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Inventor(s)	CHO; Junghoon et al.

HEAD-MOUNTED DISPLAY DEVICE FOR DISPLAYING TANGENT SCREEN AND OPERATION METHOD FOR HEAD-MOUNTED DISPLAY DEVICE

Abstract

A head-mounted display device including: a display configured to display a tangent screen for measuring a size and a shape of a scotoma of a user; an eye-tracking sensor configured to obtain information about a gaze direction of the user; a memory storing at least one instruction; and at least one processor including a processor circuitry, wherein the at least one processor is configured to individually or collectively execute the at least one instruction stored in the memory to: identify a point of view where a gaze of the user intersects the display based on the gaze direction of the user obtained via the eye-tracking sensor; determine a position on the display at which the tangent screen is displayed, such that a center of the tangent screen corresponds to the point of view; and display the tangent screen at the determined position.

Inventors: **CHO; Junghoon (Suwon-si, KR), KIM; Yongnam (Suwon-si, KR), PARK; Jisun (Suwon-si, KR), SOHN; Junil (Suwon-si, KR), YI; Sanghyun (Suwon-si, KR), KOO; Bonkon (Suwon-si, KR)**

Applicant: **SAMSUNG ELECTRONICS CO., LTD.** (Suwon-si, KR)

Family ID: **1000008640769**

Assignee: **SAMSUNG ELECTRONICS CO., LTD. (Suwon-si, KR)**

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Background/Summary

CROSS-REFERENCE OF RELATED APPLICATIONS [0001] This application is a continuation of International Application No. PCT/KR2023/017421, filed on Nov. 2, 2023, which is based on and claims priority to Korean Patent Application 10-2022-0148140, filed on Nov. 8, 2022, in the Korean Intellectual Property Office, the disclosures of which are incorporated by reference herein in their entireties.

BACKGROUND
1. Field
[0002] The present disclosure relates to a head-mounted display device and an operating method thereof.
2. Description of Related Art
[0003] Visual impairment may be generally classified into impairment associated with visual acuity, which refers to the clarity of vision a person possesses, and impairment associated with visual field, which refers to the extent of the external world visible to an eye gazing at one point straight ahead.
[0004] Macular degeneration, a type of visual field impairment, involves degeneration occurring in a macula, a part of the eye tissue, and when degeneration occurs in a macula, which is the central part of the retina, an intended focal point may appear dark or distorted, which may eventually lead to the formation of a scotoma, i.e., an area of lost vision within the central visual field, resulting in central vision loss.
[0005] When central vision impairment occurs due to macular degeneration, accurately identifying the size and shape of the scotoma is important for treatment, and in this case, an examination using a tangent screen may be performed to identify the size and shape of the scotoma.
[0006] Furthermore, in cases of central vision loss, objects may be perceived by using peripheral vision that has been trained through eccentric viewing training.
SUMMARY
[0007] According to an aspect of the present disclosure, a head-mounted display device includes: a display configured to display a tangent screen for measuring a size and a shape of a scotoma of a user; an eye-tracking sensor configured to obtain information about a gaze direction of the user; a memory storing at least one instruction; and at least one processor including a processing circuitry, wherein the at least one processor is configured to individually or collectively execute the at least one instruction stored in the memory to: identify a point of view where a gaze of the user intersects the display based on the gaze direction of the user obtained via the eye-tracking sensor; determine a position on the display at which the tangent screen is displayed, such that a center of the tangent

screen corresponds to the point of view; and display the tangent screen at the determined position.

[0008] The point of view where the gaze of the user intersects the display may be a first point of view, and the at least one processor may be further configured to: identify, based on a change in the gaze direction determined by the eye-tracking sensor, a second point of view where the changed gaze of the user intersects the display; and change the position on the display at which the tangent screen is displayed, such that the center of the tangent screen corresponds to the second point of view.

[0009] The at least one processor may be further configured to, after displaying the tangent screen on the display such that the center of the tangent screen corresponds to the first point of view, determine whether the gaze direction of the user has changed via the eye-tracking sensor at preset tracking intervals.

[0010] The at least one processor may be further configured to: display at least one point on the tangent screen; receive, from the user, a user input comprising information indicating that the displayed at least one point is perceived abnormally; and measure the size and the shape of the scotoma of the user based on the received user input.

[0011] The at least one processor may be further configured to change a position of the at least one point displayed on the tangent screen according to a random pattern.

[0012] The at least one processor may be further configured to change a position of the at least one point displayed on the tangent screen according to a preset position pattern.

[0013] The at least one processor may be further configured to: receive an external input comprising information about a position at which the at least one point is displayed on the tangent screen; calculate a position of the at least one point displayed on the tangent screen based on the received external input; and display the at least one point at the calculated position.

[0014] The at least one processor may be further configured to display a shape of the at least one point corresponding to any one of a plurality of preset shapes.

[0015] The at least one processor may be further configured to, after measuring the size and the shape of the scotoma of the user via the tangent screen, display, on the display, visual field training content for training a visual field of the user based on the measured size and shape of the scotoma of the user.

[0016] The at least one processor may be further configured to: determine a position on the display at which the visual field training content is to be displayed, such that a center of the visual field training content corresponds to the identified point of view; and display the visual field training content at the determined position.

[0017] According to another aspect of the present disclosure, an operating method of a head-mounted display device comprising a display, the operating method includes: obtaining information about a gaze direction of a user; identifying, based on the obtained gaze direction of the user, a point of view where a gaze of the user intersects the display; determining a position on the display at which a tangent screen is to be displayed, such that a center of the tangent screen for measuring a size and a shape of a scotoma of the user corresponds to the point of view; and displaying the tangent screen at the determined position.

[0018] The point of view identified in the identifying of the point of view where the gaze of the user intersects the display may be a first point of view, and after the displaying of the tangent screen at the determined position such that the center of the tangent screen corresponds to the first point of view, the operating method may further include: determining whether the gaze direction of the user has changed; identifying, based on the changed gaze direction of the user, a second point of view where the changed gaze of the user intersects the display; and changing the position on the display at which the tangent screen is displayed, such that the center of the tangent screen corresponds to the second point of view.

[0019] The determining of whether the gaze direction of the user has changed may be at performed preset tracking intervals.

[0020] The operating method may further include: displaying at least one point on the tangent screen; receiving, from the user, a user input comprising information indicating that the displayed at least one point is perceived abnormally; and measuring the size and the shape of the scotoma of the user based on the received user input.
[0021] According to another aspect of the present disclosure, a computer-readable recording medium having recorded thereon a program for causing a computer to execute the operating method.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0022] The above and other aspects, features, and advantages of certain embodiments of the present disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:
[0023] FIG. **1** is a diagram for describing a head-mounted display device according to one or more embodiments of the present disclosure;
[0024] FIG. **2** is a block diagram illustrating a head-mounted display device and an operating method thereof, according to one or more embodiments of the present disclosure;
[0025] FIG. **3** is a diagram for describing an operation of measuring the size and shape of a scotoma of a user by using a tangent screen and at least one point, according to one or more embodiments of the present disclosure;
[0026] FIG. **4** is a diagram for describing a head-mounted display device and operations of the head-mounted display device, according to one or more embodiments of the present disclosure;
[0027] FIG. **5** is a flowchart for describing an operating method of a head-mounted display device according to one or more embodiments of the present disclosure;
[0028] FIG. **6** is a diagram for describing displaying a tangent screen on a display such that the center of the tangent screen corresponds to a point of view, according to one or more embodiments of the present disclosure;
[0029] FIG. **7** is a flowchart for describing a method of measuring the size and shape of a scotoma of a user by displaying a tangent screen and at least one point, according to one or more embodiments of the present disclosure;
[0030] FIG. **8**A is a diagram for describing changing the position of at least one point according to a random pattern, according to one or more embodiments of the present disclosure;
[0031] FIG. **8**B is a diagram for describing changing the position of at least one point according to a preset position pattern, according to one or more embodiments of the present disclosure;
[0032] FIG. **9** is a diagram for describing obtaining a notification signal for at least one point and measuring the size and shape of a scotoma of a user based on the obtained notification signal, according to one or more embodiments of the present disclosure;
[0033] FIG. **10** is a flowchart for describing a method of identifying, at preset tracking intervals, whether a gaze direction of a user has changed, and changing the position of a tangent screen, according to one or more embodiments of the present disclosure;
[0034] FIG. **11** is a diagram for describing changing, when a gaze direction of a user has changed, the position of a tangent screen such that the center of the tangent screen corresponds to a changed point of view, according to one or more embodiments of the present disclosure;
[0035] FIG. **12** is a flowchart for describing a method of, when a gaze direction of a user has changed, measuring the size and shape of a scotoma of the user while changing the position of a tangent screen, according to one or more embodiments of the present disclosure; and
[0036] FIG. **13** is a diagram for describing displaying visual field training content on a display such that the center of the visual field training content corresponds to a point of view, according to one

or more embodiments of the present disclosure.

DETAILED DESCRIPTION

[0037] Terms used herein will be briefly described, and then one or more embodiments of the present disclosure will be described in detail.

[0038] Although the terms used herein are selected from among common terms that are currently widely used in consideration of their functions in one or more embodiments of the present disclosure, the terms may be different according to an intention of one of ordinary skill in the art, a precedent, or the advent of new technology. Also, in particular cases, the terms are discretionally selected by the applicant of the present disclosure, in which case, the meaning of those terms will be described in detail in the corresponding description of one or more embodiments of the present disclosure. Therefore, the terms used herein are not merely designations of the terms, but the terms are defined based on the meaning of the terms and content throughout the present disclosure.

[0039] The singular expression may also include the plural meaning as long as it is not inconsistent with the context. All the terms used herein, including technical and scientific terms, may have the same meanings as those generally understood by those of skill in the art related to the present specification.

