

# **EYE IMAGE PROCESSING METHOD, APPARATUS AND DEVICE, AND COMPUTER READABLE STORAGE MEDIUM**

The present application claims priority to Chinese Patent Application No. 201910494821.8, filed with the China National Intellectual Property Administration on June 05, 2019 and entitled "EYE IMAGE PROCESSING METHOD, APPARATUS AND DEVICE, AND COMPUTER READABLE STORAGE MEDIUM", which is incorporated herein by reference in its entirety.

## **TECHNICAL FIELD**

The present application mainly relates to the field of image processing technologies, and in particular, to an eye image processing method, apparatus and device, and a computer readable storage medium.

## **BACKGROUND**

At present, in the process of eye disease examination, an eye image is usually obtained through color fundus photographs; then medical personnel manually determine the optic disc area and the macular area in the eye image, and further determine whether there is a lesion in the macular area, whether there is abnormal information, and so on. In the method for determining the abnormal information in the eye image by the medical personnel alone, the workload of the medical personnel is very heavy. Especially for the medical personnel who lack work experience, it takes more time, resulting in low work efficiency.

## **SUMMARY**

A main purpose of the present application is to provide an eye image processing method, apparatus and device, and a computer readable storage medium, so as to solve the prior-art problem that abnormal information in an eye image is manually determined by medical personnel alone, resulting in low work efficiency.

To achieve the foregoing purpose, the present application provides an eye image processing method. The eye image processing method includes the following steps:

when a detection instruction for an eye image is detected, invoking a preset algorithm to

detect the eye image, and generating a detection result, where the detection result includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image;

when a prediction instruction for an abnormal change trend is detected, determining whether the detection result includes a risk-related factor; if the detection result includes the risk-related factor, predicting an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability; and

when a trigger instruction for generating a detection report is detected, generating a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

In addition, to achieve the foregoing purpose, the present application further provides an eye image processing apparatus. The eye image processing apparatus includes:

a detection module, configured to: when a detection instruction for an eye image is detected, invoke a preset algorithm to detect the eye image, and generate a detection result, where the detection result includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image;

a prediction module, configured to: when a prediction instruction for an abnormal change trend is detected, determine whether the detection result includes a risk-related factor; if the detection result includes the risk-related factor, predict an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability; and

a generation module, configured to: when a trigger instruction for generating a detection report is detected, generate a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

In addition, to achieve the foregoing purpose, the present application further provides an eye

image processing device. The eye image processing device includes a memory, a processor, a communications bus, and a readable instruction for eye image processing stored in the memory.

The communications bus is configured to implement connection and communication between the processor and the memory.

The processor is configured to execute the readable instruction for eye image processing, so as to perform the following steps:

when a detection instruction for an eye image is detected, invoking a preset algorithm to detect the eye image, and generating a detection result, where the detection result includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image;

when a prediction instruction for an abnormal change trend is detected, determining whether the detection result includes a risk-related factor; if the detection result includes the risk-related factor, predicting an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability; and

when a trigger instruction for generating a detection report is detected, generating a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

In addition, to achieve the foregoing purpose, the present application further provides a computer readable storage medium. The computer readable storage medium stores one or more readable instructions, and the one or more readable instructions can be executed by one or more processors to:

when a detection instruction for an eye image is detected, invoke a preset algorithm to detect the eye image, and generate a detection result, where the detection result includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image;

when a prediction instruction for an abnormal change trend is detected, determine whether the detection result includes a risk-related factor; if the detection result includes the risk-related

factor, predict an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability; and

when a trigger instruction for generating a detection report is detected, generate a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

According to the eye image processing method in this embodiment, image processing is performed on the eye image to obtain the detection result that includes the eye type, the position of the macula, the position of the optic disc, the position of the abnormality, and the like in the eye image; in addition, the abnormal change probability of the abnormal change trend is predicted based on the risk-related factor in the detection result; the reference detection report serving as a reference for the medical personnel is generated based on the detection result, the risk-related factor, and the abnormal change probability, so that the medical personnel quickly determine the abnormal information in the eye image based on the reference detection report, and do not need to manually determine the abnormal information alone, thereby improving the work efficiency.

## **BRIEF DESCRIPTION OF DRAWINGS**

FIG. 1 is a schematic flowchart of a first embodiment of an eye image processing method according to the present application;

FIG. 2 is a schematic diagram of a functional module of a first embodiment of an eye image processing apparatus according to the present application; and

FIG. 3 is a schematic diagram of a device structure of a hardware operating environment used in a method according to an embodiment of the present application.

The achievement of purposes, functional features, and advantages of the present application will be further described in combination with embodiments with reference to the accompanying drawings.

## **DESCRIPTION OF EMBODIMENTS**

It should be understood that the specific embodiments described herein are merely intended

to explain the present application and are not intended to limit the present application.

The present application provides an eye image processing method.

FIG. 1 is a schematic flowchart of a first embodiment of an eye image processing method according to the present application. In this embodiment, the eye image processing method includes the following steps:

Step S10: When a detection instruction for an eye image is detected, invoke a preset algorithm to detect the eye image, and generate a detection result, where the detection result includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image.

The eye image processing method in the present application is suitable for processing an eye image through a server, so as to assist medical personnel in determining abnormal information in the eye image. Specifically, the server is in communicative connection with a preset terminal having a display apparatus. The preset terminal may be a tablet computer, a desktop computer, a smartphone, etc. A display screen of the display apparatus is used as a screen of the preset terminal. The screen of the preset terminal includes a tool window, a main image display area, a thumbnail display area, and a functional area. The tool window includes various types of tools for editing an eye image. The main image display area is used to display a currently processed eye image. The thumbnail display area is used to display thumbnails of other eye images to be processed. The functional area includes multiple functional virtual keys to send various types of trigger instructions to the server for processing the eye image.

