coarse segmentation region by expanding outwards by a preset distance according to the long axis direction and the short axis direction with the center point as the center.

15 **[0015]** Alternatively, the positioning module is also configured to:

adjust the bone age image in the each coarse segmentation region to meet the requirements of the fine positioning module before inputting the bone age image in the each coarse segmentation region into the corresponding fine positioning module.

20 **[0016]** In a third aspect, the embodiment of the application provides equipment for detecting bone age, including at least one processor and at least one memory, wherein the memory stores a computer program which enables the processor to perform the steps of the method in the first aspect when the computer program is executed by the processor.

25 **[0017]** In a fourth aspect, the embodiment of the application provides a computer-readable medium, storing a computer program that can be executed by equipment for detecting bone age, and when the program runs on the equipment for detecting bone age, the equipment for detecting bone age performs the steps of the method in the first aspect.

30 **[0018]** In a fifth aspect, the embodiment of the disclosure provides a computer program product, including a calculation program stored on a non-transient computer readable storage medium, the computer program includes a program instruction, and when the program instruction is executed by a computer, the computer executes the method described in the first aspect.

35 **[0019]** Since different epiphysis shapes represent different bone age stages, and the epiphysis shapes at different positions also have certain differences, the embodiment of this application uses the positioning model to first automatically determine the position of the target epiphysis, then the bone age score is determined based on the features and the position of the target

epiphysis, and finally the bone age of the user to be detected is determined based on the bone age scores without subjective judgment of bone age based on the bone age image, thus improving the accuracy of detecting bone age on one hand, and improving the efficiency of bone age detection on the other hand. When positioning the position of the target epiphysis in the bone age image, the position of the target epiphysis in the coarse segmentation region is positioned after positioning the coarse segmentation region including the target epiphysis, so that the accuracy of positioning the target epiphysis is improved.

Brief Description of the Drawings

- 10 **[0020]** In order to explain the technical solution in the embodiments of the disclosure clearer, the drawings needed in the description of the embodiments will be described below briefly. Obviously, the drawings in the following description correspond to only some embodiments of the disclosure. For those of ordinary skill in the art, other drawings can be obtained according to those attached drawings without any creative labor.
- 15 **[0021]** Fig. 1 is a flow diagram of a method for detecting bone age provided by the embodiment of the present application;
- [0022]** Fig. 2 is a schematic diagram of a bone age image provided by the embodiment of the present application;
- [0023]** Fig. 3 is a schematic diagram of epiphyses provided by the embodiment of the present application;
- 20 **[0024]** Fig. 4 is a flow diagram of a method for adjusting the bone age image provided by the embodiment of the application;
- [0025]** Fig. 5 is a structural diagram of a depth residual network provided by the embodiment of the present application;
- 25 **[0026]** Fig. 6 is a structural diagram of a convolution feature extraction block provided by the embodiment of the present application;
- [0027]** Fig. 7 is a flow diagram of a method for positioning a target epiphysis provided by the embodiment of the present application;
- [0028]** Fig. 8 is a schematic diagram of a coarse segmentation region provided by the embodiment of the present application;
- 30 **[0029]** Fig. 9 is a schematic diagram of a thumb region provided by the embodiment of the present application;
- [0030]** Fig. 10 is a schematic diagram of a thumb region provided by the embodiment of the present application;
- 35 **[0031]** Fig. 11 is a structural diagram of a device for detecting bone age provided by the

embodiment of the present application; and

[0032] Fig. 12 is a structural diagram of equipment for detecting bone age provided by the embodiment of the present application.

5 Detailed Description of the Embodiments

[0033] In order to make the object, technical solution and advantages of the disclosure clearer, the disclosure will be further described in detail below in combination with the drawings. Obviously, the described embodiments are only part of the embodiments of the disclosure, not all of them. Based on the embodiments in the disclosure, all other embodiments obtained by those skilled in the art without creative labor should fall into the scope of protection of the disclosure.

[0034] For the convenience of understanding, the terms involved in the embodiments of the disclosure will be explained below.