[0040] Throughout the present disclosure, when a part “includes” an element, it is to be understood that the part may additionally include other elements rather than excluding other elements as long as there is no particular opposing recitation. In addition, as used herein, the terms such as “ . . . er (or)”, “ . . . unit”, “ . . . module”, etc., denote a unit that performs at least one function or operation, which may be implemented as hardware or software or a combination thereof.

[0041] As used herein, the expression “configured to” may be interchangeably used with, for example, “suitable for”, “having the capacity to”, “designed to”, “adapted to”, “made to”, or “capable of”, according to a situation. The expression “configured to” may not imply only “specially designed to” in a hardware manner. Instead, in a certain circumstance, the expression “a system configured to” may indicate the system “capable of” together with another device or components. For example, “a processor configured (or set) to perform A, B, and C” may imply a dedicated processor (e.g., an embedded processor) for performing a corresponding operation or a generic-purpose processor (e.g., central processing unit (CPU) or an application processor) capable of performing corresponding operations by executing one or more software programs stored in a memory.

[0042] In addition, in the present disclosure, it should be understood that when components are “connected” or “coupled” to each other, the elements may be directly connected or coupled to each other, but may alternatively be connected or coupled to each other with an element therebetween, unless specified otherwise.

[0043] In the present disclosure, an ‘electronic device’ may be a head-mounted display (HMD) device. However, the present disclosure is not limited thereto, and the ‘electronic device’ may also be implemented as various types of electronic devices, such as a television (TV), a mobile device, a smart phone, a laptop computer, a desktop computer, a tablet PC, an electronic book terminal, a digital broadcasting terminal, personal digital assistant (PDA), a portable multimedia player (PMP), a wearable device, or the like.

[0044] In the present disclosure, a ‘scotoma’ may refer to an area in a central visual field that appears dark or distorted, or becomes invisible, resulting from degeneration occurring in the macula, which is a central part of the retina.

[0045] In the present disclosure, a ‘tangent screen’ is a planar perimeter that uses a plane to measure the visual field of a user gazing at the ‘tangent screen’, and is also referred to as a Bjerrum screen. The ‘tangent screen’ allows for the measurement of the size and shape of a scotoma in a user gazing at the center of the ‘tangent screen’.

[0046] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings to allow those of skill in the art to easily carry out the embodiments.

One or more embodiments of the present disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiment of the present disclosure set forth herein. In addition, parts in the drawings unrelated to the detailed description are omitted to ensure clarity of one or more embodiments of the present disclosure, and like reference numerals in the drawings denote like elements.
[0047] Hereinafter, embodiments of the disclosure will be described in detail with reference to the drawings.
[0048] FIG. **1** is a diagram for describing an HMD device according to one or more embodiments of the present disclosure.
[0049] Referring to FIG. **1**, an electronic device **100** according to one or more embodiments of the present disclosure may provide content to a user **200** wearing the electronic device **100**. In one or more embodiments, the electronic device **100** is a device capable of providing content to the user **200**, and may be an HMD device **100**. In one or more embodiments, FIG. **1** illustrates that the electronic device **100** has a shape similar to eyeglasses, including a support portion that extends over a facial part of the user **200**. However, the present disclosure is not limited thereto, and the electronic device **100** may also include a support portion that extends over a facial part and a head part of the user **200**. In addition, in one or more embodiments of the present disclosure, the electronic device **100** is not limited to an HMD device and may also be implemented as various types of electronic devices, such as a TV, a mobile device, a smart phone, a laptop computer, a desktop computer, a tablet PC, an electronic book terminal, a digital broadcasting terminal, a PDA, a PMP, or a wearable device. Hereinafter, for convenience of description, the electronic device **100** will be referred to as the HMD device **100**.
[0050] In one or more embodiments, the HMD device **100** may include a display **110** and an eye-tracking sensor **120** configured to obtain information about a gaze direction **201_1** or **201_2** of the user **200** viewing the display **110**.
[0051] In one or more embodiments, the HMD device **100** may display, on the display **110**, content obtained based on data received externally or data previously stored in the HMD device **100**, so as to provide the content to the user **200**. In one or more embodiments, the HMD device **100** may receive, from an external electronic device, data including information about content to be displayed on the display **110**. However, the disclosure is not limited thereto. The HMD device **100** may be a video see-through electronic device capable of obtaining content by capturing, with a camera, a physical environmental space toward which the gaze direction of the user **200** is directed, and then providing the obtained content to the user US via the display **110**.
[0052] Hereinafter, for convenience of description, the HMD device **100** will be described as a device capable of obtaining content based on data received externally or data previously stored in the HMD device **100**, and displaying the obtained content on the display **110** to provide the content to the user **200**.
[0053] In one or more embodiments, the content displayed by the HMD device **100** on the display **110** may be a tangent screen **111_1** or **111_2** for measuring the size and shape of a scotoma **117** (see FIG. **3**) of the user **200**. In one or more embodiments, the content may also include at least one point **113** (see FIG. **3**) displayed on the tangent screen **111_1** or **111_2**. The tangent screens **111_1** and **111_2** and the at least one point **113** will be described below with reference to FIG. **3**.
[0054] In one or more embodiments, the content displayed by the HMD device **100** on the display **110** may also include visual field training content **111_3** (see FIG. **13**) for training the visual field of the user **200**. The visual field training content **111_3** will be described below with reference to FIG. **13**.
[0055] In one or more embodiments, the eye-tracking sensor **120** may track the gaze of an eye of the user **200** viewing the display **110**, to obtain information about the gaze direction **201_1** or **201_2** of the user **200**. In one or more embodiments, the eye-tracking sensor **120** may calculate the distance between an eye of the user **200** and the display **110**. The HMD device **100** may identify,

via the eye-tracking sensor **120**, a point of view **210_1** or **210_2** where the gaze of the user **200** intersects the display **110**. In one or more embodiments, when the gaze direction **201_1** or **201_2** of the user **200**, obtained by the eye-tracking sensor **120**, changes, the point of view **210_1** or **210_2**, identified by the HMD device **100**, where the gaze of the user **200** intersects the display **110**, may also change.

[0056] In one or more embodiments, the HMD device **100** may display content on the display **110** such that a center **112_1** or **112_2** of the content corresponds to the point of view **210_1** or **210_2** where the obtained gaze of the user **200** intersects the display **110**. In one or more embodiments, the HMD device **100** may display the tangent screens **111_1** and **111_2** on the display **110** such that the centers **112_1** and **112_2** of the tangent screens corresponds to the identified points of view **210_1** and **210_2**, respectively. In one or more embodiments, the HMD device **100** may display the visual field training content **111_3** (see FIG. **13**) on the display **110** such that a center **112_3** or **112_4** of the content corresponds to the identified point of view **210_1** or **210_2**.

[0057] In one or more embodiments, the HMD device **100** may display the content on the display **110** such that the center **112_1** of the content corresponds to the identified point of view **210_1**, and then determine whether the gaze direction **201_1** of the user **200** changes. When the gaze direction **201_1** of the user **200** changes, the HMD device **100** may identify, based on the changed gaze direction **201_2**, the point of view **210_2** where the changed gaze of the user **200** intersects the display **110**. The HMD device **100** may change the position where the content is displayed on the display **110**, such that the center **112_2** of the content displayed on the display **110** corresponds to the point of view **210_2** identified based on the gaze of the user **200**.

[0058] According to the HMD device **100** and an operating method of the HMD device **100** of the present disclosure, while measuring the size and shape of the scotoma **117** (see FIG. **3**) of the user **200**, the gaze direction **201_2** of the user **200** may change, such that the user **200** may no longer gaze at the center **112_1** of the content screen displayed on the display **110**. In this case, the HMD device **100** may change the position of the content screen **111_2** displayed on the display **110**, such that the size and shape of the scotoma **117** of the user is measured while maintaining the state in which the user gazes at the center **112_2** of the content screen. Thus, the accuracy and reliability of an operation of measuring the size and shape of the scotoma **117** of the user may be enhanced.

[0059] FIG. **2** is a block diagram illustrating an HMD device and an operating method thereof, according to one or more embodiments of the present disclosure.

[0060] Referring to FIG. **2**, the HMD device **100** may include the display **110**, the eye-tracking sensor **120**, a memory **130**, at least one processor **140**, and a communication interface **150**. However, not all components illustrated in FIG. **2** are essential components. The HMD device **100** may be implemented with more or fewer components than those illustrated in FIG. **2**. In one or more embodiments, the HMD device **100** may further include a camera for photographing a real world space toward which the gaze direction of the user **200** is directed.

[0061] In one or more embodiments, the display **110**, the eye-tracking sensor **120**, the memory **130**, the at least one processor **140**, and the communication interface **150** may be electrically and/or physically connected to each other. Hereinafter, the same reference numerals are assigned to the same components as those described above with reference to FIG. **1**B, and redundant descriptions thereof will be omitted.

[0062] In one or more embodiments, the display **110** may include any one of a liquid-crystal display, a plasma display, an organic light-emitting diode display, and an inorganic light-emitting diode display. However, the present disclosure is not limited thereto, and the display **110** may include other types of displays capable of providing content to the user **200**.

[0063] Referring to FIGS. **1** and **2**, in one or more embodiments, the eye-tracking sensor **120** may obtain information about the gaze direction **201_1** or **201_2** of the user **200**. In one or more embodiments, the eye-tracking sensor **120** may detect the gaze direction **201_1** or **201_2** of the user **200** by detecting an image of an iris or pupil of the user **200**, or by detecting the direction or amount of light, such as near-infrared light, reflected from a cornea. In one or more embodiments, the eye-tracking sensor **120** may include a left-eye eye-tracking sensor and a right-eye eye-tracking sensor. The eye-tracking sensor **120** may detect a gaze direction of the left eye of the user **200** and a gaze direction of the right eye of the user **200**. Detecting the gaze direction **201_1** or **201_2** of the user **200** may include obtaining information about the gaze direction **201_1** or **201_2** of the user **200**.