The functional area is provided with a virtual key that is used to trigger detection of the eye image, and a trigger operation on the virtual key is used as a detection instruction for the eye image. When the detection instruction is detected, it indicates that the eye image needs to be detected. Content of the detection includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image. The eye type includes a left eye and a right eye. The macula is located 0.35 cm from and slightly below a temporal side of the optic disc of the fundus, is located in an optical center area of a human eye, and is a projection point of a vision

axis. The optic disc is a light red disc-like structure with a diameter of about 1.5 mm and a clear boundary at about 3 mm from the macula to the nose in the retina. The abnormality is abnormal information that the eye image of the normal eye does not have, such as drusen. The position of the macula in the eye image is the position of the macula. The position of the optic disc in the eye image is the position of the optic disc. The position of the abnormal information in the eye image is the position of the abnormality. An algorithm for detecting the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the eye image is preset. The preset algorithm is invoked to detect the eye image, and a detection result that represents the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the eye image displayed on the preset terminal screen is generated.

Specifically, the step of invoking the preset algorithm to detect the eye image, and generating the detection result includes the following:

Step S11: Invoke a first preset algorithm to locate the center of the macula in the eye image, and determine coordinates of the center of the macula.

Step S12: Invoke a second preset algorithm to segment an optic disc area in the eye image, and determine the position of the optic disc, coordinates of the center of the optic disc, and a diameter of the optic disc.

Further, the preset algorithm includes the first preset algorithm and the second preset algorithm. The first preset algorithm may be the You Only Look Once (YOLO) algorithm, and the second preset algorithm may be the V-Net algorithm. The YOLO algorithm is an object detection algorithm, the V-Net algorithm is a 3D version of U-Net [1], and U-Net is an algorithm for image classification and segmentation with the image as a whole to reduce an amount of calculation. In the process of detecting the eye image, the first preset algorithm is first invoked to locate the center of the macula in the eye image and obtain the coordinates of the center of the macula. Afterwards, the second preset algorithm is invoked to segment the optic disc area in the eye image. The position of the optic disc is obtained after the segmentation, and the center of the position of the optic disc is located to obtain the coordinates of the center of the optic disc. In addition, a length of the optic

disc in the vertical direction is detected, and the length is used as the diameter of the optic disc.

It should be noted that, to help locate the center coordinates, a virtual coordinate system can be established in the eye image. For example, a starting position in the lower left corner of the eye image is used as the coordinate origin, or the center position of the length and the width of the eye image is used as the coordinate origin to establish a virtual coordinate system. Then, the coordinates of the center of the optic disc are determined based on the position of the center of the optic disc in the virtual coordinate system.

Step S13: Determine the eye type based on the coordinates of the center of the optic disc, and determine the position of the macula based on the coordinates of the center of the macula and the diameter of the optic disc.

Still further, the eye type represented by the eye image is identified based on the coordinates of the center of the optic disc, to determine the eye type. In addition, a circle is made with the coordinates of the center of the macula as the center and twice the diameter of the optic disc as the radius. The obtained circle center area is the position of the macula.

Step S14: Determine whether there is abnormal information in the eye image based on the second preset algorithm; if the abnormal information exists, detect a position of the abnormal information, determine the position of the abnormality, and generate the detection result based on the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality.

Considering that the abnormal information in the eye image is mainly targeted at the abnormality in the macular area, after the position of the macula is determined, the image of the position of the macula can be first optimized and the image styles can be unified, to determine whether there is an abnormality in the position of the macula. Afterwards, for the optimized position of the macula, it is determined whether there is abnormal information in the eye image based on the second preset algorithm. If there is abnormal information, the position of the abnormal information is identified and detected to determine the position of the abnormality.

After the first preset algorithm and the second preset algorithm are used to detect the eye

image, and the detection result that includes the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality is obtained, the detection result is displayed in a corresponding detection item in the functional area of the preset terminal screen. If the detected abnormal information is drusen, an area of the detected drusen is displayed in the detection item of drusen in the functional area. In addition, the detection result is directly displayed in the eye image, so as to intuitively reflect the position and area of each detection item in the eye image. When the detection result is displayed in the eye image, to help medical personnel view different types of information in the detection result, the same type of information in the eye image is selected and marked with lines in the same color. For example, selection is made using a red line at a boundary of the position of the macula, and selection is made using a blue line at a boundary of the position of a certain abnormality A. Lines in different colors are used to represent types of abnormalities in the eye image and positions of various abnormalities.

Understandably, the detection result obtained by the server by detecting the eye image may be inaccurate. To improve the accuracy of the detection result, a modification mechanism is provided to modify the detection result. Specifically, after the step of generating the detection result, the method includes the following steps:

Step a: When a modification instruction for the detection result is detected, determine a modification type of the modification instruction based on a type identifier in the modification instruction.

After the detection result is generated for the eye image, the medical personnel view the eye image and its corresponding detection result, and determine, based on experience, whether the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality determined in the detection result are accurate. If any item is inaccurate, the item can be changed using various editing tools in the tool window of the preset terminal screen. Content of the change includes drawing various types of selection boxes such as rectangular boxes, circles, unclosed curves, and polygons to change the inaccurate detection result. If the boundary of the position of the macula determined in the detection result is inaccurate, causing the area of the position of the macula to be relatively large, the position of the macula can be selected and adjusted using the

circle tool, so that the determined position of the macula is more accurate. In addition, the tool window further includes a measurement tool, a dragging tool, a modification tool, a translation tool, an eraser tool, etc. The measurement tool can be used to measure various selection boxes that are changed and drawn, determine the area of each selection box, and update the area of each adjusted position. In addition, operations can be performed on a drawn selection box, such as adding a label for naming, modifying the line width of the selection box, translating the selection box, and modifying the outline of the selection box.

In addition, an addition mechanism is further provided for the detection result. The medical personnel determine that there is abnormal information in the eye image based on experience, but the server does not detect the abnormal information, such as abnormal information of pigment in the eye image. In this case, the addition mechanism can be used to add the abnormal information to the detection result. Likewise, addition is also carried out through various editing tools in the tool window, such as drawing and measurement tools. Triggering of the change operation or the addition operation is used as a modification instruction. When the modification instruction is detected, the operation type indicated by the modification instruction needs to be determined because the methods for processing the change operation and the addition operation are different. Specifically, when being sent, the modification instruction carries a type identifier that represents the operation type. When the modification instruction is detected, the type identifier in the modification instruction is read, and the modification type of the modification instruction is determined based on the read type identifier.