[0035] Bone age: the age of bone, which needs to be determined by the specific image of bone in X-ray photography. The X-ray film of the left hand wrist is usually taken. Doctors can determine the bone age by observing the development degree of ossification centers at the lower ends of the phalanx bone, carpal bone and radioulna of the left hand.

[0036] The technical solution of bone age detection in the embodiment of the application is applicable to detecting the bone age of adolescents in hospital, providing references for doctors to judge the growth and development of adolescents, and helping doctors to diagnose chromosomal abnormalities, genetic diseases, endocrine diseases and other diseases.

[0037] Fig. 1 schematically illustrates a flow diagram of a method for detecting bone age provided by the embodiment of the application. The flow can be performed by a device for detecting bone age, which specifically includes the following steps:

[0038] Step S101, obtaining a bone age image of a detection user.

[0039] The bone age image refers to a specific image taken by X-ray. Generally, the X-ray film of a person's left hand is taken as the bone age image, as shown in Fig. 2.

[0040] After obtaining the bone age image of the user to be detected, the bone age image is preprocessed. The preprocessing process mainly includes hand bone segmentation and image normalization.

[0041] Hand bone segmentation includes the following steps: firstly, Gaussian filter is used for the whole bone age image, the result of filtering is binarized, and the threshold of binarization is obtained by the method of finding the maximum class spacing of the image gray histogram; then, after the result of binarization is expanded, separate regional blocks are obtained by flood fill and the area of each regional block is counted; the regional block with the

largest area is reserved to segment a hand bone image; and the segmented hand bone image is pasted onto a pure black image matching the length and width of the hand bone image.

[0042] Image normalization includes the following steps: the bone age image is a dicom-format image, and first, the window width and window level are selected according to the dicom information, and the image is converted into a bone age image in a png format; then, the length-width ratio of the bone age image is adjusted into 1:1 by adding black edge(s) on the top or both sides of the bone age image; and finally, the bone age image is scaled to 512 * 512.

[0043] Step S102, determining positions of respective target epiphyses in the bone age image by using a positioning model.

[0044] The positioning model is a trained depth residual network. Epiphysis is the ossification point that occurs in the cartilage at both ends of the bone during its development. It is commonly seen at both ends of the long bone, the border of the flat bone, the nodule, the tuberosity and the protuberance. After most epiphyseal ossification, only one layer of cartilage plate, i.e. epiphyseal cartilage, remains adjacent to the diaphysis. Through the division, proliferation and ossification of chondrocytes, the bone lengthens continuously. For example, for the bone age image of the hand bone shown in Fig. 3, including the phalanx epiphysis, the ulna epiphysis and the radius epiphysis, it should be noted that in the bone age image shown in Fig. 3, the epiphyses marked by circles are only part of the epiphyses marked as an example, and the epiphyses in the hand bone are not limited to those.

[0045] Step S103, for each of the respective target epiphyses, determining a bone age score of the each of the respective target epiphyses according to features and the position of the each of the respective target epiphyses.

[0046] The bone age score is determined by querying the bone age scoring standard according to the features and the position of the target epiphysis. The epiphyses of different positions and different features correspond to different bone age scores. When scoring, the bone age scores determined by different bone age scoring standards will be different. The bone age scoring standards include but not limited to the TW3 bone age scoring standard and G-P (Greulich-Pyle).

[0047] Step S104: determining a bone age of the detection user according to bone age scores of the respective target epiphyses.

[0048] Since different epiphysis shapes represent different bone age stages, and the epiphysis shapes at different positions also have certain differences, the embodiment of this application uses the positioning model to first automatically determine the position of the target epiphysis, then the bone age score is determined based on the features and the position of the target epiphysis, and finally the bone age of the user to be detected is determined based on the bone

age scores without artificial subjective judgment of bone age based on the bone age image, thus improving the accuracy of detecting bone age on one hand, and improving the efficiency of bone age detection on the other hand.