[0064] In one or more embodiments, the eye-tracking sensor **120** may also calculate the distance between the display **110** and an iris or pupil of the user **200** based on a preset positional relationship between the display **110** and the eye-tracking sensor **120**, an image of the iris or pupil of the user **200**, or the like. The eye-tracking sensor **120** may identify the point of view **210_1** or **210_2** where the gaze of the user **200** intersects the display **110**, based on the gaze direction **201_1** or **201_2** of the user **200** and the distance between the display **110** and the iris of the user **200**.

[0065] In one or more embodiments, the eye-tracking sensor **120** may include a light emission unit and a light detection unit. In one or more embodiments, the light emission unit may include an infrared (IR) light-emitting diode (LED) configured to emit infrared light toward an eye of the user **200**, and the light detection unit may include an IR camera configured to detect light reflected from the eye. However, the present disclosure is not limited thereto. The light emission unit may include an IR scanner (e.g., a microelectromechanical systems (MEMS) scanner) configured to emit line-shaped IR light toward an eye of the user **200**, and the light detection unit may include an IR detector (e.g., a photodiode) configured to detect light reflected from the eye of the user **200**. In one or more embodiments, the left-eye eye-tracking sensor and the right-eye eye-tracking sensor may each include a light emission unit and a light detection unit.

[0066] In one or more embodiments of the present disclosure, the memory **130** may include at least one of flash memory-type memory, hard disk-type memory, multimedia card micro-type memory, card-type memory (e.g., SD or XD memory), random-access memory (RAM), static RAM (SRAM), read-only memory (ROM), electrically erasable programmable ROM (EEPROM), programmable ROM (PROM), mask ROM, flash ROM, a hard disk drive (HDD), or a solid-state drive (SSD). At least one instruction or program code for performing functions or operations of the HMD device **100** may be stored in the memory **130**. At least one instruction, algorithm, data structure, program code, and application program stored in the memory **130** may be implemented in a programming or scripting language such as C, C++, Java, or an assembler.

[0067] In one or more embodiments, a gaze obtaining module **131**, a point-of-view obtaining module **132**, a content display module **133**, a point display module **134**, a visual field measurement module **135**, and a visual field training module **136** may be stored in the memory **130**. However, not all modules illustrated in FIG. **2** are essential modules. More or fewer modules than those illustrated in FIG. **2** may be stored in the memory **130**.

[0068] A 'module' included in the memory **130** may refer to a unit that processes a function or operation performed by the at least one processor **140**. A 'module' included in the memory **130** may be implemented as software, such as at least one instruction, algorithm, data structure, or program code.

[0069] Referring to FIGS. **1** and **2**, in one or more embodiments, the gaze obtaining module **131** may include instructions or program code related to an operation or function for the HMD device **100** to obtain information about the gaze direction **201_1** or **201_2** of the user **200**. In one or more embodiments, by executing the instructions or program code of the gaze obtaining module **131**, the at least one processor **140** may obtain information about the gaze direction **201_1** or **201_2** of the user **200**, via the eye-tracking sensor **120**. However, the present disclosure is not limited thereto, and by executing instructions or program code of the gaze obtaining module **131**, the at least one processor **140** may also obtain information about the gaze direction **201_1** or **201_2** of the user **200**, from a server or a peripheral electronic device.

[0070] In one or more embodiments, the point-of-view obtaining module **132** may include instructions or program code related to an operation or function for identifying the point of view **210_1** or **210_2** where the gaze of the user **200** intersects the display **110**, based on the obtained gaze direction **201_1** or **201_2** of the user **200**. In one or more embodiments, by executing the instructions or program code of the point-of-view obtaining module **132**, the at least one processor **140** may identify the point of view **210_1** or **210_2** where the gaze of the user **200** intersects the display **110**, via the eye-tracking sensor **120**.

[0071] In one or more embodiments, the content display module **133** may include instructions or program code related to an operation or function for determining a position on the display **110** where content is to be displayed, such that the center **112_1**, **112_2**, **112_3**, or **112_4** (see FIG. **13**) of the content corresponds to the identified point of view **210_1** or **210_2**, and for displaying the content at the determined position. In one or more embodiments, by executing the instructions or program code of the content display module **133**, the at least one processor **140** may determine a position on the display **110** where the content is to be displayed, such that the center **112_1**, **112_2**, **112_3**, or **112_4** (see FIG. **13**) of the content corresponds to the identified point of view **210_1** or **210_2**. By executing the instructions or program code of the content display module **133**, the at least one processor **140** may display the content at the determined position.

[0072] In one or more embodiments, the content that the at least one processor **140** displays on the display **110** by executing the instructions or program code of the content display module **133** may include the tangent screen **111_1** or **111_2** for measuring the size and shape of a scotoma of the user **200**, and the visual field training content **111_3** for training the visual field of the user **200**.

[0073] In one or more embodiments, the point display module **134** may include instructions or program code related to an operation or function for displaying at least one point **113_1** or **113_2** (see FIGS. **8**A and **8**B) on the tangent screen **111_1** or **111_2** when the tangent screen **111_1** or **111_2** is displayed on the display **110**. In one or more embodiments, the point display module **134** may include instructions or program code related to an operation or function for changing the at least one point **113_1** or **113_2** according to a random pattern **114_1** (see FIG. **8**A) or a preset position pattern **114_2** (see FIG. **8**B), and displaying the changed at least one point **113_1** or **113_2** on the tangent screen **111_1** or **111_2**. In addition, the point display module **134** may include instructions or program code related to an operation or function for changing the shape of the at least one point **113_1** or **113_2** to correspond to any one of a plurality of preset shapes and displaying the changed at least one point **113_1** or **113_2** on the tangent screen **111_1** or **111_2**.

[0074] In one or more embodiments, by executing the instructions or program code of the point display module **134**, the at least one processor **140** may display the at least one point **113_1** or **113_2** on the tangent screen **111_1** or **111_2**. The at least one point **113_1** and **113_2** displayed on the tangent screens **111_1** and **111_2** of the present disclosure will be described below with reference to FIGS. **3**, **8**A, **8**B, and **9**.

[0075] In one or more embodiments, the visual field measurement module **135** may include instructions or program code related to an operation or function for measuring the visual field of the user **200** via the tangent screen **111_1** or **111_2** and the at least one point **113_1** or **113_2** that are displayed on the display **110**. In one or more embodiments, the visual field measurement module **135** may include instructions or program code related to an operation or function for measuring the size and shape of the scotoma **117** (see FIG. **9**) of the user **200** via the tangent screen **111_1** or **111_2** and the at least one point **113_1** or **113_2** that are displayed on the display **110**, and thereby measuring the visual field of the user **200**.

[0076] In one or more embodiments, the visual field measurement module **135** may include instructions or program code related to an operation or function for receiving, from the user **200**, a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2** is perceived abnormally, and for measuring the size and shape of the scotoma **117** of the user **200** based on the received user input.

[0077] In one or more embodiments, by executing the instructions or program code of the visual field measurement module **135**, the at least one processor **140** may measure the size and shape of the scotoma **117** of the user **200** and measure the visual field of the user **200**. Measuring the size and shape of the scotoma **117** of the user **200** according to the present disclosure will be described below with reference to FIGS. **3**, **8**A, **8**B, and **9**.

[0078] In one or more embodiments, the visual field training module **136** may include instructions or program code related to an operation or function for displaying, on the display **110**, the visual field training content **111_3** for training the visual field of the user **200** measured via the visual field measurement module **135**. In one or more embodiments, the visual field training module **136** may include instructions or program code related to an operation or function for displaying, on the display, the visual field training content **111_3** for performing, based on the measured size and shape of the scotoma **117** of the user **200**, eccentric viewing training such that the user **200** may perceive objects through peripheral vision.

[0079] In one or more embodiments, the visual field training module **136** may include instructions or program code related to an operation or function for determining a position on the display **110** where the visual field training content **111_3** is displayed, such that the center **112_3** or **112_4** of the visual field training content **111_3** corresponds to the identified point of view **210_1** or **210_2**, and for displaying the visual field training content **111_3** at the determined position.

[0080] In one or more embodiments, by executing the instructions or program code of the visual field training module **136**, the at least one processor **140** may determine a position on the display **110** where the visual field training content **111_3** is to be displayed, such that the center **112_3** or **112_4** of the visual field training content **111_3** corresponds to the identified point of view **210_1** or **210_2**. By executing the instructions or program code of the visual field training module **136**, the at least one processor **140** may display the visual field training content **111_3** at the determined position. Eccentric viewing training through the visual field training content **111_3** of the present disclosure will be described below with reference to FIG. **13**.

[0081] In one or more embodiments, the at least one processor **140** may include, but is not limited to, at least one of a CPU, a microprocessor, a graphics processing unit, an application processor (AP), an application-specific integrated circuit (ASIC), a digital signal processor (DSP), a digital signal processing device (DSPD), a programmable logic device (PLD), a field-programmable gate array (FPGA), or a neural processing unit or a dedicated artificial intelligence processor designed with a hardware structure specialized for training and processing of an artificial intelligence model.

[0082] According to an embodiment of the disclosure, the at least one processor **140** may include circuitry such as a system on chip (SoC) or an integrated circuit (IC).

[0083] In one or more embodiments, the communication interface **150** may perform data communication with an external server (not shown), under control of the at least one processor **140**. In addition, the communication interface **150** may perform data communication not only with the external server but also with other peripheral electronic devices.

[0084] In one or more embodiments, the communication interface **150** may perform data communication with a server or other peripheral electronic devices by using at least one of data communication schemes including, for example, wired local area network (LAN), wireless LAN, Wi-Fi, Bluetooth, ZigBee, Wi-Fi Direct (WFD), Infrared Data Association (IrDA), Bluetooth Low Energy (BLE), near-field communication (NFC), wireless broadband internet (WiBro), Worldwide Interoperability for Microwave Access (WiMAX), Shared Wireless Access Protocol (SWAP), Wireless Gigabit Alliance (WiGig), and radio-frequency (RF) communication.