Step b: When the modification type is a correction type, correct the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result based on the modification instruction.

Further, the modification type includes two aspects: a correction type and an addition type. The correction type is used to change the detection result, and the addition type is used to make addition to the detection result. When it is determined that the modification type of the modification instruction is a correction type based on the type identifier, the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection

result are corrected based on the modification instruction. Specifically, the correction instruction carries information that represents a needed change to the detection result. For example, the area of the position of the macula determined in the detection result is  $a$ , the change information is to adjust the boundary of the position of the macula so that the boundary becomes larger, and the area of the position of the macula changed based on the change information is  $a+x$ . In this case, the area of the macula displayed in the functional area and the eye image is corrected based on this, and the value of the area of the macula is corrected from  $a$  to  $a+x$ .

Step c: When the modification type is an addition type, determine abnormal information of pigment in the eye image based on the modification instruction, and add the abnormal information of pigment to the detection result, so as to update the detection result.

Still further, when it is determined that the modification type of the modification instruction is an addition type based on the type identifier, it indicates that there is abnormal information of pigment in the eye image. The abnormal information of pigment includes pigment enhancement and pigment shedding, which is specifically determined by medical personnel. The medical personnel mark the position of the abnormal information of pigment by using the editing tool in the tool window. The marking operation is a modification instruction whose modification type is an addition type. The marking operation serving as the modification instruction is received. The modification instruction carries type information that represents the type of the abnormal information of pigment, and position information of the abnormal information of pigment. The abnormal information of pigment in the eye image can be determined based on the modification instruction, the abnormal information of pigment is added to the detection result, and the detection result is updated, so as to represent the abnormal information of pigment and its position in the eye image.

Step S20: When a prediction instruction for an abnormal change trend is detected, determine whether the detection result includes a risk-related factor; if the detection result includes the risk-related factor, predict an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability.

Understandably, the abnormal information in the detection result indicates that there is an abnormality in the eye image, that is, the patient from whom the eye image is derived has a certain type of eye disease, and this type of eye disease may change over time. In this embodiment, a mechanism for predicting the abnormal change trend based on the detection result is provided. Content of the prediction includes determining whether there is information in the eye image that represents the patient's risk of advanced age-related macular degeneration (AMD) in the next five years, and an amplitude of the possibility of change in an amount of the information. The prediction result is used as a reference basis for the medical personnel to determine the change trend of the eye disease. Specifically, the functional area includes a virtual key for predicting an abnormal change trend of the eye image, and a tap operation on the virtual key is detected as a prediction instruction for the abnormal change trend.

When the prediction instruction is detected, it is first determined whether the detection result includes a risk-related factor. Because the abnormal information in the detection result includes two types: drusen and pigment abnormality, the risk-related factor is used to represent that the maximum drusen diameter is greater than 125  $\mu\text{m}$ , and abnormalities such as pigment shedding or pigment enhancement. When the prediction instruction is detected, it is determined whether the detection result includes either of the two risk-related factors. If the detection result includes either of the two risk-related factors, it can be determined that the detection result includes a risk-related factor, that is, it indicates that there is information in the eye image that represents the patient's risk of advanced AMD in the next five years. The risk-related factor in the detection result is risk information included in the eye image, the quantities of risk-related factors in the detection result are different, and amplitudes of possibilities of change in the amount of information are different. The amplitude of the possibility is used as the abnormal change probability. A mapping relationship between a quantity of risk-related factors and a probability is preset. For example, the probability corresponding to the presence of no risk factor is set to 0.5%, the probability corresponding to the presence of either risk factor is set to 10%, and the probability corresponding to the presence of both risk factors is set to 25%. After it is determined that the detection result includes a risk-related factor, the preset mapping relationship is invoked, and a quantity of risk-

related factors in the detection result is compared with the mapping relationship to determine the probability corresponding to the quantity of risk-related factors. The corresponding probability is the predicted abnormal change probability corresponding to the risk-related factor. The abnormal change probability is output and displayed as reference information for the medical personnel.

Understandably, the prediction of the server for the risk information in the eye image and an amplitude of the possibility of change in an amount of the information may be inaccurate, that is, the risk-related factor in the determined detection result and the predicted abnormal change probability are inaccurate. To improve the accuracy of both, an adjustment mechanism for adjusting the risk-related factor is provided. Specifically, after the step of predicting the abnormal change probability corresponding to the risk-related factor, the method includes the following steps:

Step d: When an adjustment instruction for the risk-related factor is detected, adjust the risk-related factor based on adjustment information in the adjustment instruction, and generate an adjusted risk-related factor.

Step e: Update the abnormal change probability based on the adjusted risk-related factor.

After the abnormal change probability for the detection result of the eye image is generated, the medical personnel view the eye image, the detection result, the risk-related factor, and the abnormal change probability, and determine whether the determined risk-related factor in the detection result is accurate based on experience. If the determined risk-related factor in the detection result is inaccurate, the risk-related factor can be adjusted using various editing tools in the tool window of the preset terminal screen. For example, the tool for modifying the outline of the selection box is selected to change the drusen area so that the drusen area becomes larger or smaller. The larger or smaller area is adjustment information for adjusting the risk-related factor, and the change operation on the drusen is an adjustment instruction for adjusting the risk-related factor. The adjustment information is added to the adjustment instruction, and is sent together with the adjustment instruction to the server, so as to adjust the risk-related factor. When detecting the adjustment instruction, the server reads the adjustment information included in the adjustment instruction, and adjusts the risk-related factor based on the adjustment information. After the

adjustment operation, a detection item that was originally a risk-related factor in the detection result may be changed to a non-risk-related factor, and a detection item that was originally not a risk-related factor may be changed to a risk-related factor. After the adjustment operation, the quantity of risk-related factors in the detection result is changed, and the changed quantity of risk-related factors is the generated adjusted risk-related factor. Because the change in the quantity of risk-related factors causes a change in the abnormal change probability, the adjusted risk-related factor is compared with the preset mapping relationship between the risk factor and the probability to determine the probability corresponding to the adjusted risk-related factor. The probability is the new abnormal change probability. In this way, the abnormal change probability is updated.

