

Description

Title of Invention

VISION IMPROVING DEVICE

Technical Field

[0001]

The present invention relates to a vision training device that trains muscles of the eyes on the basis of a status of personal vision of a user.

Background Art

[0002]

Human's vision is particularly associated with a ciliary muscle among muscles of the eyes. Thus, human's vision can be improved or maintained by training of contracting or relaxing the ciliary muscle. However, since human's ciliary muscle has different abilities for individuals, it is effective to perform customized vision training corresponding to each individual's vision.

[0003]

However, in a vision training device of a related art, training the ciliary muscle is performed by simply changing a focal length of the eye of the user without considering the status of personal vision. For this reason, the training efficiency is low, and it is not easy for the user to adapt to training.

Disclosure of Invention

Technical Problem

[0004]

It is an object of the present invention to provide a vision training device with a relatively high training efficiency for the ciliary muscle.

Solution to Problem

[0005]

In order to achieve the object of the present invention, a vision training device according to the present invention includes a housing having at least one eyepiece unit corresponding to an eye of a user, a display that displays a target image in front of a fixation axis of the user, a lens arranged between the eyepiece unit and the display unit, a movable unit capable of moving at least one of the display and the lens along the fixation axis, and a control unit that sets at least one training range within a movable range of the display and the lens and controls the movable unit such that at least one of the display and the lens is moved within the training range.

[0006]

Preferably, the control unit sets an accommodation range corresponding to a range between a predetermined near point of accommodation position and a far point of accommodation position within the movable range, and the training range includes the accommodation range.

[0007]

Preferably, a user input unit that receives a user input signal from the user is further included, and the near point of accommodation position and the far point of accommodation position are set through an input of the user input signal.

[0008]

Preferably, a sensor module that checks if the eye of the user transitions from an accommodated state to a non-accommodated state or transitions from the non-accommodated state to the accommodated state and generates an accommodation state change confirmation signal is further included, and the control unit sets the near point of accommodation position and the far point of accommodation position on the basis of the accommodation state change confirmation signal.

[0009]

Preferably, the control unit measures a continuous or intermittently accommodation speed through the user input unit or the sensor module within the accommodation range, and the training speed in the training range of the display and the lens is determined by reflecting the measured speed.

[0010]

Preferably, the control unit sets a predetermined critical point of accommodation position and a far critical point of accommodation position within the accommodation range, and the training range includes at least a part of a fast accommodation range between the near critical point of accommodation position and the far critical point of accommodation position.

[0011]

Preferably, at least one second lens arranged between the lens and the display along the fixation axis or between the lens and the eyepiece unit is further included.

[0012]

Preferably, the movable unit includes a second movable unit that moves the second lens, and the second movable unit is any one of a piezo actuator, a VCM actuator, and an encoder actuator.

[0013]

Preferably, the movable unit selectively moves at least one of the lens and the second lens.

[0014]

Preferably, an image size of the target image varies depending on a position of the display.

Advantageous Effects of Invention

[0015]

In a vision training device according to the present invention, training the ciliary muscle is performed in consideration of the status of personal vision of the user, and thus the training efficiency is high, and the vision recovery effect is high as well.

Brief Description of Drawings

[0016]

FIG. 1 is a perspective view illustrating a vision training device according to the present invention.

[0017]

FIG. 2 is a control block diagram of a vision training device according to the present invention.

[0018]

FIG. 3 is an explanatory diagram illustrating various methods of measuring a near point of accommodation position and a far point of accommodation position in a vision training device of the present invention.

[0019]

FIG. 4 is a reference diagram for describing measurement and training processes based on display movement according to the present invention.

[0020]

FIG. 5 is a flowchart illustrating a process of measuring a near point of accommodation position and a far point of accommodation position using a measurement method illustrated in (A) of FIG. 3.

[0021]

FIG. 6 is a flowchart illustrating a training mode process in a vision training device according to the present invention.

[0022]

FIG. 7 is a sequence diagram illustrating a training mode process in a vision training device according to another embodiment of the present invention.

[0023]

FIG. 8 is a reference diagram for describing a training method according to an example illustrated in FIG. 7.

[0024]

FIG. 9 is a reference diagram for describing a training process based on lens movement.

[0025]

FIG. 10 is an explanatory diagram schematically illustrating a vision training device including a plurality of lenses.

[0026]

FIG. 1 is a perspective view illustrating a vision training device according to the present invention. As illustrated in FIG. 1, a vision training device includes a housing 110 indicated by a two-dot chain line and a pair of vision training units 120 arranged side by side in the housing 110. The housing 110 further includes a shielding plate 122 which is arranged between a pair of vision training units 120 and shields the visual fields of the left and right eyes from each other. Here, the shielding plate 122 may be replaced with a configuration in which each of the vision training units 120 has a separate housing structure.