[0085] In one or more embodiments, the communication interface **150** may also receive, from a server or other peripheral electronic devices, data including the tangent screen **111_1** or **111_2**, or the visual field training content **111_3**. The at least one processor **140** may also display, on the display **110**, the tangent screen **111_1** or **111_2**, or the visual field training content **111_3** obtained based on the received data.

[0086] In one or more embodiments, the communication interface **150** may receive, from a server or other peripheral electronic devices, an external input including information about a position at which to display the at least one point **113_1** or **113_2** on the tangent screen **111_1** or **111_2**. The at least one processor **140** may calculate, based on the received external input, a position of the at least one point **113_1** or **113_2** to be displayed on the tangent screen **111_1** or **111_2**, and display the at least one point **113_1** or **113_2** at the calculated position.

[0087] In one or more embodiments, the communication interface **150** may also receive, from the user **200**, a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2** is perceived abnormally. In one or more embodiments, the communication interface **150** may also receive, via a server or other peripheral electronic devices, a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2** is perceived abnormally. The at least one processor **140** may measure the size and shape of the scotoma **117** of the user **200**, based on the received user input.

[0088] However, the present disclosure is not limited thereto, and the electronic device **100** may further include an input/output interface. In one or more embodiments, an input/output interface **170** may perform an input/output operation for data including the tangent screen **111_1** or **111_2**, or the visual field training content **111_3**, with an external server or an external electronic device by using at least one of input/output methods including High-Definition Multimedia Interface (HDMI), Digital Visual Interface (DVI), and Universal Serial Bus (USB).

[0089] FIG. **3** is a diagram for describing an operation of measuring the size and shape of a scotoma of a user by using a tangent screen and at least one point, according to one or more embodiments of the present disclosure.

[0090] FIG. **3** illustrates an operation of measuring the size and shape of the scotoma **117** of the user **200** (see FIG. **1**) viewing a tangent screen **111**, by using the tangent screen **111** and the at least one point **113** displayed on the tangent screen **111**.

[0091] In one or more embodiments, the tangent screen **111** is a planar perimeter that uses a plane, and is also referred to as a Bjerrum screen. The tangent screen **111** is content for measuring the visual field of the user **200** using the tangent screen **111**. In one or more embodiments, the tangent screen **111** is content for measuring the central visual field of the user **200** and measuring the size and shape of a scotoma of the user **200**, when the user **200** using the tangent screen is gazing at a center **112** of the tangent screen **111**.

[0092] Referring to FIGS. **2** and **3**, the at least one processor **140** may display the tangent screen **111** on the display **110**, and display the at least one point **113** on the tangent screen **111**. In one or more embodiments, the at least one processor **140** may display the at least one point **113** on the tangent screen **111** such that the position of the at least one point **113** changes in a direction from an outermost peripheral position on the tangent screen **111** toward the center **112** of the tangent screen.

[0093] In one or more embodiments, while displaying the point **113** on the tangent screen **111** such that the position of the point **113** changes in a direction from an outermost peripheral position on the tangent screen **111** toward the center **112** of the tangent screen, the at least one processor **140** may obtain a user input including information indicating that the point **113** is perceived abnormally. In one or more embodiments, the at least one processor **140** may determine, based on the user input, that the at least one point **113** falls within the scotoma of the user **200**.

[0094] In one or more embodiments, the user input may be a signal obtained based on a reaction of the user **200** when the point **113** displayed on the tangent screen **111** begins to be perceived abnormally by the user **200** gazing at the center **112** of the tangent screen. In one or more embodiments, the HMD device **100** may sense a voice signal of the user **200** indicating that the point **113** is perceived abnormally, and generate a user input based on the sensed voice signal.

[0095] In one or more embodiments, the at least one processor **140** may receive, via the communication interface **150**, a user input that has been generated by other peripheral electronic devices that have sensed inputs from the user **200** when the point **113** began to be perceived abnormally, and have generated the user input based on the inputs sensed from the user **200**. The present disclosure is not limited thereto, and the HMD device **100** may also obtain a user input by sensing an input from the user **200**.

[0096] When the user input is obtained, the at least one processor **140** may obtain position information **115** about the point that is displayed on the tangent screen **111** at the moment the user input is obtained.

[0097] In one or more embodiments, the at least one processor **140** may repeat the process of changing the position of the point **113** displayed on the tangent screen **111** in a direction from an outermost peripheral position on the tangent screen **111** toward the center **112** of the tangent screen **111** while obtaining a user input and the position information **115** about the at least one point, while shifting, in a clockwise or counterclockwise direction around the tangent screen **111**, the position where the point **113** is displayed on the tangent screen **111**. However, the present disclosure is not limited thereto, and the position of the at least one point **113** displayed on the tangent screen **111** may also be changed according to the random pattern **114_1** (see FIG. **8**A) or the preset position pattern **114_2** (see FIG. **8**B).

[0098] In one or more embodiments, the at least one processor **140** may obtain an isopter contour line **116** based on pieces of position information **115** about a plurality of points obtained while changing the position of the at least one point **113** displayed on the tangent screen **111**. In one or more embodiments, the isopter contour line **116** may be a line connecting points of equivalent vision within the visual field of the user **200** gazing at the center **112** of the tangent screen.

[0099] In one or more embodiments, because the isopter contour line **116** is obtained by connecting a plurality of pieces of position information **115** where the point **113** displayed on the tangent screen **111** is perceived abnormally, the at least one processor **140** may determine the isopter contour line **116** and the area **117** inside the isopter contour line **116** as a visual field defect area of the user **200**, and determine this area as the scotoma **117**. In one or more embodiments, the at least one processor **140** may measure the size and shape of the scotoma **117** of the user **200** based on the size and shape of the isopter contour line **116**.

[0100] FIG. **4** is a diagram for describing an HMD device and operations of the HMD device, according to one or more embodiments of the present disclosure. Hereinafter, the same reference numerals are assigned to the same components as those described above with reference to FIGS. **1** and **3**, and redundant descriptions thereof will be omitted.

[0101] Referring to FIG. **4**, the HMD device **100** may include the display **110**, the eye-tracking sensor **120**, a frame **160**, and a nose support **170**. In one or more embodiments, FIG. **4** discloses only components for describing a structure of the HMD device **100**, and the components included in the HMD device **100** are not limited to those illustrated in FIG. **4**.

[0102] In one or more embodiments, the HMD device **100** may further include a camera for photographing a physical environmental space viewed by the user **200**, a sensing unit for sensing an input from the user **200** when the point **113_1** (see FIG. **8**A) displayed on the tangent screen **111_1** begins to be perceived abnormally by the user **200**, a battery, and the like. In addition, the HMD device **100** may include the components illustrated in FIG. **2**.

[0103] In one or more embodiments, the display **110** may be arranged on the frame **160**. Although FIG. **4** illustrates the display **110** as having a circular shape, the present disclosure is not limited thereto. The display **110** may have a quadrangular shape or the like.

[0104] In one or more embodiments, the frame **160** may have a shape similar to a frame of a general eyeglass structure. The frame **160** may include a rim surrounding the display **110** and temple portions that extend over ear parts of the user **200** to support the HMD device **100** when the user **200** wears the HMD device **100**. In one or more embodiments, in a case in which the HMD device **100** includes a memory, a processor, a battery, and the like, the memory, the processor, the battery, and the like may be embedded in the temple portions of the frame **160**.

[0105] In one or more embodiments, the nose support **170** may be connected to the frame **160**. The nose support **170** is a portion that extends over a nose part of the user **200** to support the HMD device **100** when the user **200** wears the HMD device **100**. In one or more embodiments of the present disclosure, the nose support **170** may include a bridge and nose pads. In addition, the bridge and the nose pads may be configured integrally, but are not limited thereto. In one or more embodiments, the nose support **170** and the frame **160** may also be formed integrally.

[0106] In one or more embodiments, the HMD device **100** may further include a camera connected to the frame **160**. The camera may be oriented in a direction opposite to the direction in which the display **110** faces the user, so as to photograph a physical environmental space viewed by the user **200**.

[0107] In one or more embodiments, the HMD device **100** may obtain, via the eye-tracking sensor **120**, the gaze direction **201_1** of the user **200** wearing the HMD device **100**, and the point of view **210_1** where the gaze of the user **200** intersects the display **110**.

[0108] In one or more embodiments, the HMD device **100** may determine a position on the display **110** at which to display the tangent screen **111_1** such that the center of the tangent screen **111_1** corresponds to the point of view **210_1**. The HMD device **100** may display the tangent screen **111_1** at the determined position. The HMD device **100** may display the at least one point **113_1** (see FIG. **8**A) on the tangent screen **111_1**, change the position of the displayed at least one point **113_1**, and obtain, from the user **200**, a user input including information indicating that the at least one point **113_1** is perceived abnormally.

[0109] In one or more embodiments, the HMD device **100** may obtain the size and shape of a scotoma **117_1** of the user, based on the obtained user input.

[0110] When macular degeneration occurs in a macula **202** of the user, a scotoma may be located in the center of the visual field of the user, and thus, central vision loss may occur in the user **200**. In one or more embodiments, during the process of obtaining the size and shape of the scotoma **117_1** of the user by displaying the tangent screen **111_1** and the at least one point **113_1** on the HMD device **100**, the point of view **210_1** of the user needs to correspond to the center **112_1** of the tangent screen as the user **200** gazes at the center **112_1** of the tangent screen, in order to accurately obtain the size and shape of the scotoma **117_1**.

[0111] Due to central vision loss, the user **200** may be unable to perceive the center **112_1** of the tangent screen when gazing at the center **112_1** of the tangent screen. Thus, the user **200** may gaze at a peripheral area rather than the center **112_1** of the tangent screen, in order to perceive the position of the center **112_1** of the tangent screen **111_1** or the like by using peripheral vision **201_3**. Thus, the point of view **210_2** of the user may not correspond to the center **112_1** of the tangent screen displayed on the display **110**.