Step S30: When a trigger instruction for generating a detection report is detected, generate a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

Further, to make the detection result, the risk-related factor, and the abnormal change probability provide a better reference for the medical personnel, the functional area includes a virtual key for generating a detection report for the eye image. When there is a need to generate a detection report, the virtual key is triggered, and the trigger operation is detected as a trigger instruction for generating the detection report. When the trigger instruction is detected, it indicates that there is a need to generate a detection report, so that the reference detection report for the eye image is generated based on the information such as the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result, as well as the risk-related factor and the abnormal change probability, so as to complete processing of the eye image. Afterwards, the generated reference detection report is used as reference information and provided to the medical personnel for viewing and reference.

In the processes of generating the detection result, determining the risk-related factor in the detection result, and predicting the abnormal change probability, the detection result, the risk-related factor, and the abnormal change probability are corrected. If the correction operation is performed after the step of generating a reference detection report, that is, any one of the detection result, the risk-related factor, or the abnormal change probability is corrected after the reference

detection report for the eye image is generated based on the detection result, the risk-related factor, and the abnormal change probability, the generated reference detection report is inaccurate. In this case, the reference detection report needs to be updated based on the correction item. If the position of the optic disc in the detection result is corrected after the reference detection report is generated, the position of the optic disc in the detection result of the reference detection report needs to be corrected accordingly to update the reference detection report. When the correction operation is performed after the step of generating the reference detection report, if any one of the detection result, the risk-related factor, or the abnormal change probability is corrected, the reference detection report for the eye image is generated directly based on the corrected detection result, risk-related factor, or abnormal change probability.

In addition, the functional area further includes a virtual key used to save and print the reference detection report. After the reference detection report is generated, if the virtual key for saving is triggered, the reference detection report can be saved in a preset path in PDF format. For the reference detection report generated for the same eye image, if the saving operation has been performed previously, a subsequent saving operation overwrites the previously saved content. In addition, if the virtual key for printing is triggered, the latest saved reference detection report can be printed. The saving and printing operations help provide the reference detection report to the medical personnel for viewing and reference.

According to the eye image processing method in this embodiment, image processing is performed on the eye image to obtain the detection result that includes the eye type, the position of the macula, the position of the optic disc, the position of the abnormality, and the like in the eye image; in addition, the abnormal change probability of the abnormal change trend is predicted based on the risk-related factor in the detection result; the reference detection report serving as a reference for the medical personnel is generated based on the detection result, the risk-related factor, and the abnormal change probability, so that the medical personnel quickly determine the abnormal information in the eye image based on the reference detection report, avoiding manual determining of the abnormal information in the eye image by the medical personnel alone, and improving the work efficiency of the medical personnel.

Further, in another embodiment of the eye image processing method in the present application, before the step when the detection instruction for the eye image is detected, the method includes the following steps:

Step S40: When an opening instruction for the eye image is detected, open the eye image and display it on a preset terminal screen, and detect whether a patient information input instruction corresponding to the eye image is received.

Understandably, before the eye image is detected, the eye image needs to be opened and displayed on the preset terminal screen. Specifically, the tool window includes a tool for opening the eye image. When the tool is selected, a dialog box for selecting a path of the eye image is displayed. When the path of the eye image is selected in the dialog box, the opening instruction for the eye image can be triggered. When the opening instruction is detected, the eye image in the selected path is opened and displayed in the main image display area of the preset terminal screen, so as to view and process the displayed eye image. In addition, the functional area includes a virtual key used to input patient information. The patient information is information about the patient corresponding to the eye image, including name, gender, age, examination number, examination date, etc. The virtual key is provided with a corresponding identifier, and whether a patient information input instruction corresponding to the eye image is received is determined by detecting whether a trigger instruction carrying the identifier is received.

Step S50: If the patient information input instruction corresponding to the eye image is received, display an information input box on the preset terminal screen, and detect whether patient information that is input based on the information input box meets a preset rule.

Further, if it is determined through the identifier that the patient information input instruction corresponding to the eye image is received, it indicates that the patient information of the patient from which the eye image is derived needs to be input for the eye image, so that the information input box is displayed on the preset terminal screen, and the patient information is input through the information input box. After the patient information that is input based on the information input box is received, the received patient information is detected to determine whether the patient

information meets the preset rule. The preset rule is a rule that is set in advance to determine whether the patient information is reasonable. For example, it is set that the length of the patient's name does not exceed six words; the gender field is preset as "male" or "female"; the age ranges from 0 to 120 years; and the detection date is within 30 years before the current date. By comparing the received patient information with the preset rule, it is determined whether the patient information meets the preset rule, so as to ensure the accuracy of the input patient information.

Step S60: If the patient information that is input based on the information input box meets the preset rule, display the patient information in the eye image; if the patient information that is input based on the information input box does not meet the preset rule, output prompt information for re-input.

Still further, if it is determined by comparison that each piece of input patient information meets its preset rule, the patient information is saved; in addition, the patient information is displayed in a predetermined position in the eye image, such as the upper left corner of the main image display area. If it is determined by comparison that any item of the input patient information does not meet its preset rule, the patient information and other patient information that meets the preset rule are displayed differently, and prompt information for re-inputting the patient information that does not meet its preset rule is output.

Understandably, after the eye image is displayed on the preset terminal screen, the eye image may be unclearly displayed due to various factors in the shooting process, affecting the processing result of the eye image. To avoid impact on the processing result, a mechanism for enhancing the color in the eye image is provided in this embodiment. Specifically, after the step of displaying the patient information in the eye image, the method includes the following steps:

Step S70: When an enhancement instruction for image enhancement is detected, determine an enhancement type of the image enhancement based on a type code in the enhancement instruction.