[0049] Alternatively, in the step S101 above, since the position of the bone in the obtained bone age image is sometimes not the reference position, which affects the position of the target epiphysis in subsequent positioning, after obtaining the bone age image of the user to be detected, each bone in the bone age image is adjusted to the reference position, which specifically includes the following steps, as shown in Fig. 4:

[0050] Step S401, obtaining the coordinates of the preset reference point.

[0051] The coordinates of the preset reference point can be the coordinates of a preset part of bone for representing the reference position of the part of bone. For example, the coordinates of the preset reference point can be the preset coordinates of the point related to the middle finger for representing the reference position of the middle finger. The coordinates of the preset reference point can also be the preset coordinates of the point related to the little finger for representing the reference position of the little finger.

[0052] Step S402, determining the coordinates of key points in the bone age image by using an adjusting model, wherein the adjusting model is determined after training the depth residual network by taking the multiple bone age images with the coordinates of the key points marked in advance as the training samples.

[0053] The coordinates of the key points and preset reference points are in the same coordinate system.

[0054] For example, first, multiple bone age images are obtained, the key points around the little fingers in the bone age images are artificially marked, then the bone age images marked with the key points are input into the depth residual network for training. When the objective function of the depth residual network meets the preset conditions, the adjusting model is determined. When the bone age image of the user to be detected is obtained, the bone age image is input into the adjusting model to determine the key points around the little finger of the bone age image.

[0055] Step S403, determining the corresponding relationship between the current position and the reference position of each bone in the bone age image according to the coordinates of the preset reference points and the key points.

[0056] Step S404, adjusting each bone in the bone age image to the reference position according to the corresponding relationships.

[0057] When both the preset reference point and key point are points related to the little finger, the corresponding relationship between the current position of the little finger in the bone age

image and the reference position of the little finger in the bone age image can be determined according to the coordinates of the preset reference point and key point, and the corresponding relationship between the current positions of other bones in the bone age image and the reference positions of the other bones in the bone age image can be further obtained, wherein the corresponding relationship includes translation relationship and rotation relationship. Then, according to the corresponding relationships, each bone in the bone age image is adjusted to the reference position. Because the positioning model is obtained after training with the bone age image in the reference position as the training sample, each bone in the bone age image of the user to be detected is adjusted to the reference position before positioning each target epiphysis in the bone age image, so that the accuracy of positioning the target epiphysis is improved.

[0058] In the above step S102, the positioning model includes a coarse positioning module and fine positioning modules, both of which are depth residual networks. The coarse positioning module is determined after training the depth residual network with multiple bone age images pre-marked with key points as the training samples. The fine positioning module is determined after training the depth residual network with multiple bone age images, pre-marked with key points, of coarse segmentation regions, as the training samples. The number of the fine positioning modules is determined according to the number of the coarse segmentation regions output by the coarse positioning module.

[0059] The following is the detailed introduction of the training process of the coarse positioning module: multiple bone age images are obtained as training samples; each bone age image is pre-processed; each bone in the bone age image is adjusted to the reference position, wherein the process of adjusting the position of the bone age image and pre-processing of the bone age image have been described above, which will be omitted here; key points are marked in each bone age image by marking staff, wherein the key points are the points near the epiphyses in the bone age image, and each key point corresponds to a serial number; data enhancement is performed on the training samples, and the data size is enhanced 10 times of the original data size, the methods of data enhancement include but not limited to:

[0060] 1. Rotating by a certain angle randomly.

[0061] 2. Translating 0-30 pixels up, down, left or right randomly.

[0062] 3. Scaling 0.85-1.15 times randomly.

[0063] 4. Jittering image contrast and brightness a little.

[0064] Then, the training samples are input into the depth residual network for training. During the training, a loss function is calculated according to the coordinates of the marked key points and the predicted key points by the network, wherein the back propagation method is used for training, and an sgd algorithm with momentum and ladder attenuation is used in the

training optimization algorithm.