[0027]

The housing 110 further includes a pair of eyepiece units 124 corresponding to both eyes of the user, and the user can view the inside of the housing 110 through the eyepiece units 124. Here, the pair of eyepiece units 124 may be connected with no shielding partition so that a single through hole is formed. A user input unit 160 that receives a signal in accordance with a manipulation of the user is installed on the upper surface of the housing 110. The user can input necessary information or select a training condition, a training mode, or the like through the user input unit 160. The housing 110 may include a strap or a device made of a material with elasticity which enables the housing 110 to be fixed on the head of the user.

[0028]

The vision training unit 120 further includes displays 130 and lenses 140 which are arranged to face each other along a fixation axis. The vision training unit 120 further includes lens holders 142 that holds the lenses 140. Each of the lens holder 142 is arranged corresponding to the corresponding eyepiece unit 124. The user can see the displays 130 through the lenses 140 supported by the lens holders 142.

[0029]

The display 130 displays a target image for vision training. The display 130 may be an electronic display device such as an LCD or an LED or a simple display panel such as paper, a plastic plate, or the like. The target image can be a static image such as a landscape, a graphic, a point, or a geometric shape or a moving

picture.

[0030]

The lens 140 is mounted on the lens holder 142 and arranged between the eyepiece unit 124 and the display 130. The user can view the target image displayed on the display 130 through the eyepiece unit 124 and the lens 140. Here, the lens 140 is preferably a convex lens. The convex lens can extend the perspective of an image by changing the focal length between the eye of the user and the target image so that the user recognizes the image as if the image were at a distance farther than an actual distance. However, the lens 140 is not limited to the convex lens, and various types of lenses such as a polarizing lens, a color lens, and the like can be employed. In a case in which a polarizing lens or a color lens is employed, the user can view a portion of the target image which is filtered.

[0031]

The display 130 and the lens holder 142 are connected by a movable unit 150. The movable unit 150 includes a lead screw 151, a movable body 152, and a drive motor unit 153. Here, the movable body 152 may be coupled to the display 130, and the drive motor unit 153 may be coupled to the lens holder 142, or vice versa.

The lead screw 151 connects the drive motor 153 with the movable body 152.

[0032]

With this configuration, as the drive motor 153 is driven, the lead screw 151 rotates, and the display 130 and the lens 140 is moved toward or away from each other along the fixation axis. In other words, in a case in which the display 130 is fixed to the housing 110, the lens 140 is moved relative to the display 130 as the drive motor 153 is driven, whereas in a case in which the lens holder 142 is fixed to the housing 110, the display 130 is moved relative to the lens 140 as the drive motor 153 is driven. The display 130 and the lens holder 142 may be configured to move relative to the housing 110 so that the display 130 and the lens 140 can be moved independently at the same time. Further, a manual driving method in which they are moved in accordance with a manipulation of the user may be employed.

[0033]

FIG. 2 is a control block diagram of the vision training device according to the present invention. Referring to FIGS. 1 and 2, the vision training device includes a control unit 190 that receive information input from the user input unit 160 including a plurality of user input buttons 161 to 166. The user input unit 160 may include a power button, a user selection button, a forward moving button, a backward moving button, a measurement mode button, and a training mode button. The user input unit 160 may be replaced with a wired or wireless remote controller or may receive information using a voice recognition technique, a technique using a gyro sensor, or an eye tracking technique using an image recognition sensor.

[0034]

The vision training device may further include a communication unit 170 that enables wired or wireless communication with an external device such as a smart phone, a tablet, a PC, or a user server. The communication unit 170 can perform transmission and reception of data generated in the vision training device with the external device.

[0035]

The vision training device may further include a memory 180 that stores user information, diopter conversion data, vision data, training data, and various types of data necessary for the operation of the vision training device. The diopter conversion data refers to data obtained by converting a position of the display 130 and the lens 140 into a diopter value within a movable range of the display 130 or the lens 140.

[0036]

The control unit 190 can control at least one of the pair of displays 130 and the pair of lenses 140 individually. Accordingly, in the vision training device according to the present invention, it is possible to freely select and train either of the left eye and the right eye or both of the left eye and the right eye.

[0037]

FIG. 3 is an explanatory diagram illustrating various methods of measuring a near point of accommodation position P5 and a far point of accommodation

position P6 in the vision training device of the present invention, FIG. 4 is a reference diagram for describing measurement and training processes based on display movement according to the present invention, and FIG. 5 is a flowchart illustrating a process of measuring the near point of accommodation position P5 and the far point of accommodation position P6 using a measurement method illustrated in (A) of FIG. 3. Referring to FIGS. 3, 4, and 5, the near point of accommodation position P5 and the far point of accommodation position P6 according to the present invention can be measured while the display 130 or the lens 140 is being moved from a far position P2 to a near position P1 as illustrated in (A) of FIG. 3.