[0112] In this case, the user **200**, using the peripheral vision **201_3**, may normally perceive the at least one point **113_1**, which may appear abnormal in a case in which the user **200** is gazing at the center **112_1** of the tangent screen. In addition, when the user **200** is gazing at the center **112_1** of the tangent screen, the at least one point **113_1**, which may appear normal when using the peripheral vision **201_3**, may fall within the scotoma **117_2** of the user and thus appear abnormal. Thus, during the process of measuring the size and shape of the scotoma **117_1** or **117_2** of the user by using the tangent screen **111_1** and the at least one point **113_1**, when the gaze direction **201_1** or **201_2** of the user changes, the scotoma **117_1** or **117_2** of the user may not be obtained accurately.

[0113] Hereinafter, obtaining the accurate size and shape of the scotoma **117_1** of the user by displaying the tangent screen **111_1** on the display **110** such that the center **112_1** of the tangent screen corresponds to the point of view **210_1** of the user, via the HMD device **100** and the operating method of the HMD device **100** of the present disclosure will be described with reference to FIGS. **5** to **12**. In addition, obtaining, during the process of measuring the size and shape of the scotoma **117_1** of the user, the accurate size and shape of the scotoma **117_1** of the user by changing the position of the tangent screen **111_2** displayed on the display **110** such that the center

112_2 (see FIG. **12**) of the tangent screen displayed on the display **110** corresponds to the changed point of view **210_2** of the user, when the gaze direction **201_1** or **201_2** of the user changes will be described.
[0114] FIG. **5** is a flowchart for describing an operating method of an HMD device according to one or more embodiments of the present disclosure. FIG. **6** is a diagram for describing displaying a tangent screen on a display such that the center of the tangent screen corresponds to a point of view, according to one or more embodiments of the present disclosure. Hereinafter, the same reference numerals are assigned to the same components as those described above with reference to FIGS. **1** and **4**, and redundant descriptions thereof will be omitted.
[0115] Referring to FIGS. **5** and **6**, in one or more embodiments, the operating method of the HMD device **100** may include obtaining information about the gaze direction **201_1** of the user viewing the display **110** (S**100**). In one or more embodiments, in the obtaining of the information about the gaze direction **201_1** of the user (S**100**), the at least one processor **140** (see FIG. **2**) may obtain the gaze direction **201_1** of the user, via the eye-tracking sensor **120**.
[0116] In one or more embodiments, the operating method of the HMD device **100** may include identifying the point of view **210_1** where the gaze of the user **200** intersects the display **110**, based on the obtained gaze direction **201_1** of the user (S**200**). In one or more embodiments, in the identifying of the point of view **210_1** (S**200**), the at least one processor **140** may identify the point of view **210_1** where the gaze of the user **200** intersects the display **110**, based on the gaze direction **201_1** of the user obtained via the eye-tracking sensor **120**, and a calculated distance between the eye of the user **200** and the display **110**.
[0117] In one or more embodiments, the operating method of the HMD device **100** may include determining a position on the display **110** at which the tangent screen **111_1** is to be displayed, such that the center **112_1** of the tangent screen corresponds to the identified point of view **210_1** (S**250**). In one or more embodiments, in the determining of the position on the display **110** at which the tangent screen **111_1** is to be displayed (S**250**), the at least one processor **140** may determine the position of the tangent screen **111_1** based on the identified point of view **210_1**, such that the center **112_1** of the tangent screen corresponds to the identified point of view **210_1**.
[0118] In one or more embodiments, the operating method of the HMD device **100** may include displaying the tangent screen **111_1** at the determined position (S**300**). In one or more embodiments, in the displaying of the tangent screen **111_1** on the display **110** (S**300**), the at least one processor **140** may display the tangent screen **111_1** at the position determined such that the center **112_1** of the tangent screen corresponds to the identified point of view **210_1**. In one or more embodiments, the at least one processor **140** may provide the tangent screen **111_1** to the user **200** viewing the display **110**.
[0119] FIG. **7** is a flowchart for describing a method of measuring the size and shape of a scotoma of a user by displaying a tangent screen and at least one point, according to one or more embodiments of the present disclosure. FIG. **8**A is a diagram for describing changing the position of at least one point according to a random pattern, according to one or more embodiments of the present disclosure. FIG. **8**B is a diagram for describing changing the position of at least one point according to a preset position pattern, according to one or more embodiments of the present disclosure. FIG. **9** is a diagram for describing obtaining a notification signal for at least one point and measuring the size and shape of a scotoma of a user based on the obtained notification signal, according to one or more embodiments of the present disclosure. Hereinafter, the same reference numerals are assigned to the same components and operations as those described above with reference to FIGS. **1**, **3**, and **5**, and redundant descriptions thereof will be omitted.
[0120] Referring to FIGS. **7** and **8**A, in one or more embodiments, the operating method of the HMD device **100** may include, after the displaying of the tangent screen **111_1** on the display **110** (S**300**), displaying the at least one point **113_1** on the tangent screen **111_1** (S**301**). In one or more embodiments, in the displaying of the at least one point **113_1** on the tangent screen **111_1** (S**301**),

the at least one processor **140** may display the at least one point **113_1** on the tangent screen **111_1** to overlap with the tangent screen **111_1** displayed on the display **110**. In one or more embodiments, the at least one processor **140** may display a single point on the tangent screen **111_1** to overlap with the tangent screen **111_1**, and shift the position of the displayed single point. In one or more embodiments, the at least one processor **140** may display a plurality of points on the tangent screen **111_1** during a plurality of frames. Here, the position of a point displayed on the tangent screen **111_1** in each frame may be changed.

[0121] FIG. **8**A illustrates that the at least one processor **140** displays the at least one point **113_1** on the tangent screen **111_1** while changing the position of the at least one point **113_1** to correspond to the random pattern **114_1**.

[0122] In one or more embodiments, in the displaying of the at least one point **113_1** on the tangent screen **111_1** (S**301**), the position of the at least one point **113_1** may be randomly changed. In one or more embodiments, in the displaying of the at least one point **113_1** on the tangent screen **111_1** (S**301**), the at least one processor **140** may display the at least one point **113_1** on the tangent screen **111_1** while randomly changing the position of the at least one point **113_1**. In one or more embodiments, the at least one processor **140** may display a plurality of points on the tangent screen **111_1** during a plurality of frames. Here, the position of a point displayed on the tangent screen **111_1** in each frame may be randomly changed.

[0123] In one or more embodiments, when the at least one point **113_1** is displayed on the tangent screen **111_1** while randomly changing the position of the at least one point **113_1**, the user **200** cannot predict the position of the point to be displayed in the next frame, based on the position of the point displayed in the current frame. Thus, it is possible to prevent reception of an incorrect user input generated to include information indicating that a point that does not actually fall within the scotoma **117** (see FIG. **9**) is perceived abnormally because the user **200** has predicted the position of the point to be displayed in the next frame.

[0124] In one or more embodiments, in the displaying of the at least one point **113_1** on the tangent screen **111_1** (S**301**), the at least one point **113_1** may be displayed such that its shape corresponds to any one of a plurality of preset shapes. In one or more embodiments, in the displaying of the at least one point **113_1** on the tangent screen **111_1** (S**301**), the at least one processor **140** may display the at least one point **113_1** such that its shape corresponds to any one of a plurality of preset shapes.

[0125] In one or more embodiments, the plurality of preset shapes may include Arabic numerals, arrows, special characters, and the like. The at least one processor **140** may display a plurality of points on the tangent screen **111_1** during a plurality of frames. Here, the at least one processor **140** may display the point displayed on the tangent screen **111_1** in each frame such that the shape of the point corresponds to any one shape selected from among the plurality of preset shapes. In one or more embodiments, the shape of the point displayed on the tangent screen **111_1** in each frame may correspond to any one shape randomly selected from among the plurality of preset shapes.

[0126] In one or more embodiments, FIG. **8**A illustrates four points **113_1** displayed in four frames, respectively. Here, the position of the point in each of the four frames may have been randomly changed. The shapes of the points in the four frames are illustrated as ‘3’, ‘2’, ‘8’, and ‘1’, respectively. In one or more embodiments, the shapes ‘3’, ‘2’, ‘8’, and ‘1’ may be shapes randomly selected from a plurality of preset shapes including Arabic numerals.

[0127] In one or more embodiments, when the shape of the at least one point **113_1** is randomly changed every frame and then displayed on the tangent screen **111_1**, the user **200** cannot predict the shape of the point to be displayed in the next frame based on the shape of the point displayed in the current frame. Thus, it is possible to prevent an inaccurate size and shape of the scotoma **117** from being obtained due to receiving an incorrect user input generated because the user **200** has predicted the shape of the point to be displayed in the next frame and thus indicated a normal perception response for the next point, which actually falls within the scotoma **117** and thus is