[0065] Alternatively, the structure of the depth residual network is shown in Fig. 5, including N continuous convolution feature extraction blocks and a fully-connected layer. For any two continuous first and second convolution feature extraction blocks in N convolution feature extraction blocks, the second image feature output by the second convolution feature extraction block and the first image output by the first convolution feature extraction block are added to be the input of the third convolution feature extraction block or the output of N continuous convolution feature extraction blocks. The third convolution feature extraction block is located behind the second convolution feature extraction block and is continuous with the second convolution feature extraction block. The convolution feature extraction block includes L convolution modules, wherein L is greater than 0, and any convolution module includes a convolution layer, a BN layer and an excitation layer, which is specifically shown in Fig. 6.

[0066] The following is the detailed introduction of the training process of the fine positioning module: multiple bone age images are obtained as training samples; each bone in the bone age image is adjusted to the reference position for each bone age image; the bone age image is pre-processed; multiple coarse segmentation regions are segmented from the bone age image according to the preset rules, such as the thumb region, the middle finger region, the little finger region and the wrist region; a fine positioning module is trained for each coarse segmentation region; the key points in the bone age image of each coarse segmentation region are marked by marking staff for any fine positioning module, or the key points already marked in the training samples corresponding to the coarse segmentation module are directly used, wherein the key points are the points near the epiphysis in the coarse segmentation region, and each key point corresponds to a serial number; the bone age image of the coarse segmentation region is adjusted into a positive image, for example, the thumb region may be an inclined region in the same direction as the thumb, and after the thumb region is captured, the thumb region will be adjusted to a positive image by rotating it at a certain angle; data enhancement is performed on the training samples, the data size is enhanced 10 times of the original data size, the methods of data enhancement include but not limited to:

[0067] 1. Rotating by a certain angle randomly.

[0068] 2. Translating 0-30 pixels up, down, left or right randomly.

[0069] 3. Scaling 0.85-1.15 times randomly.

[0070] 4. Jittering image contrast and brightness a little.

[0071] Then, the training samples are input into the depth residual network for training. During the training, a loss function is calculated according to the coordinates of the marked key points and the predicted key points by the network, wherein the back propagation method is

used for training, and an sgd algorithm with momentum and ladder attenuation is used in the training optimization algorithm. The depth residual network includes M continuous convolution feature extraction blocks and a fully-connected layer, and the convolution feature extraction block is shown in Fig. 6.

5 **[0072]** After determining the coarse positioning module and the fine positioning modules in the positioning model, the positioning model is used to determine the position of each target epiphysis in the bone age image, as shown in Fig. 7, which specifically includes the following steps:

10 **[0073]** Step S701, inputting the bone age image into the coarse positioning module for determining coordinates of respective first key points corresponding to the respective target epiphyses in the bone age image.

[0074] Alternatively, the bone age image is a hand bone film, and the first key point can be the key point of each epiphyseal appendage in the hand bone, and each first key point corresponds to a serial number.

15 **[0075]** Step S702, determining one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses, wherein one coarse segmentation region includes one or more target epiphyses.

20 **[0076]** The coarse segmentation region can be a thumb region, an index finger region, a middle finger region, a ring finger region, a little finger region, a wrist region, etc., and the specific position of the coarse segmentation region and the target epiphysis contained in the coarse segmentation region can be set in advance.

25 **[0077]** Step S703, for each coarse segmentation region, inputting bone age image in the each coarse segmentation region into corresponding fine positioning module for determining coordinates of a second key point corresponding to each target epiphysis in the each coarse segmentation region.

[0078] Step S704, determining a position of the each target epiphysis according to the coordinates of the second key point corresponding to the each target epiphysis in the each coarse segmentation region.

30 **[0079]** When positioning each epiphysis by the positioning module, first the coarse positioning module is used to segment the coarse segmentation regions from the bone age image, thus reducing the positioning range of the target epiphysis, then the position of each target epiphysis is positioned from the coarse segmentation region, so that the accuracy of the target epiphysis positioning is improved.