[0038]

First, the user presses the power button of the user input unit 160 so that it is powered on. Then, the user wears the vision training device and selects a measurement mode by pressing the measurement mode selection button of the user input unit 160 (S110).

[0039]

When the measurement mode is selected by the user, the control unit 190 controls the drive motor 153 such that the display 130 or the lens 140 is moved to the far position P2 (S120). The far position P2 is the farthest position from the eyepiece unit 124 in a movable range MR of the display 130 or the lens 140 but can be adjusted within a predetermined range.

[0040]

The control unit 190 controls the drive motor 153 such that the display 130 or the lens 140 is continuously or intermittently moved from the far position P2 toward the eyepiece unit 124 (step S130). At this time, the moving speed in the case of continuous moving or the intermittent moving interval in the case of the intermittent moving can be adjusted to a set speed or a set interval.

[0041]

The control unit 190 checks whether or not an accommodation reflex confirmation signal is input from the user input unit 160 (S140). The accommodation reflex confirmation signal is a signal which is generated in accordance with the manipulation of the user on the user input unit 160 and

transmitted to the control unit 190 when the eye of the user transitions from an accommodated state to a non-accommodated state. At a moment at which a target image TI which is blurred is seen clear as the display 130 or the lens 140 is moved, that is, at a moment at which the visibility of the target image TI by the user changes, the user presses the user selection button of the user input unit 160, so that the accommodation reflex confirmation signal is input.

[0042]

When the accommodation reflex confirmation signal is input from the user input unit 160, the control unit 190 stores a critical position of the display 130 or the lens 140 at a time point at which the accommodation reflex confirmation signal is input as the far point of accommodation position P6 (S150).

[0043]

Then, the control unit 190 controls the drive motor 153 such that the display 130 or the lens 140 is moved toward the eyepiece unit 124 continuously or intermittently (S160). At this time, a moving speed in the case of the continuous moving or a waiting time in a non-moving state in the case of the intermittent moving can be adjusted.

[0044]

The control unit 190 checks whether or not an accommodation reflex confirmation signal is input from the user input unit 160 (S170). At this time, the accommodation reflex confirmation signal is a signal which is generated in accordance with a manipulation of the user on the user input unit 160 and transmitted to the control unit 190 when the eye of the user transitions from the accommodated state to the non-accommodated state. At a moment at which the target image TI which is clear is seen blurred as the display 130 or the lens 140 is moved, that is, at a moment at which the visibility of the target image TI by the user changes, the user presses the user selection button of the user input unit 160, so that the accommodation reflex confirmation signal is input.

[0045]

When the accommodation reflex confirmation signal is input from the user input unit 160, the control unit 190 stores a critical position of the display 130 or the

lens 140 at a time point at which the accommodation reflex confirmation signal is input as the near point of accommodation position P5 (S180). The far point of accommodation position P6 and the near point of accommodation position P5 are individually measurable.

[0046]

The far point of accommodation position P6 and the near point of accommodation position P5 according to the present invention can be measured by various methods instead of the method of moving from the far position (P2) to the near position (P1).

[0047]

Incidentally, the near point of accommodation position P5 and the far point of accommodation position P6 according to the present invention can be measured while the display 130 or the lens 140 is being moved from the near position (P1) to the far position (P2) as illustrated in (B) of FIG. 3.

[0048]

The control unit 190 controls the drive motor 153 such that the display 130 or the lens 140 is moved to the near position P1. Preferably, the near position P1 is a position which is closest to the eyepiece unit 124 in the movable range of the display 130 or a position which is apart from the eyepiece unit 124 by a predetermined distance.

[0049]

After the display 130 or the lens 140 is moved to the near position P1, the control unit 190 controls the drive motor 153 such that the display 130 or the lens 140 is continuously or intermittently moved in a direction from the eyepiece unit 124 toward the far point P2. At this time, the moving speed in the case of the continuous moving or the waiting time in the non-moving state in the case of the intermittent moving can be adjusted.

[0050]

The control unit 190 checks whether or not the accommodation reflex confirmation signal is input from the user input unit 160. At a moment at which the target image TI which is blurred is seen clear as the display 130 or the lens 140 is

moved, that is, at a moment at which the visibility of the target image TI by the user changes, the user presses the user selection button of the user input unit 160, so that the accommodation reflex confirmation signal is input. The control unit 190 stores the position of the display 130 or the lens 140 as the near point of accommodation position P5 at a time point at which the accommodation reflex confirmation signal is input from the user input unit 160.

[0051]

The control unit 190 controls the drive motor 153 such that the display 130 or the lens 140 is continuously or intermittently moved toward the far position P2. At this time, the moving speed in the case of the continuous moving or the waiting time in the case of the intermittent moving can be adjusted.