Further, the image enhancement in this embodiment includes two types: tricolor channel enhancement and preset algorithm enhancement. The functional area includes different virtual

keys for the two enhancement types, and the virtual keys carry different type codes. The trigger operation performed on either of the two virtual keys is detected as an enhancement instruction for image enhancement. When the enhancement instruction is detected, the type code carried in the enhancement instruction is first read to determine the enhancement type for image enhancement of the eye image based on the type code.

Step S80: When the enhancement type is a first preset type, read color information in the enhancement instruction, and enhance a color corresponding to the color information in the eye image.

Still further, the tricolor channel enhancement type in the image enhancement is used as the first preset type, where the tricolor channels are red, green, and blue color channels, and the first preset type is a type of enhancement performed through the red, green, and blue color channels. This type of image enhancement is targeted at the entire image. When it is determined by using the type code that the enhancement type of the image enhancement is the first preset type, the enhancement instruction for image enhancement carries color information that represents the color that needs to be enhanced. The color information in the enhancement instruction is first read to determine, based on the color information, the color channel that needs to be enhanced. Then the color corresponding to the color information in the eye image is enhanced, that is, the color channel represented by the color information in the eye image is enhanced, so that the entire eye image presents the color corresponding to the color information.

Step S90: When the enhancement type is a second preset type, enhance an image in a box selection area or a preset default area of the eye image based on the enhancement instruction.

Further, the preset algorithm enhancement in the image enhancement is used as the second preset type, where the preset algorithm may be the AREDS algorithm, and the second preset type is a type of enhancement performed using the AREDS algorithm. This type of image enhancement is targeted at the box selection area or the preset default area in the eye image. When it is determined by using the type code that the enhancement type of the image enhancement is the second preset type, the eye image is detected to determine whether there is a box selection area in

the eye image. If there is a box selection area in the eye image, the image in the box selection area is enhanced based on the enhancement instruction. If there is no box selection area in the eye image, a preset default area in the eye image is first determined, and the image in the preset default area is enhanced based on the enhancement instruction. The preset default area is determined by a preset rule. For example, a circular area whose center is the origin and whose radius is a certain value in the eye image is preset as the default area.

In addition, to help view the original image of the eye image, the functional area further includes a virtual key for canceling image enhancement. When a trigger instruction for the virtual key is detected, the image enhancement part in the eye image is canceled, and the original image of the eye image is displayed, so as to compare the eye images before and after enhancement.

Further, in another embodiment of the eye image processing method in the present application, the eye image processing method further includes the following steps:

Step q1: When a parameter configuration instruction is received, determine whether the eye image exists on the preset terminal screen; if the eye image exists, output prompt information for closing the eye image.

Still further, the tool window further includes a virtual key used to configure overall parameters of the eye image. When there is a need to configure the parameters, the virtual key is tapped. The tap operation is received as a parameter configuration instruction. The configurable parameters include image size units, conversion between various size units, etc. When the parameter configuration instruction is received, it is first detected whether the eye image is displayed in the main image display area of the preset terminal screen. If the eye image is displayed, prompt information for closing the displayed eye image is output. After the eye image is closed, the parameters are configured again. This prevents the configured parameters from affecting the displayed eye image.

Step q2: If the eye image does not exist, display a configuration input box on the preset terminal screen, and configure parameters based on configuration information that is input based on the configuration input box.

If it is detected that there is no eye image displayed in the main image display area of the preset terminal screen, the configuration input box is displayed on the preset terminal screen, so that various parameters are input based on the configuration input box for configuration. After the configuration information that is input based on the configuration input box is received, various parameters are configured based on the configuration information. If the size unit of the original image is mm, and the size unit received by the input box is  $\mu\text{m}$ , the original image size unit mm is changed to  $\mu\text{m}$ , so as to implement configuration of the image size unit. Through parameter configuration, the consistency of various parameters in the eye image is ensured, and different parameters can be configured for different processing requirements, so that the processing accuracy is consistent with the processing requirements.

In addition, referring to FIG. 2, the present application provides an eye image processing apparatus. In a first embodiment of the eye image processing apparatus in the present application, the eye image processing apparatus includes:

a detection module 10, configured to: when a detection instruction for an eye image is detected, invoke a preset algorithm to detect the eye image, and generate a detection result, where the detection result includes an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image;

a prediction module 20, configured to: when a prediction instruction for an abnormal change trend is detected, determine whether the detection result includes a risk-related factor; if the detection result includes the risk-related factor, predict an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability; and

a generation module 30, configured to: when a trigger instruction for generating a detection report is detected, generate a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

According to the eye image processing apparatus in the present embodiment, image

processing is performed on the eye image to obtain the detection result that includes the eye type, the position of the macula, the position of the optic disc, the position of the abnormality, and the like in the eye image; in addition, the abnormal change probability of the abnormal change trend is predicted based on the risk-related factor in the detection result; the reference detection report serving as a reference for the medical personnel is generated based on the detection result, the risk-related factor, and the abnormal change probability, so that the medical personnel quickly determine the abnormal information in the eye image based on the reference detection report, avoiding manual determining of the abnormal information in the eye image by the medical personnel alone, and improving the work efficiency of the medical personnel.

Further, in another embodiment of the eye image processing apparatus in the present application, the detection module further includes:

a locating unit, configured to invoke a first preset algorithm to locate the center of the macula in the eye image, and determine coordinates of the center of the macula;

an invoking unit, configured to invoke a second preset algorithm to segment an optic disc area in the eye image, and determine the position of the optic disc, coordinates of the center of the optic disc, and a diameter of the optic disc;

a determining unit, configured to determine the eye type based on the coordinates of the center of the optic disc, and determine the position of the macula based on the coordinates of the center of the macula and the diameter of the optic disc; and

a detection unit, configured to determine whether there is abnormal information in the eye image based on the second preset algorithm; if the abnormal information exists, detect a position of the abnormal information, determine the position of the abnormality, and generate the detection result based on the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality.