35 **[0080]** Alternatively, in the above step S702, the coarse segmentation regions are a thumb

region, a middle finger region, a little finger region and a wrist region; and the first key points include the first key point of the thumb region, the first key point of the middle finger region, the first key point of the little finger region and the first key point of the wrist region. For the first key point of each region, the long axis direction and the short axis direction are determined according to the coordinates of the first key point of the region, and the center point of the region is determined. Then taking the center point as the center, the region is expanded outwards by a preset distance according to the long axis direction and the short axis direction, and the coarse segmentation region is determined, which is shown in Fig. 8. In specific implementation, principal component analysis (PCA) can be performed on the coordinates of the first key point to determine the long axis direction and the short axis direction. The coarse segmentation region can be a rectangle with the ratio of the long axis direction to the short axis direction of 1:3.

[0081] Alternatively, in the above step S703, before inputting the bone age image in the coarse segmentation region into the corresponding fine positioning module, the bone age image of the coarse segmentation region is adjusted to meet the requirements of the fine positioning module. For example, Fig. 9 shows a bone age image of the thumb region captured from the bone age image shown in Fig. 8. The positive image is obtained by rotating the bone age image of the thumb region to the left by a certain angle, which is shown in Fig. 10. Then the positive image of the thumb region is input into the fine positioning module.

[0082] In the above step S704, after determining the coordinates of the second key point corresponding to each target epiphysis in the coarse segmentation region, the second key point corresponding to each target epiphysis is determined according to the serial number of the second key point, then a rectangular frame of the target epiphysis is determined according to the coordinates of the second key point.

[0083] In the above step S103, the features of the target epiphysis is recognized by the recognition model, which is determined by training the depth residual network with multiple epiphysis images having pre-marked feature types of the target epiphysis as the training samples. Because of the differences of target epiphysis features, each target epiphysis is provided with a trained recognition model, so that the recognition accuracy of the target epiphysis features is improved.

[0084] Based on the same technical concept, the embodiment of the application provides a device for detecting bone age, as shown in Fig. 11. The device 1100 includes:

an obtaining module 1101 configured to obtain a bone age image of a detection user;

a positioning module 1102 configured to determine positions of respective target epiphyses in the bone age image by using a positioning model;

a processing module 1103 configured to, for each of the respective target epiphyses,

determine a bone age score of the each of the respective target epiphyses according to the features and the position of the each of the respective target epiphyses; and

a detecting module 1104 configured to determine a bone age of the detection user according to bone age scores of the respective target epiphyses.

5 **[0085]** Alternatively, the positioning model includes a coarse positioning module and fine positioning modules;

the positioning module 1102 is specifically configured to:

10 input the bone age image into the coarse positioning module for determining coordinates of respective first key point corresponding to the respective target epiphyses in the bone age image;

determine one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses, wherein one coarse segmentation region includes one or more target epiphyses;

15 for each of the coarse segmentation regions, input bone age image in the each coarse segmentation region into corresponding fine positioning module for determining the coordinates of a second key point corresponding to each target epiphysis in the each of the coarse segmentation region; and

20 determine a position of the each target epiphysis in the each coarse segmentation region according to the coordinates of the second key point corresponding to the each target epiphysis in the coarse segmentation region.

[0086] Alternatively, the bone age image is a hand bone film; the first key points include first key points of a thumb region, first key points of a middle finger region, first key points of a little finger region and first key points of a wrist region;

25 the positioning module 1102 is specifically configured to:

for the first key points of the each region, determine a long axis direction and a short axis direction according to the coordinates of the first key points of the each region;

determine a center point of the each region; and

30 determine a coarse segmentation region by expanding outwards by a preset distance according to the long axis direction and the short axis direction with the center point as the center.

[0087] Alternatively, the positioning module 1102 is also configured to:

35 adjust the bone age image in the each coarse segmentation region to meet the requirements of the fine positioning module before inputting the bone age image in the each coarse segmentation region into the corresponding fine positioning module.

[0088] Based on the same technical concept, the embodiment of the application provides equipment for detecting bone age, as shown in Fig. 12, which includes at least one processor 1201 and a memory 1202 connected with the at least one processor. In the embodiment of the application, the specific connection medium between the processor 1201 and the memory 1202 is not limited. For example, the processor 1201 and the memory 1202 in Fig. 12 is connected by a bus. The bus can be an address bus, a data bus and a control bus.