[0052]

The control unit 190 checks whether or not the accommodation reflex confirmation signal is input from the user input unit 160. At a moment at which the target image TI which is clear is seen blurred as the display 130 or the lens 140 is moved, that is, at a moment at which the visibility of the target image TI by the user changes, the user presses the user selection button of the user input unit 160, so that the accommodation reflex confirmation signal is input. When the accommodation reflex confirmation signal is input from the user input unit 160, the control unit 190 receives stores the position of the display 130 or the lens 140 at a time point at which the signal is input as the far point of accommodation position P6. The near point of accommodation P5 and the far point of accommodation P6 need not necessarily be continuously measured, and any one of the near point of accommodation P5 and the far point of accommodation P6 may be measured.

[0053]

The near point of accommodation position P5 and the far point of accommodation position P6 according to the present invention may be measured while the display 130 or the lens 140 is being moved to the near point of accommodation position P5 or the far point of accommodation position P6 with reference to a user reference position.

[0054]

A middle point of a statistically average accommodation range at the user's age may be set as the user reference position, or a position at which the user can see most comfortably when the display 130 or the lens 140 is moved forward or backward at a predetermined speed within the line of sight range may be set as the user reference position in accordance with the input from the user, and the near point of accommodation position P5 may be decided on the basis of the signal input from the user input unit when the transition from the accommodated state to the non-accommodated states is performed while the display 130 or the lens 140 is being moved toward the eyepiece unit 124 with reference to the user reference position input from the user input unit 160, and the far point of accommodation position P6 may be decided while the display 130 or the lens 140 is being moved in the opposite direction.

[0055]

Further, as the near point of accommodation P5 and the far point of accommodation position P6 according to the present invention, as illustrated in (D) of FIG. 3, the near point of accommodation position P5 may be decided while the display 130 or the lens 140 is being moved from the far position P2 to the near position P1, and then the far point of accommodation position P6 may be decided while the display 130 or the lens 140 is being moved from the near position P1 to the far position P2.

[0056]

In a case in which the display 130 or the lens 140 is moved from the far position P2 to the near position P1, the transition from the non-accommodated state to the accommodated state and the transition from the accommodated state to the non-accommodated state are performed. In the measurement method illustrated in (D) of FIG. 3, when the transition from the accommodated state to the non-accommodated state is performed, the near point of accommodation position P5 is decided on the basis of the signal input from the user input unit.

[0057]

Further, when the display 130 or the lens 140 is moved from the near position P1 to the far position P2, the transition from the non-accommodated state to

the accommodated state and the transition from the accommodated state to the non-accommodated state are performed. In the measurement method illustrated in (D) of FIG. 3, when the transition from the accommodated state to the non-accommodated state is performed, the far point of accommodation position P6 is decided on the basis of the signal input from the user input unit. At this time, preferably, the near point of accommodation position P5 and the far point of accommodation position P6 are repeatedly measured while reducing the moving speed of the display 130 or the lens 140, and converged positions are selected as the near point of accommodation position P5 and the far point of accommodation position P6.

[0058]

The near point of accommodation position P5 and the far point of accommodation position P6 according to the present invention can be decided by various methods other than the above-described four methods. For example, the near point of accommodation position P5 and the far point of accommodation position P6 may be measured while the display 130 or the lens 140 is being moved continuously from the far position P2 to the near position P1 or from the near position P1 to the far position P2. Here, when the moving speed of the display 130 or the lens 140 is different, positions measured as the near point of accommodation position P5 and the far point of accommodation position P6 may be different. As the moving speed of the display 130 or the lens 140 increases, the width between the near point of accommodation position P5 and the far point of accommodation position P6 which are measured decreases, whereas as the moving speed of the display 130 or the lens 140 decreases, the width between the near point of accommodation position P5 and the far point of accommodation position P6 which are measured increases.

[0059]

Alternatively, one of a plurality of near point of accommodation positions P5 and one of a plurality of far point of accommodation positions P6 measured by various methods as described above may be appropriately selected. For example, the position measured by the method described in (B) of FIG. 3 may be selected as

the near point of accommodation position P5, and the position measured by the method described in (A) of FIG. 3 may be selected as the far point of accommodation position P6.

[0060]

The near point of accommodation positions P5 and the far point of accommodation positions P6 measured in the methods illustrated in (A) to (D) of FIG. 3 may be slightly different in positions. In this case, the near point of accommodation position P5 measured by the method illustrated in (B) of FIG. 3 is desirable as the near point of accommodation position P5, and the far point of accommodation position P6 measured by the method illustrated in (A) of FIG. 3 is desirable as the far point of accommodation position P6, but the near point of accommodation position P5 and the far point of accommodation position P6 measured by the methods illustrated in (C) and (D) of FIG. 3 may be selected.

[0061]

To determine the near point of accommodation position P5 and the far point of accommodation position P6 which are reliable, it is desirable for the user to perform the above-described measurement procedure repeatedly and decide an average near point of accommodation position P5 and an average far point of accommodation position P6 as the near point of accommodation position P5 and the far point of accommodation position P6.