Further, in another embodiment of the eye image processing apparatus in the present application, the eye image processing apparatus further includes:

a first determining module, configured to: when a modification instruction for the detection result is detected, determine a modification type of the modification instruction based on a type identifier in the modification instruction;

a correction module, configured to: when the modification type is a correction type, correct the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result based on the modification instruction; and

a first update module, configured to: when the modification type is an addition type, determine abnormal information of pigment in the eye image based on the modification instruction, and add the abnormal information of pigment to the detection result, so as to update the detection result.

Further, in another embodiment of the eye image processing apparatus in the present application, the eye image processing apparatus further includes:

an adjustment module, configured to: when an adjustment instruction for the risk-related factor is detected, adjust the risk-related factor based on adjustment information in the adjustment instruction, and generate an adjusted risk-related factor; and

a second update module, configured to: update the abnormal change probability based on the adjusted risk-related factor.

Further, in another embodiment of the eye image processing apparatus in the present application, the eye image processing apparatus further includes:

a display module, configured to: when an opening instruction for the eye image is detected, open the eye image and display it on a preset terminal screen, and detect whether a patient information input instruction corresponding to the eye image is received;

a receiving module, configured to: if the patient information input instruction corresponding to the eye image is received, display an information input box on the preset terminal screen, and detect whether patient information that is input based on the information input box meets a preset rule; and

an output module, configured to: if the patient information that is input based on the information input box meets the preset rule, display the patient information in the eye image; if the patient information that is input based on the information input box does not meet the preset rule, output prompt information for re-input.

Further, in another embodiment of the eye image processing apparatus in the present application, the eye image processing apparatus further includes:

a second determining module, configured to: when an enhancement instruction for image enhancement is detected, determine an enhancement type of the image enhancement based on a type code in the enhancement instruction;

a reading module, configured to: when the enhancement type is a first preset type, read color information in the enhancement instruction, and enhance a color corresponding to the color information in the eye image; and

an enhancement module, configured to: when the enhancement type is a second preset type, enhance an image in a box selection area or a preset default area of the eye image based on the enhancement instruction.

Further, in another embodiment of the eye image processing apparatus in the present application, the eye image processing apparatus further includes:

a determining module, configured to: when a parameter configuration instruction is received, determine whether the eye image exists on the preset terminal screen; if the eye image exists, output prompt information for closing the eye image; and

a configuration module, configured to: if the eye image does not exist, display a configuration input box on the preset terminal screen, and configure parameters based on configuration information that is input based on the configuration input box.

The virtual functional modules of the above-described eye image processing apparatus are stored in a memory 1005 of the eye image processing device shown in FIG. 3. A processor 1001 executes readable instructions for eye image processing to implement the functions of various

modules in the embodiment shown in FIG. 2.

FIG. 3 is a schematic diagram of a device structure of a hardware operating environment used in a method according to an embodiment of the present application.

An eye image processing device in this embodiment of the present application may be a personal computer (PC), or a terminal device such as a smartphone, a tablet computer, an e-book reader, or a portable computer.

As shown in FIG. 3, the eye image processing device may include: the processor 1001 such as a central processing unit (CPU), the memory 1005, and a communications bus 1002. The communications bus 1002 is configured to implement connection and communication between the processor 1001 and the memory 1005. The memory 1005 may be a high-speed random access memory (RAM), or may be a non-volatile memory such as a magnetic disk memory. Optionally, the memory 1005 may also be a storage apparatus independent of the processor 1001.

Optionally, the eye image processing device may further include a user interface, a network interface, a camera, a radio frequency (RF) circuit, a sensor, an audio circuit, a wireless fidelity (Wi-Fi) module, etc. The user interface may include a display and an input unit such as a keyboard. Optionally, the user interface may further include a standard wired interface and wireless interface. Optionally, the network interface may include a standard wired interface and wireless interface (for example, a Wi-Fi interface).

It can be understood by a person skilled in the art that the structure of the eye image processing device shown in FIG. 3 constitutes no limitation on the eye image processing device. The eye image processing device may include more or fewer components than those shown in the figure, combine some components, or have different component arrangements.

As shown in FIG. 3, as a computer readable storage medium, the memory 1005 may include an operating system, a network communications module, and readable instructions for eye image processing. The operating system manages and controls readable instructions for hardware and software resources of the eye image processing device, and can run the readable instructions for eye image processing and other software and/or readable instructions. The network

communications module is configured to implement communication between various components in the memory 1005, and communication with other hardware and software in the eye image processing device.

In the eye image processing device shown in FIG. 3, the processor 1001 is configured to execute the readable instructions for eye image processing stored in the memory 1005 to perform the steps of the foregoing eye image processing method in various embodiments.

The present application provides a computer readable storage medium. The computer readable storage medium may be a non-volatile storage medium, and stores one or more readable instructions. The one or more readable instructions can further be executed by one or more processors to perform the steps of the foregoing eye image processing method in various embodiments.

It should be further noted that the term "comprise", "include", or any other variant thereof is intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that includes a series of elements includes not only those elements, but also other elements not explicitly listed, or elements that are inherent to such a process, method, article, or apparatus. Without more restrictions, an element defined by the phrase "including a ..." does not exclude the presence of another same element in a process, method, article, or apparatus that includes the element.

Sequence numbers of the embodiments of the present application are merely for a purpose of description, and do not represent advantages or disadvantages of the embodiments.

From the descriptions of the implementations, a person skilled in the art can clearly understand that the method in the embodiments may be implemented by software and a necessary universal hardware platform, and certainly may alternatively be implemented by hardware. However, in many cases, the implementation performed by software and a necessary universal hardware platform is better. Based on such an understanding, the technical solutions of the present application essentially or the part contributing to the prior art may be implemented in a form of a software product. The software product is stored in the above-described computer readable storage

medium (for example, a ROM/RAM, a magnetic disk, or an optical disc), and includes several instructions for instructing a terminal device (which may be a mobile phone, a computer, a server, or a network device) to perform the methods described in the embodiments of the present application.