[0089] In the embodiment of the present application, the memory 1202 stores instructions that can be executed by the at least one processor 1201. The at least one processor 1201 can execute the steps included in the aforementioned method of detecting bone age by executing the instructions stored in the memory 1202.

[0090] The processor 1201 is the control center of the equipment for detecting bone age. The processor 1201 can use various interfaces and lines to connect all parts of the equipment for detecting bone age. By running or executing the instructions stored in the memory 1202 and calling the data stored in the memory 1202, the detection of bone age can be realized. Optionally, the processor 1201 may include one or more processing units, and the processor 1201 may integrate an application processor and a modulation and demodulation processor, wherein the application processor mainly processes the operating system, user interface, application program, etc., and the modulation and demodulation processor mainly processes wireless communication. It is understood that the above modulation and demodulation processor may not be integrated into the processor 1201. In some embodiments, the processor 1201 and memory 1202 may be implemented on the same chip, or in some embodiments, they may also be implemented on separate chips.

[0091] The processor 1201 may be a general-purpose processor, such as a central processing unit (CPU), a digital signal processor, an application specific integrated circuit (ASIC), a field programmable gate array, a programmable logic device, a discrete gate or transistor logic device, or a discrete hardware component. The processor 1201 may implement or execute all methods, steps and logic block diagrams disclosed in the embodiment of the present application. The general-purpose processor may be a microprocessor or any conventional processor, etc. By combining with the steps of the method disclosed in the embodiment of the application, the execution of the hardware processor, or the execution of the hardware and software module combination in the processor can be directly embodied.

[0092] As a non-volatile computer-readable storage medium, the memory 1202 may be used to store non-volatile software programs, non-volatile computer executable programs and modules. The memory 1202 may include at least one type of storage medium, such as flash memory, hard disk, multimedia card, card type memory, random access memory (RAM), static

random access memory (SRAM), programmable read only memory (PROM), read only memory (ROM), electrically erasable programmable read-only memory (EEPROM), magnetic memory, disk, optical disk, etc. The memory 1202 is any other medium capable of carrying or storing the desired program code in the form of an instruction or data structure and being accessible by a computer, but is not limited to these. The memory 1202 in the embodiment of the present application may also be a circuit or any other device capable of realizing the storage function for storing program instructions and/or data.

[0093] Based on the same concept of the disclosure, the embodiment of the application also provides a computer-readable medium, which stores a computer program that can be executed by the equipment for detecting bone age. When the program runs on the equipment for detecting bone age, the equipment for detecting bone age performs the steps of the method for detecting bone age.

[0094] Based on the same concept of the disclosure, the embodiment of the application also provides a computer program product, which includes a calculation program stored on a non-transient computer readable storage medium, and the computer program includes a program instruction. When the program instruction is executed by the computer, the computer performs the method for detecting bone age.

[0095] Those skilled in the art should appreciate that the embodiments of the disclosure may be provided as methods, systems, or computer program products. Therefore, the present disclosure may take the form of a complete hardware embodiment, a complete software embodiment, or an embodiment combining software and hardware aspects. Moreover, the disclosure can adopt the form of the computer program product implemented on one or more computer available storage media (including but not limited to the disk memory, CD-ROM, optical memory, etc.) including computer available program codes.

[0096] The disclosure is described with reference to the flow diagrams and/or block diagrams of the method, equipment (system), and computer program product according to the embodiment of the disclosure. It should be understood that each flow and/or block in the flow diagram and/or block diagram and the combination of flow and/or block in the flow diagram and/or block diagram can be realized by computer program instructions. These computer program instructions can be provided to a general-purpose computer, special-purpose computer, embedded processor or processor of other programmable data processing equipment to generate a machine, so that the instructions executed by the processor of a computer or other programmable data processing equipment can be used to generate a device to realize specified functions in one or more flows in the flow diagram and / or one or more blocks in the block diagram.