perceived abnormally.
[0128] In one or more embodiments, “3”, “2”, “8”, and “1” illustrated in FIG. **8**A are not related to the order of the at least one point **113_1** displayed on the tangent screen **111_1**, and the at least one point **113_1** displayed sequentially at random positions may have a shape randomly selected from among the plurality of preset shapes. In one or more embodiments, the at least one point **113_3** may have a shape randomly selected from among shapes including not only Arabic numerals but also figures, arrows, and the like.
[0129] FIG. **8**B illustrates that the at least one processor **140** displays the at least one point **113_2** on the tangent screen **111_1** while changing the position of the at least one point **113_2** to correspond to the preset position pattern **114_2**.
[0130] Referring to FIGS. **7** and **8**B, in one or more embodiments, in the displaying of the at least one point **113_2** on the tangent screen **111_1** (S**301**), the position of the at least one point **113_2** may be changed to correspond to the preset position pattern **114_2**. In one or more embodiments, in the displaying of the at least one point **113_2** on the tangent screen **111_1** (S**301**), the at least one processor **140** may display the at least one point **113_2** on the tangent screen **111_1** while changing the position of the at least one point **113_2** according to the preset position pattern **114_2**. In one or more embodiments, while the at least one processor **140** displays a plurality of points on the tangent screen **111_1** during a plurality of frames, the position of the point displayed on the tangent screen **111_1** in each frame may be changed according to the preset position pattern **114_2**.
[0131] Although FIG. **8**B illustrates that the preset position pattern **114_2** is set in a direction from an outermost peripheral position of the tangent screen **111_1** toward the center **112_1** of the tangent screen **111_1**, along the outermost periphery of the tangent screen **111_1** clockwise, the present disclosure is not limited thereto. The position pattern may be preset to extend from the center **112_1** of the tangent screen **111_1** toward the outermost periphery, or may be preset counterclockwise along the outermost periphery of the tangent screen **111_1**, and is not limited to any particular pattern.
[0132] In one or more embodiments, the operating method of the HMD device **100** may further include receiving an external input including information about a position on the tangent screen **111_1** at which the at least one point **113_2** is to be displayed. In one or more embodiments, the external input may be received from a server or other peripheral electronic devices. In one or more embodiments, the external input may be an input for providing information about the position of the at least one point **113_2** provided to the user **200** via the HMD device **100**.
[0133] In one or more embodiments, the operating method of the HMD device **100** may further include calculating a position of the at least one point **113_2** to be displayed on the tangent screen **111_1**, based on the received external input. In one or more embodiments, in the displaying of the at least one point **113_2** on the tangent screen **111_1** (S**301**), the at least one point **113_2** may be displayed at the calculated position.
[0134] In one or more embodiments, the at least one processor **140** may receive an external input including information about a position on the tangent screen **111_1** at which the at least one point **113_2** is to be displayed. The at least one processor **140** may calculate, based on the received external input, a position of the at least one point **113_1** to be displayed on the tangent screen **111_1**, and display the at least one point **113_1** at the calculated position.
[0135] In one or more embodiments, when the at least one point **113_2** displayed on the tangent screen **111_1** is displayed at a position calculated via an arbitrary external input, rather than according to the random pattern **114_1** or the preset position pattern **114_2**, a visual field test for a desired point may be performed again based on a state or reaction of the user **200** or accumulated test results, so as to measure the accurate size and shape of the scotoma **117**.
[0136] Referring to FIGS. **7**, **8**A, **8**B, and **9**, in one or more embodiments, the operating method of the HMD device **100** may include receiving, from the user, a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** is

perceived abnormally (S**400**). In one or more embodiments, in the receiving of a user input (S**400**), the at least one processor **140** may obtain a user input including information indicating that the at least one point **113_1** or **113_2** is perceived abnormally, from the user **200** viewing the tangent screen **111_1** and the at least one point **113_1** or **113_2**.
[0137] In one or more embodiments, the operating method of the HMD device **100** may include measuring the size and shape of the scotoma **117** of the user, based on the received user input (S**500**). In one or more embodiments, in the measuring of the size and shape of the scotoma **117** of the user (S**500**), the at least one processor **140** may measure, based on the user input, the size and shape of the scotoma **117** of the user viewing the tangent screen **111_1**.
[0138] In one or more embodiments, the measuring of the size and shape of the scotoma **117** of the user (S**500**) may include obtaining, based on the received user input, the position information **115** about a point that is perceived abnormally by the user **200**, among the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1**. In one or more embodiments, based on the received user input, the at least one processor **140** may obtain the position information **115** about a point that is perceived abnormally by the user **200**, among a plurality of points displayed on the tangent screen **111_1** during a plurality of frames. In one or more embodiments, when displaying the plurality of points on the tangent screen **111_1** while changing their positions according to the preset position pattern **114_2** during the plurality of frames, the position information **115** may be position information **115** about a point displayed on the tangent screen **111_1** that the user **200** begins to perceive abnormally. In one or more embodiments, the position information **115** may be obtained corresponding to each of a plurality of directions to be measured via the tangent screen **111_1**, relative to the center **112_1** of the tangent screen.
[0139] In one or more embodiments, the measuring of the size and shape of the scotoma **117** of the user (S**500**) may include obtaining the isopter contour line **116** based on a plurality of obtained pieces of position information **115**. In one or more embodiments, the at least one processor **140** may obtain the isopter contour line **116** based on pieces of position information **115** about a plurality of points obtained while changing the position of the at least one point **113** displayed on the tangent screen **111**.
[0140] In one or more embodiments, the measuring of the size and shape of the scotoma **117** of the user (S**500**) may include measuring the size and shape of the scotoma **117** of the user, based on the obtained isopter contour line **116**. In one or more embodiments, the at least one processor **140** may determine, as the scotoma **117**, the obtained isopter contour line **116** and the area **117** inside the isopter contour line **116**, and measure the size and shape of the scotoma **117**.
[0141] According to the HMD device **100** and the operating method of the HMD device **100** of the present disclosure, the gaze direction **201_1** (see FIG. **6**) of the user **200** wearing the HMD device **100** is obtained, the point of view **210_1** of the user is identified based on the obtained gaze direction **201_1**, the position of the tangent screen **111_1** is determined such that the center **112_1** of the tangent screen corresponds to the identified point of view **210_1**, and the tangent screen **111_1** is displayed at the determined position. Thereafter, the size and shape of the scotoma **117** of the user is measured based on the position information **115** obtained by displaying the at least one point **113_1** or **113_2** on the tangent screen **111_1**.
[0142] According to the HMD device **100** and the operating method of the HMD device **100** of the present disclosure, because the size and shape of the scotoma **117** of the user is measured in a state in which the point of view **210_1** of the user corresponds to the center **112_1** of the tangent screen, the accuracy and reliability of the measurement of the size and shape of the scotoma **117** may be increased.
[0143] FIG. **10** is a flowchart for describing a method of identifying, at preset tracking intervals, whether a gaze direction of a user has changed, and changing the position of a tangent screen, according to one or more embodiments of the present disclosure. FIG. **11** is a diagram for describing changing, when a gaze direction of a user has changed, the position of a tangent screen

such that the center of the tangent screen corresponds to a changed point of view, according to one or more embodiments of the present disclosure. Hereinafter, the same reference numerals are assigned to the same components and operations as those described above with reference to FIGS. **5** to **9**, and redundant descriptions thereof will be omitted.

[0144] Referring to FIGS. **6**, **10**, and **11**, in one or more embodiments, when the point of view **210_1** of the user obtained in the identifying of the point of view **210_1** where the gaze of the user **200** intersects the display **110** (S**200**) is referred to as a first point of view **210_1**, in the displaying of the tangent screen **111_1** on the display **110** (S**300**), the tangent screen **111_1** may be displayed on the display **110** such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1**.

[0145] In one or more embodiments, the operating method of the HMD device **100** may further include, after the displaying of the tangent screen **111_1** at the position determined such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1** (S**300**), identifying, at preset tracking intervals, whether the gaze direction **201_1** of the user has changed (S**310**). In one or more embodiments, after displaying the tangent screen **111_1** on the display **110** such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1**, the at least one processor **140** may determine whether the gaze direction **201_1** of the user, which is obtained via the eye-tracking sensor **120** at preset tracking intervals, has changed.

[0146] In one or more embodiments, according to a preset determination criterion, the at least one processor **140** may determine, when a change in the obtained gaze direction **201_1** of the user is greater than the preset determination criterion, that the obtained gaze direction **201_1** of the user has changed. In one or more embodiments, the at least one processor **140** may determine, when a change in the obtained gaze direction **201_1** of the user is less than or equal to the preset determination criterion, that the obtained gaze direction **201_1** of the user has not changed. Here, the preset determination criterion may be set based on the degree of change in the gaze direction of the user, the position of the iris of the user, or the like.

[0147] In one or more embodiments, the preset tracking interval may be an interval set for performing an operation of obtaining information about the gaze direction **201_1** of the user via the eye-tracking sensor **120**. For example, in a case in which the preset tracking interval is 3 seconds, the at least one processor **140** may obtain information about the gaze direction **201_1** of the user via the eye-tracking sensor **120** every 3 seconds, and determine whether the previously obtained gaze direction **201_1** of the user has changed. As the preset tracking interval decreases, an interval during which the size and shape of the scotoma **117** of the user is measured in a state in which the point of view **210_1** or **210_2** of the user and the center **112_1** or **112_2** of the tangent screen do not coincide when the gaze direction **201_1** or **201_2** of the user has changed may be decreased, and thus, the accuracy and reliability of the operation of measuring the size and shape of the scotoma **117** of the user may be increased.

[0148] In one or more embodiments, the operating method of the HMD device **100** may include, when it is determined, in the determining of whether the gaze direction **201_1** of the user has changed (S**310**), that the gaze direction **201_2** of the user has changed, identifying a second point of view **210_2**, where the changed gaze of the user intersects the display **110**, based on the changed gaze direction **201_2** of the user.

[0149] In one or more embodiments, the at least one processor **140** may identify the second point of view **210_2** where the changed gaze of the user intersects the display **110**, based on the changed gaze direction **201_2** of the user and the distance between the display **110** and the iris of the user **200**.

[0150] In one or more embodiments, the operating method of the HMD device **100** may include changing the position on the display **110** at which the tangent screen **111_2** is displayed, such that the center **112_2** of the tangent screen corresponds to the identified second point of view **210_2** (S**320**). In one or more embodiments, the at least one processor **140** may change the position on the display **110** at which the tangent screen **111_2** is displayed, such that the center **112_2** of the tangent screen corresponds to the identified second point of view **210_2**.

[0151] In one or more embodiments, the operating method of the HMD device **100** includes, when it is determined, in the determining of whether the gaze direction **201_1** of the user has changed (S**310**), that the gaze direction **201_1** of the user has not changed, maintaining the position on the display **110** at which the tangent screen **111_1** is displayed, such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1** (S**330**).