[0062]

The vision training device according to the embodiment of the present invention may set critical accommodation information specific to each user on the basis of information derived by various methods of measuring the near point of accommodation position P5 and far point of accommodation position P6. The critical accommodation information may be set on the basis of the near point of accommodation position P5 and the far point of accommodation position P6, and the critical accommodation information may be indicated by the near point of accommodation position P5 and the far point of accommodation position P6 themselves, may be indicated by a distance value of the display 130 or the lens 140 from a reference position, or may be indicated by a diopter conversion value of a

corresponding position. The near point of accommodation position and the far point of accommodation position information can be used as parameter which are important for evaluating the vision of the user. The status of personal vision of the user is detected with this measurement mode as described above, and vision training in which the detected status of personal vision is considered is provided, so that the vision improvement effect can be maximized.

[0063]

Incidentally, the vision training device according to the embodiment of the present invention may further include a sensor module that detects whether the eye of the user is in the accommodated state or the non-accommodated state by emitting infrared rays or light toward the eye of the user and receiving infrared rays or light reflected from the eye of the user. The sensor module repeatedly checks if there is a change in an accommodation state of the eye of the user at set intervals. In other words, the sensor module checks if the eye of the user transitions from the accommodated state to the non-accommodated state, and transmits an accommodation state change confirmation signal to the control unit 190 when it is determined that the eye of the user transitions from the accommodated state to the non-accommodated state. Further, the sensor module checks if the eye of the user transitions from the non-accommodated state to the accommodated state, and transmits the accommodation state change confirmation signal to the control unit 190 when it is determined that the eye of the user transitions from the non-accommodated state to the accommodated state. The control unit 190 sets the near point of accommodation position P5 and the far point of accommodation position P6 on the basis of the accommodation state change confirmation signals.

[0064]

The sensor module may employ a principle similar to an examination principle of an auto refractor. In other words, the sensor module includes a light output unit that outputs infrared light or light toward the eye of the user, a light detecting unit that detects reflected light reflected from the eye of the user, and a refraction evaluating unit that calculates the focal length of the detected reflected light and calculates a position at which infrared ray or light output toward the eye

focus on the eye using the focal length.

[0065]

The control unit 190 sets an accommodation range AR on the basis of the near point of accommodation P5 and the far point of accommodation P6 decided in the measurement mode. The accommodation range AR corresponds to a range between the near point of accommodation position P5 and the far point of accommodation position P6. Ranges (NAR1 and NAR2) outside the accommodation range AR within the movable range MR of the display 130 or the lens 140 are non-accommodation range.

[0066]

FIG. 6 is a flowchart illustrating a training mode process in the vision training device of the present invention. The user presses the power button of the user input unit 160 so that the vision training device is powered, wears the vision training device, and selects a training mode by pressing the training mode selection button of the user input unit 160 (S210).

[0067]

If the training mode is selected by the user, the control unit 190 sets at least one training range within the movable range MR of the display 130 (S220). The training range includes the accommodation range AR for effective vision improvement. Here, the control unit 190 may set a range including the accommodation range AR and at least a part of the non-accommodation range (NAR1 and NAR2) within the movable range (MR) as the training range.

[0068]

In step S230, the display 130 or the lens 140 is continuously moved in the set training range or is intermittently moved such that moving with a predetermined distance and waiting with a predetermined waiting time are repeated (step S230). At this time, when the speed at which the display 130 or the lens 140 is moved and the waiting time after the movement are set in consideration of the status of personal vision of the individual user, the vision improvement by the vision training can be more effectively achieved.

[0069]

FIG. 7 is a flowchart illustrating a training mode process in the vision training device according to another embodiment of the present invention, and FIG. 8 is a reference diagram for describing a training method according to an example of FIG. 7. Referring to FIGS. 7 and 8, in order to set the continuous moving speed or the intermittent waiting time in which the status of personal vision of the user is reflected, in step S310, the control unit 190 controls the display 130 or the lens 140 such that the display 130 or the lens 140 is positioned at one of a plurality of measurement positions in the training range. For convenience of description, it is assumed that the display 130 or the lens 140 is moved from a first measurement position MP1 to a second measurement position MP2.

[0070]

In step S320, the control unit 190 checks whether or not the accommodation reflex confirmation signal is input from the user input unit 160 or the sensor module 200. The accommodation reflex confirmation signal is a signal indicating that the target image recognized by the user becomes clear or that the eye of the user transitions to the accommodated state.

[0071]

If the user presses the user input unit 160 at the moment at which the target image becomes clear at the second measurement position MP2, the accommodation reflex confirmation signal is input. In a case in which the sensor module 200 is used, the sensor module 200 repeatedly checks the accommodation state of the eye of the user, and inputs the accommodation reflex confirmation signal to the control unit 190 when the eye of the user transitions to the accommodated state.