The foregoing descriptions are merely example embodiments of the present application, and the protection scope of the present application is not limited thereto. All equivalent structure changes made based on the content of the specification and accompanying drawings in the present application or by directly or indirectly applying the present application in other related technical fields without departing from the ideas of the present application shall fall within the protection scope of the present application.

## CLAIMS

1. An eye image processing method, wherein the eye image processing method comprises the following steps:

when a detection instruction for an eye image is detected, invoking a preset algorithm to detect the eye image, and generating a detection result, wherein the detection result comprises an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality corresponding to abnormal information in the eye image;

when a prediction instruction for an abnormal change trend is detected, determining whether the detection result comprises a risk-related factor; if the detection result comprises the risk-related factor, predicting an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability, wherein the risk-related factor is related to drusen and pigment abnormality in the abnormal information; and

when a trigger instruction for generating a detection report is detected, generating a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

2. The eye image processing method according to claim 1, wherein the step of invoking the preset algorithm to detect the eye image, and generating the detection result comprises:

invoking a first preset algorithm to locate the center of the macula in the eye image, and determining coordinates of the center of the macula;

invoking a second preset algorithm to segment an optic disc area in the eye image, and determining the position of the optic disc, coordinates of the center of the optic disc, and a diameter of the optic disc;

determining the eye type based on the coordinates of the center of the optic disc, and determining the position of the macula based on the coordinates of the center of the macula and the diameter of the optic disc; and

determining whether there is abnormal information in the eye image based on the second preset algorithm; if the abnormal information exists, detecting a position of the abnormal information, determining the position of the abnormality, and generating the detection result based on the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality.

3. The eye image processing method according to claim 1, after the step of generating the detection result, comprising:

when a modification instruction for the detection result is detected, determining a modification type of the modification instruction based on a type identifier in the modification instruction;

when the modification type is a correction type, correcting the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result based on the modification instruction; and

when the modification type is an addition type, determining abnormal information of pigment in the eye image based on the modification instruction, and adding the abnormal information of pigment to the detection result, so as to update the detection result.

4. The eye image processing method according to claim 1, after the step of predicting the abnormal change probability corresponding to the risk-related factor, comprising:

when an adjustment instruction for the risk-related factor is detected, adjusting the risk-related factor based on adjustment information in the adjustment instruction, and generating an adjusted risk-related factor; and

updating the abnormal change probability based on the adjusted risk-related factor.

5. The eye image processing method according to claim 1, before the step when the detection instruction for the eye image is detected, comprising:

when an opening instruction for the eye image is detected, opening the eye image and displaying it on a preset terminal screen, and detecting whether a patient information input

instruction corresponding to the eye image is received;

if the patient information input instruction corresponding to the eye image is received, displaying an information input box on the preset terminal screen, and detecting whether patient information that is input based on the information input box meets a preset rule; and

if the patient information that is input based on the information input box meets the preset rule, displaying the patient information in the eye image; if the patient information that is input based on the information input box does not meet the preset rule, outputting prompt information for re-input.

6. The eye image processing method according to claim 5, after the step of displaying the patient information in the eye image, comprising:

when an enhancement instruction for image enhancement is detected, determining an enhancement type of the image enhancement based on a type code in the enhancement instruction;

when the enhancement type is a first preset type, reading color information in the enhancement instruction, and enhancing a color corresponding to the color information in the eye image; and

when the enhancement type is a second preset type, enhancing an image in a box selection area or a preset default area of the eye image based on the enhancement instruction.

7. The eye image processing method according to claim 6, wherein the eye image processing method further comprises the following steps:

when a parameter configuration instruction is received, determining whether the eye image exists on the preset terminal screen; if the eye image exists, outputting prompt information for closing the eye image; or

if the eye image does not exist, displaying a configuration input box on the preset terminal screen, and configuring parameters based on configuration information that is input based on the configuration input box.

8. An eye image processing apparatus, wherein the eye image processing apparatus comprises:

a detection module, configured to: when a detection instruction for an eye image is detected, invoke a preset algorithm to detect the eye image, and generate a detection result, wherein the detection result comprises an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality in the eye image;

a prediction module, configured to: when a prediction instruction for an abnormal change trend is detected, determine whether the detection result comprises a risk-related factor; if the detection result comprises the risk-related factor, predict an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability; and

a generation module, configured to: when a trigger instruction for generating a detection report is detected, generate a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

9. The eye image processing apparatus according to claim 8, wherein the detection module further comprises:

a locating unit, configured to invoke a first preset algorithm to locate the center of the macula in the eye image, and determine coordinates of the center of the macula;

an invoking unit, configured to invoke a second preset algorithm to segment an optic disc area in the eye image, and determine the position of the optic disc, coordinates of the center of the optic disc, and a diameter of the optic disc;

a determining unit, configured to determine the eye type based on the coordinates of the center of the optic disc, and determine the position of the macula based on the coordinates of the center of the macula and the diameter of the optic disc; and

a detection unit, configured to determine whether there is abnormal information in the eye

image based on the second preset algorithm; if the abnormal information exists, detect a position of the abnormal information, determine the position of the abnormality, and generate the detection result based on the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality.

10. The eye image processing apparatus according to claim 8, wherein the eye image processing apparatus further comprises:

a first determining module, configured to: when a modification instruction for the detection result is detected, determine a modification type of the modification instruction based on a type identifier in the modification instruction;

a correction module, configured to: when the modification type is a correction type, correct the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result based on the modification instruction; and

a first update module, configured to: when the modification type is an addition type, determine abnormal information of pigment in the eye image based on the modification instruction, and add the abnormal information of pigment to the detection result, so as to update the detection result.

11. The eye image processing apparatus according to claim 8, wherein the eye image processing apparatus further comprises:

an adjustment module, configured to: when an adjustment instruction for the risk-related factor is detected, adjust the risk-related factor based on adjustment information in the adjustment instruction, and generate an adjusted risk-related factor; and

a second update module, configured to: update the abnormal change probability based on the adjusted risk-related factor.