[0152] In one or more embodiments, when it is determined that the gaze direction **201_1** of the user has not changed, the at least one processor may not change the position of the tangent screen **111_1** displayed on the display **110** such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1**.

[0153] FIG. **12** is a flowchart for describing a method of, when a gaze direction of a user has changed, measuring the size and shape of a scotoma of the user while changing the position of a tangent screen, according to one or more embodiments of the present disclosure. Hereinafter, the same reference numerals are assigned to the same operations as those described above with reference to FIG. **10**, and redundant descriptions thereof will be omitted.

[0154] Referring to FIGS. **6**, **8**A, **9**, **11**, and **12**, in one or more embodiments, the operating method of the HMD device **100** may include, after the displaying of the tangent screen **111_1** on the display **110** (S**300**), displaying the at least one point **113_1** on the tangent screen **111_1** (S**301**).

[0155] In one or more embodiments, the operating method of the HMD device **100** may include, after the displaying of the at least one point **113_1** on the tangent screen **111_1** (S**301**), determining, at preset tracking intervals, whether the gaze direction **201_1** of the user has changed (S**310**).

[0156] In one or more embodiments, the operating method of the HMD device **100** may include, when it is determined, in the determining of whether the gaze direction **201_1** of the user has changed (S**310**), that the gaze direction **201_2** of the user has changed, changing the position on the display **110** at which the tangent screen **111_2** is displayed, such that the center **112_2** of the tangent screen corresponds to the second point of view **210_2** (S**320**).

[0157] In one or more embodiments, after the changing of the position on the display **110** at which the tangent screen **111_2** is displayed such that the center **112_2** of the tangent screen corresponds to the second point of view **210_2** (S**320**), in the displaying of the at least one point **113_2** (S**301**), the at least one point **113_2** may be displayed on the tangent screen **111_2** whose position has been changed. In one or more embodiments, the at least one processor **140** may change the position of the tangent screen **111_2** such that the center **112_2** of the tangent screen corresponds to the second point of view **210_2**, then display the tangent screen **111_2** on the display **110**, and then display the at least one point **113_2** on the tangent screen **111_2** whose position has been changed.

[0158] In one or more embodiments, the operating method of the HMD device **100** may include, when it is determined, in the determining of whether the gaze direction **201_1** of the user has changed (S**310**), that the gaze direction **201_1** of the user has not changed, maintaining the position on the display **110** at which the tangent screen **111_1** is displayed, such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1** (S**330**).

[0159] In one or more embodiments, after the maintaining of the position on the display **110** at which the tangent screen **111_1** is displayed such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1** (S**330**), in the displaying of the at least one point **113_1** (S**301**), an operation of displaying the at least one point **113_1** on the tangent screen **111_1** displayed on the display **110**, such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1** may be repeated. In one or more embodiments, the at least one processor **140** may display the at least one point **113_2** on the tangent screen **111_1** displayed on the display **110**, such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1**.

[0160] In one or more embodiments, the operating method of the HMD device **100** may include

receiving, from the user **200**, a user input including information indicating that at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** is perceived abnormally (S**400**).
[0161] In one or more embodiments, the operating method of the HMD device **100** may repeat the determining of whether the gaze direction of the user has changed (S**310**), and according to a result of the determining of whether the gaze direction of the user has changed (S**310**), either the displaying on the display **110** such that the tangent screen **112_2** corresponds to the second point of view **210_2** (S**320**) or the displaying on the display **110** such that the tangent screen **112_1** corresponds to the first point of view **210_1** (S**330**), and then receive a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** is perceived abnormally.
[0162] Referring to FIGS. **5**, **7**, and **12**, in one or more embodiments, upon receiving a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** is perceived abnormally, the operating method of the HMD device **100** may repeat, until a plurality of pieces of position information **115** necessary for measuring the size and shape of the scotoma **117** of the user are obtained, the identifying of the first point of view **210_1** (S**200**), the displaying of the tangent screen **111_1** at the position determined such that the center **112_1** of the tangent screen corresponds to the identified first point of view **210_1** (S**300**), the displaying of the at least one point **113_1** on the tangent screen **111_1** while changing its position (S**301**), the determining of whether the gaze direction **201_2** of the user has changed (S**310**), the changing, when the gaze direction **201_2** of the user has changed, of the position of the tangent screen **111_2** such that the center **112_2** of the tangent screen corresponds to the changed second point of view **210_2** (S**320**), and the displaying of the at least one point **113_2** on the changed tangent screen **111_2** while changing the position of the at least one point **113_2** (S**301**).
[0163] In one or more embodiments, the at least one processor **140** may repeat, until the size and shape of the scotoma **117** of the user is measured, identifying the first point of view **210_1**, displaying the tangent screen **111_1** such that the center **112_1** of the tangent screen corresponds to the identified first point of view **210_1**, displaying the at least one point **113_1** on the tangent screen **111_1** while changing the position of the at least one point **113_1** and receiving a user input, and, when the gaze direction **201_2** of the user has changed, before measuring the size and shape of the scotoma **117**, identifying the changed second point of view **210_2**, changing the position of the tangent screen **111_2** such that the center **112_2** of the tangent screen corresponds to the identified second point of view **210_2**, and displaying the at least one point **113_1** on the changed tangent screen **111_2** while changing the position of the at least one point **113_1** and obtaining a notification signal.
[0164] In one or more embodiments, the operating method of the HMD device **100** may include, upon receiving a user input including information indicating that the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** is perceived abnormally, measuring the size and shape of the scotoma of the user (S**500**). In detail, in the measuring of the size and shape of the scotoma of the user (S**500**), the at least one processor **140** may measure the size and shape of the scotoma of the user, based on the plurality of pieces of position information **115** obtained through the above-described processes.
[0165] FIG. **13** is a diagram for describing displaying visual field training content on a display such that the center of the visual field training content corresponds to a point of view, according to one or more embodiments of the present disclosure. Hereinafter, the same reference numerals are assigned to the same components as those described above with reference to FIGS. **6**, **9**, and **11**, and redundant descriptions thereof will be omitted.
[0166] In one or more embodiments, the operating method of the HMD device **100** may further include, after the measuring of the size and shape of the scotoma **117** of the user (S**500**), displaying, on the display **110**, the visual field training content **111_3** or **111_4** for training the visual field of the user **200**, based on the measured size and shape of the scotoma **117** of the user.

[0167] In one or more embodiments, the visual field training content **111_3** or **111_4** is content for performing eccentric viewing training such that the user **200**, who has the scotoma **117** in the center of the visual field due to a visual field impairment such as macular degeneration, may perceive objects through peripheral vision. In one or more embodiments, the visual field training content **111_3** or **111_4** may be spaced apart from the point of view **210_1** or **210_2** of the user by a certain interval, and thus may not fall within the scotoma **117**. According to the HMD device **100** and the operating method of the HMD device **100** of the present disclosure, the user **200** may perform eccentric viewing training to recognize, by using peripheral vision, the visual field training content **111_3** or **111_4** that is spaced apart from the point of view **210_1** or **210_2** of the user by a certain interval and thus does not fall within the scotoma **117**. Although FIG. **13** illustrates that the scotoma **117** of the user is also displayed on the display **110**, this is for explaining that the visual field training content **111_3** or **111_4** does not fall within the scotoma **117** of the user, and the scotoma **117** of the user may not actually be displayed on the display **110**.
[0168] In one or more embodiments, the displaying of the visual field training content **111_3** on the display **110** may include determining a position on the display **110** at which the visual field training content **111_3** or **111_4** is to be displayed, such that the center **112_3** or **112_4** of the visual field training content **111_3** corresponds to the identified point of view **210_1** or **210_2**. In one or more embodiments, the center of the visual field training content **111_3** or **111_4** may be a reference point for maintaining a constant interval between the visual field training content **111_3** perceived by the user **200** and the point of view **210_1** or **210_2** of the user.
[0169] In one or more embodiments, the displaying of the visual field training content **111_3** on the display **110** may include displaying the visual field training content **111_3** at the determined position.
[0170] In one or more embodiments, the displaying of the visual field training content **111_3** on the display **110** may include, when the gaze direction **201_2** of the user has changed during the eccentric viewing training of the user **200**, changing the position of the visual field training content **111_3** displayed on the display **110** such that the center **112_3** of the visual field training content **111_3** corresponds to the identified second point of view **210_2**.
[0171] In one or more embodiments, the at least one processor **140** may display, on the display **110**, the visual field training content **111_3** for training the visual field of the user **200**, based on the measured size and shape of the scotoma **117** of the user.
[0172] In one or more embodiments, the at least one processor **140** may determine the position on the display **110** at which the visual field training content **111_3** is to be displayed, such that the center **112_3** or **112_4** of the visual field training content corresponds to the identified point of view **210_1** or **210_2** of the user, and display the visual field training content **111_3** at the determined position.
[0173] According to the HMD device **100** and the operating method of the HMD device **100** of the present disclosure, even when the gaze direction **201_1** or **201_2** of the user changes while the user **200** is performing eccentric viewing training, the visual field training content **111_3** perceived by the user **200** using peripheral vision may be displayed on the display **110** while maintaining a constant interval from the point of view **210_1** or **210_2** of the user. Thus, the accuracy and effectiveness of the eccentric viewing training may be increased.
[0174] To solve the above-described technical issues, one or more embodiments provides an HMD device **100** including a display **110** configured to display a tangent screen **111_1** or **111_2** for measuring a size and a shape of a scotoma **117**, an eye-tracking sensor **120** configured to obtain information about a gaze direction **201_1** or **201_2** of a user **200**, a memory **130** storing at least one instruction, and at least one processor **140** configured to execute the at least one instruction stored in the memory **130**. In one or more embodiments, the at least one processor **140** may identify a point of view **210_1** or **210_2** where a gaze of the user **200** intersects the display **110**, based on the gaze direction **201_1** or **201_2** of the user obtained via the eye-tracking sensor **120**. The at least one

processor **140** may determine a position on the display **110** at which the tangent screen **111_1** or **111_2** is to be displayed, such that a center **112_1** or **112_2** of the tangent screen corresponds to the identified point of view **210_1** or **210_2**. The at least one processor **140** may display the tangent screen **111_1** or **111_2** at the determined position.