[0072]

When the accommodation reflex confirmation signal is input, the control unit 190 stores an accommodation time for the measurement position MP2 (S330). Here, the accommodation time refers to a period of time until the accommodation reflex confirmation signal is input after the display 130 or the lens 140 is moved to the second measurement position MP2. The accommodation time has a value that differs depending on the status of personal vision of the user. The position of the display 130 or the lens 140 in the vision training device according to the present

invention may be converted into a predetermined diopter value, and the converted diopter value may be provided to the user.

[0073]

The accommodation time can be measured for each of a plurality of measurement positions MP1 to MP10. It is desirable to measure the accommodation time for each measurement position in accordance with the moving direction of the display 130 or the lens 140. This is because, although the measurement position is the same, the accommodation time may be different depending on the position of the display 130 or the lens 140 before the target image is recognized.

[0074]

When the accommodation time is decided for each of the plurality of measurement positions, the control unit 190 sets an intermittent moving interval or the continuous moving speed V of the display 130 or the lens 140 by reflecting the decided accommodation time (S340). The intermittent moving interval refers to an interval at which the display 130 or the lens 140 moves and stops at corresponding positions, and the continuous moving speed V refers to a moving speed of the display 130 or the lens 140 at a corresponding position.

[0075]

After the intermittent moving interval or the continuous moving speed V is decided, the control unit 190 performs control such that the display 130 or the lens 140 stays or passes through a corresponding position at the set intermittent moving interval or the set moving speed at (S350).

[0076]

As described above, the vision training is performed in consideration of the accommodation time for each measurement position, and thus the customized vision training in which the accommodation time of the user for the corresponding position is considered can be provided to the user. Therefore, it is possible to perform the vision training efficiently and to strengthen the ciliary muscle more effectively through the vision training.

[0077]

In a range in which the accommodation time is short, a time taken for the eye of the user to accommodate to the target image T1 is short, and the accommodation power of the eye of the user is high. Therefore, the width of the training range is set to be relatively large in the range in which the accommodation time is short, and the width of the training range is set to be relatively small in the range in which the accommodation time is long, and thus the effective training can be performed without incurring an excessive load on the user in the training process.

[0078]

When the width of the training range and the continuous moving speed and the intermittent moving interval of the display 130 or the lens 140 within the training range are variably set in consideration of the accommodation time of the user as described above, the vision improvement effect the can be maximized.

[0079]

In order to set the effective training range on the basis of the above-described information, the control unit 190 may set a near critical point of accommodation position P3 and a far critical point of accommodation position P4 within the accommodation range AR. The control unit 190 may set the near critical point of accommodation position P3 and the far critical point of accommodation position P4 in consideration of both the width of the accommodation range AR and a value related to the age of the user. For example, if the width of the accommodation range AR is large, a wide fast accommodation range FAR can be set, and as the age increases, the width of the fast accommodation range FAR can be set to decrease. A range between the nearest critical point of accommodation position P3 and the far adjustment reaction critical position P4 can be set as the fast accommodation range FAR, and ranges other than the fast accommodation range FAR within the accommodation range AR can be set as slow accommodation ranges SAR1 and SAR2. The fast accommodation range FAR can also be set by selecting two measurement points among the measurement points MP1 to MP10. The fast accommodation range FAR is a range in which the eye of the user can perform the accommodation reflex action very comfortably and can be applied to a virtual reality (VR) technique, and in this case, the eye fatigue caused by a video reproduced in a

VR game or the like is reduced during the vision training, so that the user can enjoy a VR game or the like while feeling as if the training were not performed.

[0080]

Another training range setting method will be described below. First, the control unit 190 causes the display 130 or the lens 140 to be positioned at either the near point of accommodation position P5 or the far point of accommodation position P6. Hereinafter, for the convenience of description, it is assumed that the display 130 or the lens 140 is moved to be positioned at the near point of accommodation position P5.

[0081]

The control unit 190 controls the movable unit 150 such that the measurement operation in which the display 130 or the lens 140 positioned at the near point of accommodation position P5 is moved in the direction of the far position P2 by a predetermined distance and then stays at the position for a preset waiting time is repeated. The user inputs the accommodation reflex confirmation signal through the user input unit 160 when the target image (TI) recognized through the lens 140 becomes blurred within a set waiting time. When the control unit 190 receives the accommodation reflex confirmation signal from the user input unit 160, the control unit 190 stops the measurement operation and sets the position of the display 130 or the lens 140 at a time point at which the accommodation reflex confirmation signal is received as the far critical point of accommodation position P4. The near critical point of accommodation position P3 is set in a similar manner.