12. The eye image processing apparatus according to claim 8, wherein the eye image processing apparatus further comprises:

a display module, configured to: when an opening instruction for the eye image is detected,

open the eye image and display it on a preset terminal screen, and detect whether a patient information input instruction corresponding to the eye image is received;

a receiving module, configured to: if the patient information input instruction corresponding to the eye image is received, display an information input box on the preset terminal screen, and detect whether patient information that is input based on the information input box meets a preset rule; and

an output module, configured to: if the patient information that is input based on the information input box meets the preset rule, display the patient information in the eye image; if the patient information that is input based on the information input box does not meet the preset rule, output prompt information for re-input.

13. The eye image processing apparatus according to claim 12, wherein the eye image processing apparatus further comprises:

a second determining module, configured to: when an enhancement instruction for image enhancement is detected, determine an enhancement type of the image enhancement based on a type code in the enhancement instruction;

a reading module, configured to: when the enhancement type is a first preset type, read color information in the enhancement instruction, and enhance a color corresponding to the color information in the eye image; and

an enhancement module, configured to: when the enhancement type is a second preset type, enhance an image in a box selection area or a preset default area of the eye image based on the enhancement instruction.

14. The eye image processing apparatus according to claim 13, wherein the eye image processing apparatus further comprises:

a determining module, configured to: when a parameter configuration instruction is received, determine whether the eye image exists on the preset terminal screen; if the eye image exists, output prompt information for closing the eye image; and

a configuration module, configured to: if the eye image does not exist, display a configuration input box on the preset terminal screen, and configure parameters based on configuration information that is input based on the configuration input box.

15. An eye image processing device, wherein the eye image processing device comprises a memory, a processor, a communications bus, and a readable instruction for eye image processing stored in the memory;

the communications bus is configured to implement connection and communication between the processor and the memory; and

the processor is configured to execute the readable instruction for eye image processing, so as to perform the following steps:

when a detection instruction for an eye image is detected, invoking a preset algorithm to detect the eye image, and generating a detection result, wherein the detection result comprises an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality corresponding to abnormal information in the eye image;

when a prediction instruction for an abnormal change trend is detected, determining whether the detection result comprises a risk-related factor; if the detection result comprises the risk-related factor, predicting an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability, wherein the risk-related factor is related to drusen and pigment abnormality in the abnormal information; and

when a trigger instruction for generating a detection report is detected, generating a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

16. The eye image processing device according to claim 15, wherein the step of invoking the preset algorithm to detect the eye image, and generating the detection result comprises:

invoking a first preset algorithm to locate the center of the macula in the eye image, and

determining coordinates of the center of the macula;

invoking a second preset algorithm to segment an optic disc area in the eye image, and determining the position of the optic disc, coordinates of the center of the optic disc, and a diameter of the optic disc;

determining the eye type based on the coordinates of the center of the optic disc, and determining the position of the macula based on the coordinates of the center of the macula and the diameter of the optic disc; and

determining whether there is abnormal information in the eye image based on the second preset algorithm; if the abnormal information exists, detecting a position of the abnormal information, determining the position of the abnormality, and generating the detection result based on the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality.

17. The eye image processing device according to claim 15, wherein after the step of generating the detection result, the processor is configured to execute the readable instruction for eye image processing, so as to perform the following steps:

when a modification instruction for the detection result is detected, determining a modification type of the modification instruction based on a type identifier in the modification instruction;

when the modification type is a correction type, correcting the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result based on the modification instruction; and

when the modification type is an addition type, determining abnormal information of pigment in the eye image based on the modification instruction, and adding the abnormal information of pigment to the detection result, so as to update the detection result.

18. A computer readable storage medium, wherein the computer readable storage medium stores a readable instruction for eye image processing, and the readable instruction for eye image processing is executed by a processor to perform the following steps:

when a detection instruction for an eye image is detected, invoking a preset algorithm to detect the eye image, and generating a detection result, wherein the detection result comprises an eye type, a position of a macula, a position of an optic disc, and a position of an abnormality corresponding to abnormal information in the eye image;

when a prediction instruction for an abnormal change trend is detected, determining whether the detection result comprises a risk-related factor; if the detection result comprises the risk-related factor, predicting an abnormal change probability corresponding to the risk-related factor based on a preset mapping relationship between a quantity of risk-related factors and a probability, wherein the risk-related factor is related to drusen and pigment abnormality in the abnormal information; and

when a trigger instruction for generating a detection report is detected, generating a reference detection report for the eye image based on the detection result, the risk-related factor, and the abnormal change probability, so as to complete processing of the eye image.

19. The computer readable storage medium according to claim 18, wherein the step of invoking the preset algorithm to detect the eye image, and generating the detection result comprises:

invoking a first preset algorithm to locate the center of the macula in the eye image, and determining coordinates of the center of the macula;

invoking a second preset algorithm to segment an optic disc area in the eye image, and determining the position of the optic disc, coordinates of the center of the optic disc, and a diameter of the optic disc;

determining the eye type based on the coordinates of the center of the optic disc, and determining the position of the macula based on the coordinates of the center of the macula and the diameter of the optic disc; and

determining whether there is abnormal information in the eye image based on the second preset algorithm; if the abnormal information exists, detecting a position of the abnormal information, determining the position of the abnormality, and generating the detection result based on the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality.

20. The computer readable storage medium according to claim 18, wherein after the step of generating the detection result, the readable instruction for eye image processing is executed by the processor to perform the following steps:

when a modification instruction for the detection result is detected, determining a modification type of the modification instruction based on a type identifier in the modification instruction;

when the modification type is a correction type, correcting the eye type, the position of the macula, the position of the optic disc, and the position of the abnormality in the detection result based on the modification instruction; and

when the modification type is an addition type, determining abnormal information of pigment in the eye image based on the modification instruction, and adding the abnormal information of pigment to the detection result, so as to update the detection result.