[0097] These computer program instructions can also be stored in a computer-readable memory that can guide a computer or other programmable data processing equipment to work in a specific way, so that the instructions stored in the computer-readable memory can generate a manufactured product including an instruction device, and the instruction device can realize specified functions in one or more flows in the flow diagram and/or one or more blocks in the block diagram.

[0098] These computer program instructions can also be loaded on a computer or other programmable data processing equipment, so that a series of operation steps can be executed on the computer or other programmable equipment to generate computer implemented processing, so that the instructions executed on the computer or other programmable equipment provide steps to realize specified functions in one or more flows in the flow diagram and/or one or more blocks in the block diagram.

[0099] Although preferred embodiments of the disclosure have been described, once have learned the basic inventiveness concept, those skilled in the art may make additional changes and modifications to these embodiments. Therefore, the appended claims are intended to be interpreted to include preferred embodiments and all changes and modifications falling within the scope of the disclosure.

[00100] Obviously, those skilled in the art can make various changes and modifications to the disclosure without departing from the spirit and scope of the disclosure. In this way, if these modifications and variations of the disclosure fall within the scope of the claims of the disclosure and its equivalent technology, the disclosure also intends to include these modifications and variations.

[00101] Those skilled in the art will appreciate that embodiments of the disclosure may be provided as methods, systems, or computer program products. Therefore, the present disclosure may take the form of a complete hardware embodiment, a complete software embodiment, or an embodiment combining software and hardware. Moreover, the disclosure can adopt the form of computer program products implemented on one or more computer available storage media (including but not limited to disk memory, CD-ROM, optical memory, etc.) including computer available program codes.

[00102] The disclosure is described with reference to the flow diagrams and/or block diagrams of the method, the equipment (system), and the computer program product according to the embodiment of the disclosure. It should be understood that each flow and/or block in the flow diagrams and/or block diagrams and the combination of the flows and/or blocks in the flow diagrams and/or block diagrams can be realized by computer program instructions. These computer program instructions can be provided to a general-purpose computer, a

special-purpose computer, an embedded processor or the processor of other programmable data processing equipment to generate a machine, so that the instructions executed by the processor of a computer or other programmable data processing equipment can be used to generate a device to realize specified functions in one or more flows in the flow diagrams and/or one or more blocks in the block diagrams.

[00103] These computer program instructions can also be stored in a computer-readable memory that can guide a computer or other programmable data processing equipment to work in a specific way, so that the instructions stored in the computer-readable memory can generate a manufacturing product including an instruction device, and the instruction device can realize specified functions in one or more flows in the flow diagrams and/or one or more blocks in the block diagrams.

[00104] These computer program instructions can also be loaded on a computer or other programmable data processing equipment, so that a series of operations can be executed on the computer or other programmable equipment to generate computer implemented processing, and the instructions executed on the computer or other programmable equipment provide steps to realize specified functions in one or more flows in the flow diagrams and/or one or more blocks in the block diagrams.

[00105] Although the preferred embodiments of the disclosure have been described, once have learned the basic inventive concepts, those skilled in the art may make additional changes and modifications to these embodiments. Therefore, the appended claims are intended to be interpreted to include the preferred embodiments and all changes and modifications falling within the scope of the disclosure.

[00106] Obviously, those skilled in the art can make various modifications and variations to the disclosure without departing from the spirit and scope of the disclosure. In this way, if these modifications and variations of the disclosure fall within the scope of the claims of the disclosure and its equivalent technology, the disclosure also intends to include these modifications and variations.

CLAIMS

1. A method for detecting a bone age, comprising:

obtaining a bone age image of a detection user ;

5 determining positions of respective target epiphyses in the bone age image by using a positioning model;

for each of the respective target epiphyses, determining a bone age score of the each of the respective target epiphyses according to features of the each of the respective target epiphyses and the position of the each of the respective target epiphyses; and

10 determining a bone age of the detection user according to bone age scores of the respective target epiphyses.