[0082]

Alternatively, the control unit 190 may automatically set the near critical point of accommodation position P3 and the far critical point of accommodation position P4. A middle point of a statistically average accommodation range at the user's age may be set as the user reference position, or a position at which the user can see most comfortably when the display 130 or the lens 140 is moved forward or backward at a predetermined speed within the line of sight range may be set as the user reference position in accordance with the input from the user, and the control unit 190 may decide positions which are at predetermined distance from the user

reference position as the near critical point of accommodation position P3 and the far critical point of accommodation position P4. At this time, the near critical point of accommodation position P3 and the far point of critical point of accommodation position P4 may be set based on the age of the user.

[0083]

The near slow accommodation range SAR1 and the far slow accommodation range SAR2 are decided on the basis of the near critical point of accommodation position P3 and the far point of critical point of accommodation position P4. The near slow accommodation range SAR1 corresponds to a range between the near point of accommodation position P5 and the near critical point of accommodation position P3, and the far slow accommodation range SAR2 corresponds to a range between the far point of accommodation position P6 and the far critical point of accommodation position P4. Each of the slow accommodation ranges SAR1 and SAR2 is a range in which accommodation reserve power of the eye is reflected. In a case in which the vision training is performed in the slow accommodation ranges SAR1 and SAR2, it is possible to improve the vision of the user by expanding the accommodation reserve power and the accommodation power of the user.

[0084]

In a case in which the near slow accommodation range SAR1 and the far slow accommodation range SAR2 are set, it is desirable for the control unit 190 to include at least a part of the near slow accommodation range SAR1 or the far slow accommodation range SAR2 in the training range.

In other words, the training range may include only the fast accommodation range FAR, but it is effective in improving the vision when a part of at least one of the near slow accommodation range SAR1 and the far slow accommodation range SAR2 is included in the training range.

[0085]

The training range may be set to a range between the near slow accommodation range SAR1 and the far slow accommodation range SAR2, a range between the near slow accommodation range SAR1 and the fast accommodation

range FAR, or a range between the far slow accommodation range SAR2 and the fast accommodation range FAR. Of course, only either the near slow accommodation range (SAR1) or the far slow accommodation range (SAR2) can be set as the training range. The user can select any one of such training ranges or a combination thereof. If there is no selection from the user, the control unit 190 may arbitrarily set or select the training range.

[0086]

When the training range is set, the control unit 190 performs control such that the display 130 or the lens 140 is moved within the training range. The control unit 190 can cause the display 130 or the lens 140 to be moved continuously or intermittently. In other words, the control unit 190 may control such that the display 130 or the lens 140 performs continuous reciprocating movement within the training range or repeatedly performs movement in which the display 130 or the lens 140 is moved by a predetermined distance within the set training range and then stays for a set waiting time. Such movement of the display 130 or the lens 140 along the fixation axis produces the same effect as when the diopter value of the lens 140 is changed. In other words, the refractive index is changed.

[0087]

At this time, the image size of the target image T1 may vary depending on a distance. For example, a setting is performed so that as the display 130 or lens 140 approaches the eyepiece unit 124, the image size gradually decreases, whereas as the display 130 or lens 140 moves towards the far position P2, the image size gradually increases. Accordingly, it is possible to measure the accommodation power more accurately and perform the effective training.

[0088]

With such training, the ciliary muscle of the user contracts or relaxes and accommodates to the change in the focal length for the target image (TI) changing with the movement of the display 130 or the lens 140, so that the ciliary muscle is strengthened.

[0089]

Upon completion of the vision training, the vision training device ends the

training and stores training data in the memory 180. The training data includes information related to a time until one cycle of training ends, the training mode, and the training condition. The training data is stored for each user, and the stored training data is analyzed to confirm a degree of improvement of the vision according to the training. Therefore, the user can check the degree of improvement of the vision and effectively set up a future training plan and a training direction.

[0090]

The vision training device according to the present invention measures the near point of accommodation position P5 and the far point of accommodation position P6 corresponding to the current status of personal vision of the user and sets the training range on the basis of the near point of accommodation position P5 and the far point of accommodation position P6, and thus the high vision improvement is implemented.

[0091]

FIG. 9 is a reference view for describing the training process according to the movement of the lens 140. As can be seen in FIG. 9, the vision training device according to the present invention changes the focal length between the target image (TI) and the eye by moving the display 130 and/or the lens 140 and thus strengthen the ciliary muscle associated with the vision. The description of the measurement mode and the training mode based on the movement of the display 130 described above is similarly applied to the vision training based on the movement of the lens 140. In other words, as the lens 140 is moved, the near critical point of accommodation position P3, the far critical point of accommodation position P4, the near point of accommodation position P5, and the far point of accommodation position P6 can be measured on the basis of the position of the lens 140, the fast accommodation range FAR, the near slow accommodation range SAR1, and the far slow accommodation range SAR2 can be set on the basis of the positions, and then the vision training can be performed.

[0092]

In other words, both the movement of the display 130 and the movement of the lens 140 are performed to change the focal distance between the target image T1

and the eye. Of course, the display 130 and the lens 140 may be moved together to change the focal length between the target image TI and the eye and strengthen the ciliary muscle associated with the vision.

[0093]

FIG. 10 is an explanatory diagram schematically illustrating a vision training device according to another embodiment of the present invention. As illustrated in FIG. 10, the vision training device may include a plurality of lenses along the fixation axis. The vision training device may further include a second lens 145 arranged between the eyepiece unit 124 and the lens 140 along the fixation axis. In a case in which a plurality of lenses are installed, the vision training can be performed by changing the refractive index variously rather than in a case in which a single lens is installed. The second lens 145 may be arranged between the lens 140 and the display 130. The position of the second lens 145 can be fixed or variable. Here, the movable unit 150 according to the present invention can selectively move at least one of the lens 140 and the second lens 145. To this end, a piezo actuator, a VCM actuator, or an encoder actuator may be employed as the movable unit 150. Further, the movable unit 150 may include a second movable unit for moving the second lens 145, and any one of a piezo actuator, a VCM actuator, and an encoder actuator may be employed as the second movable unit 150. In addition to the second lens 145, at least one lens which is fixed or movable and additionally affects the adjustment of the focal length may be additionally arranged.

[0094]

The image size of the target image (TI) according to the present invention may vary depending on the position of the display 130. For example, it is desirable that as the display 130 or the lens 140 approaches the eyepiece unit 124, the image size of the target image TI increase, and as the display 130 or the lens 140 gets away from the eyepiece unit 124, the image size of the target image TI decrease. Accordingly, the accurate accommodation power measurement and the effective training can be performed.

[0095]

The target image according to the present invention can be moved up, down,

left, or right. Accordingly, it is possible to cause the muscles of the eyes to exercise in various methods.

CLAIMS

1. A device for exercising muscles in eyes, comprising:

a housing having an ocular hole corresponding to a user's eye, a line of sight being defined to intersect with the ocular hole;

a target image disposed on the line of sight;

a lens disposed on the line of sight and between the ocular hole and the target image;

a lens driver configured to drive the lens to move forward and backward along the line of sight; and

a controller configured to determine an emmetropia region, set an exercise region that includes a region beyond at least one of a close limit and a remote limit of the emmetropia region, and control the lens driver to drive the lens to reciprocate in the region of the exercise region beyond at least one of the close limit and the remote limit of the emmetropia region.

2. The device according to claim 1, wherein the controller is configured to set the exercise region within a full movable range of the lens, and control the lens driver to drive the lens to reciprocate within the exercise region.

3. The device according to claim 2, wherein the controller is configured to set

the emmetropia region as a predetermined emmetropia region within the movable range, and the exercise region includes the predetermined emmetropia region and the region beyond at least one of the close limit and the remote limit of the emmetropia region.

4. The device according to claim 3, further comprising a user input device configured to receive a user's input, wherein the controller is configured to set at least one of the emmetropia region and the exercise region based on the user's input.

5. The device according to claim 4, wherein the controller is configured to control the lens driver to drive the lens proximal a limit of the full moveable range of the lens, control the lens driver to drive the lens towards an opposite limit of the full moveable range of the lens, receive a first user input from the user input device indicating that the target image is recognized, continue to control the lens driver to drive the lens towards the opposite limit, receive a second user input from the user input device indicating that the target image is blurry, and determine the emmetropia region based on the first user input and the second user input.

6. The device according to claim 4, wherein the controller is configured to control the lens driver to drive the lens to a position outside of the emmetropia region,

wait for a standby time period, receive a user input from the user input device indicating that the target image did not become clear, and set the region beyond at least one of the close limit and the remote limit of the emmetropia region based on a location of the lens outside of the emmetropia region.

7. The device according to claim 1, further comprising a display configured to display the target image.

8. The device according to claim 1, wherein the controller is configured to set the exercise region to include a region beyond the close limit and a region beyond the remote limit of the emmetropia region.

9. The device according to claim 1, wherein the controller is configured to set the region beyond at least one of the close limit and the remote limit of the emmetropia region based on an age of the user.

10. The device according to claim 1, wherein the lens includes at least one of a convex lens, a concave lens, a polarization lens, an omni-focal lens, and a color lens.

11. The device according to claim 8, the lens includes a convex lens.

12. The device according to claim 1, wherein the lens driver includes a lead screw, the lens is coupled to a moving body, the moving body is coupled to the lead screw, and the lens driver is configured to rotate the lead screw thereby causing the moving body to translate along the lead screw and cause the lens to move forward or backward.

13. The device according to claim 1, further comprising a wireless interface, wherein the controller is configured to transmit data to or receive data from an external device using the wireless interface.

14. The device according to claim 13, wherein the controller is configured to receive and store user information and exercise data using the wireless interface.

15. The device according to claim 14, wherein the controller is configured to determine the emmetropia region based on the user information.