2. The method according to claim 1, wherein the positioning model comprises a coarse positioning module and fine positioning modules; and

15 determining positions of respective target epiphyses in the bone age image by using the positioning model comprises:

inputting the bone age image into the coarse positioning module for determining coordinates of respective first key points corresponding to the respective target epiphyses in the bone age image;

20 determining one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses, wherein one coarse segmentation region comprises one or more target epiphyses;

25 for each coarse segmentation region, inputting bone age image in the each coarse segmentation region into corresponding fine positioning module for determining coordinates of a second key point corresponding to each target epiphysis in the each coarse segmentation region; and

determining a position of the each target epiphysis in the each coarse segmentation region according to the coordinates of the second key point corresponding to the each target epiphysis in the each coarse segmentation region.

30 3. The method according to claim 2, wherein the bone age image is a hand bone image; the first key points comprise first key points of a thumb region, first key points of a middle finger region,

first key points of a little finger region and first key points of a wrist region;

for the first key points of the each region, determining one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses comprises:

5 determining a long axis direction and a short axis direction according to the coordinates of the first key points of the each region;

 determining a center point of the each region; and

 determining a coarse segmentation region by expanding outwards by a preset distance according to the long axis direction and the short axis direction with the center point as the
10 center.

4. The method according to claim 3, wherein before inputting the bone age image in the each coarse segmentation region into corresponding fine positioning module, the method further comprises:

 adjusting the bone age image in the each coarse segmentation region to meet requirements
15 of the fine positioning module.

5. A device for detecting a bone age, comprising:

 an obtaining module configured to obtain a bone age image of a detection user;

 a positioning module configured to determine positions of respective target epiphyses in the bone age image by using a positioning model;

20 a processing module configured to, for each of the respective target epiphyses, determine a bone age score of the each of the respective target epiphyses according to features of the each of the respective target epiphyses and the position of the each of the respective target epiphyses; and

 a detecting module configured to determine a bone age of the detection user according to
25 bone age scores of the respective target epiphyses.

6. The device according to claim 5, wherein the positioning model comprises a coarse positioning module and fine positioning modules; and

 the positioning module is specifically configured to:

 input the bone age image into the coarse positioning module for determining coordinates
30 of respective first key points corresponding to the respective target epiphyses in the bone age image;

determine one or a plurality of coarse segmentation regions in the bone age image according to the coordinates of the respective first key points corresponding to the respective target epiphyses, wherein one coarse segmentation region comprises one or more target epiphyses;

5 for each of the coarse segmentation regions, input bone age image in the each coarse segmentation region into corresponding fine positioning module for determining the coordinates of a second key point corresponding to each target epiphysis in the each of the coarse segmentation region; and

10 determine a position of the each target epiphysis in the each coarse segmentation region according to the coordinates of the second key point corresponding to the each target epiphysis in the each coarse segmentation region.

7. The device according to claim 6, wherein the bone age image is a hand bone image; the first key points comprise first key points of a thumb region, first key points of a middle finger region, first key points of a little finger region and first key points of a wrist region;

15 the positioning module is specifically configured to:

for the first key points of the each region, determine a long axis direction and a short axis direction according to the coordinates of the first key points of the each region;

determine a center point of the each region; and

20 determine a coarse segmentation region by expanding outwards by a preset distance according to the long axis direction and the short axis direction with the center point as the center.

8. The device according to claim 7, wherein the positioning module is also configured to:

25 adjust the bone age image in the each coarse segmentation region to meet requirements of the fine positioning module before inputting the bone age image in the each coarse segmentation region into the corresponding fine positioning module.

9. Equipment for detecting bone age, comprising at least one processor and at least one memory, wherein the memory stores a computer program which enables the processor to perform the steps of the method according to any one of claims 1-4 when the computer program is executed by the processor.

30 10. A computer-readable medium, storing a computer program that can be executed by equipment for detecting bone age, wherein when the computer program runs on the equipment for detecting bone age, the equipment for detecting bone age performs the steps of the method

according to any one of claims 1-4.

11. A computer program product, comprising a computer program stored on a non transient computer readable storage medium, wherein the computer program comprises a program instruction, and when the program instruction is executed by a computer, the computer executes

5 the method according to any one of claims 1-4.