[0175] In one or more embodiments, a point of view where the gaze of the user **200** intersects the display **110** may be referred to as a first point of view **210_1**. When the obtained gaze direction **201_1** of the user **200** is changed, the at least one processor **140** may identify, based on the changed gaze direction **201_2** of the user **200**, a second point of view **210_2** where the changed gaze of the user intersects the display **110**. The at least one processor **140** may change the position on the display **110** at which the tangent screen **111_2** is displayed, such that the center **112_2** of the tangent screen corresponds to the identified second point of view.

[0176] In one or more embodiments, after displaying the tangent screen **111_1** on the display **110** such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1**, the at least one processor **140** may determine whether the gaze direction **201_1** of the user **200**, which is obtained via the eye-tracking sensor **120** at preset tracking intervals, has changed.

[0177] In one or more embodiments, the at least one processor **140** may display at least one point **113_1** or **113_2** on the tangent screen **111_1** or **111_2**. The at least one processor **140** may receive, from the user, a user input including information indicating that the displayed at least one point **113_1** or **113_2** is perceived abnormally. The at least one processor **140** may measure the size and shape of the scotoma **117** of the user **200**, based on the received user input.

[0178] In one or more embodiments, the at least one processor **140** may change a position of the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2**, according to a random pattern **114_1**.

[0179] In one or more embodiments, the at least one processor **140** may change a position of the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2**, according to a preset position pattern **114_2**.

[0180] In one or more embodiments, the at least one processor **140** may receive an external input including information about a position at which the at least one point **113_1** or **113_2** is to be displayed on the tangent screen **111_1** or **111_2**. The at least one processor **140** may calculate a position of the at least one point **113_1** or **113_2** to be displayed on the tangent screen **111_1** or **111_2**, based on the received external input. The at least one processor **140** may display the at least one point **113_1** or **113_2** at the calculated position.

[0181] In one or more embodiments, the at least one processor **140** may display a shape of the at least one point **113_1** or **113_2** such that the shape corresponds to any one of a plurality of preset shapes.

[0182] In one or more embodiments, the at least one processor **140** may measure the size and the shape of the scotoma **117** of the user **200** via the tangent screen **111_1** or **111_2**. The at least one processor **140** may display, on the display **110**, visual field training content **111_3** for training a visual field of the user **200**, based on the measured size and shape of the scotoma **117** of the user **200**.

[0183] In one or more embodiments, the at least one processor **140** may determine a position on the display **110** at which the visual field training content **111_3** is to be displayed, such that a center **112_3** or **112_4** of the visual field training content corresponds to the identified point of view **210_1** or **210_2**. The at least one processor **140** may display the visual field training content **111_3** at the determined position.

[0184] To solve the above-described technical issues, another embodiment of the present disclosure provides an operating method of an HMD device **100** including a display **110**. The operating method of the HMD device **100** may include obtaining information about a gaze direction **201_1** or **201_2** of a user viewing the display **110** (S**100**). The operating method of the HMD device **100** may include identifying, based on the obtained gaze direction **201_1** or **201_2** of the user **200**, a point of view **210_1** or **210_2** where a gaze of the user **200** intersects the display **110** (S**200**). The operating method of the HMD device **100** may include determining a position on the display **110** at which a tangent screen **111_1** or **111_2** is to be displayed, such that a center **112_1** or **112_2** of the tangent screen for measuring a size and a shape of a scotoma **117** of the user corresponds to the identified point of view **210_1** or **210_2** (S**250**). The operating method of the HMD device **100** may include displaying the tangent screen **111_1** or **111_2** at the determined position (S**300**).

[0185] In one or more embodiments, the point of view identified in the identifying of the point of view where the gaze of the user **200** intersects the display **110** (S**200**) may be referred to as a first point of view **210_1**. The operating method of the HMD device **100** may include, after the displaying of the tangent screen **111_1** at the determined position such that the center **112_1** of the tangent screen corresponds to the first point of view **210_1** (S**300**), determining whether the gaze direction **201_2** of the user has changed (S**310**). The operating method of the HMD device **100** may include identifying, based on the changed gaze direction **201_2** of the user, a second point of view **210_2** where the changed gaze of the user **200** intersects the display **110**. The operating method of the HMD device **100** may further include changing the position on the display **110** at which the tangent screen **111_2** is displayed, such that the center **112_2** of the tangent screen corresponds to the identified second point of view **210_2** (S**320**).

[0186] In one or more embodiments, the determining of whether the gaze direction **201_2** of the user has changed (S**310**) may further include determining, at preset tracking intervals, whether the gaze direction **201_1** or **201_2** of the user **200** has changed (S**310**).

[0187] In one or more embodiments, the operating method of the HMD device **100** may further include displaying at least one point **113_1** or **113_2** on the tangent screen **111_1** or **111_2** (S**301**). The operating method of the HMD device **100** may further include receiving, from the user **200**, a user input including information indicating that the displayed at least one point **113_1** or **113_2** is perceived abnormally (S**400**). The operating method of the HMD device **100** may further include measuring the size and the shape of the scotoma **117** of the user **200**, based on the received user input (S**500**).

[0188] In one or more embodiments, in the displaying of the at least one point **113_1** or **113_2** (S**301**) in the operating method of the HMD device **100**, a position of the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2** may be randomly changed.

[0189] In one or more embodiments, in the displaying of the at least one point **113_1** or **113_2** (S**301**) in the operating method of the HMD device **100**, a position of the at least one point **113_1** or **113_2** displayed on the tangent screen **111_1** or **111_2** may be changed to correspond to a preset position pattern **114_4**.

[0190] In one or more embodiments, the operating method of the HMD device **100** may further include receiving an external input including information about a position on the tangent screen **111_1** or **111_2** at which the at least one point **113_2** or **113_2** is to be displayed. The operating method of the HMD device **100** may further include calculating a position of the at least one point **113_1** or **113_2** to be displayed on the tangent screen **111_1** or **111_2**, based on the received external input. In the displaying of the at least one point **113_1** or **113_2** (S**301**) in the operating method of the HMD device **100**, the at least one point **113_1** or **113_2** may be displayed at the calculated position.

[0191] In one or more embodiments, in the displaying of the at least one point **113_1** or **113_2** (S**301**) in the operating method of the HMD device **100**, a shape of the at least one point **113_1** or **113_2** may be displayed such that the shape corresponds to any one of a plurality of preset shapes.

[0192] In one or more embodiments, the operating method of the HMD device **100** may further include, after the measuring of the size and the shape of the scotoma **117_1** or **117_2** of the user **200** (S**500**), displaying, on the display **110**, visual field training content **111_3** for training a visual field of the user **200**, based on the measured size and shape of the scotoma **117** of the user **200**. In the displaying of the visual field training content **111_3** on the display **110**, the operating method of

the HMD device **100** may include determining a position on the display **110** at which the visual field training content **111_3** is to be displayed, such that a center **112_3** or **112_4** of the visual field training content corresponds to the identified point of view **210_1** or **210_2**. In the displaying of the visual field training content **111_3** on the display **110**, the operating method of the HMD device **100** may include displaying the visual field training content **111_3** at the determined position.
[0193] One or more embodiments may provide a computer-readable recording medium having recorded thereon a program for causing a computer to execute the operating method of the electronic device **100** according to at least one of embodiments.
[0194] A program executable by the HMD device **100** described herein may be implemented as a hardware component, a software component, and/or a combination of hardware components and software components. The program is executable by any system capable of executing computer-readable instructions.
[0195] The software may include a computer program, code, instructions, or a combination of one or more thereof, and may configure the processor to operate as desired or may independently or collectively instruct the processor.
[0196] The software may be implemented as a computer program that includes instructions stored in computer-readable storage media. The computer-readable storage media may include, for example, magnetic storage media (e.g., ROM, RAM, floppy disks, or hard disks) and optical storage media (e.g., a compact disc ROM (CD-ROM) or a digital versatile disc (DVD)). The computer-readable recording medium may be distributed in computer systems connected via a network and may store and execute computer-readable code in a distributed manner. The recording medium may be computer-readable, may be stored in a memory, and may be executed by a processor.
[0197] The computer-readable storage medium may be provided in the form of a non-transitory storage medium. Here, the term ‘non-transitory storage medium’ refers to a tangible device and does not include a signal (e.g., an electromagnetic wave), and the term ‘non-transitory storage medium’ does not distinguish between a case where data is stored in a storage medium semi-permanently and a case where data is stored temporarily. For example, the ‘non-transitory storage medium’ may include a buffer in which data is temporarily stored.
[0198] In addition, a program according to embodiments disclosed herein may be provided in a computer program product. The computer program product may be traded as commodities between sellers and buyers.
[0199] The computer program product may include a software program and a computer-readable recording medium storing the software program. For example, the computer program product may include a product (e.g., a downloadable application) in the form of a software program electronically distributed through a manufacturer of the HMD device **100** or an electronic market (e.g., Samsung Galaxy Store). For electronic distribution, at least part of the software program may be stored in a storage medium or temporarily generated. In this case, the storage medium may be a storage medium of a server of the manufacturer of the HMD device **100**, a server of the electronic market, or a relay server that temporarily stores the software program.
[0200] While the disclosure has been illustrated and described with reference to one or more embodiments, it will be understood that the one or more embodiments are intended to be illustrative, not limiting. It will be further understood by those skilled in the art that various changes in form and detail may be made without departing from the true spirit and full scope of the disclosure, including the appended claims and their equivalents. It will also be understood that any of the embodiments described herein may be used in conjunction with any other embodiments described herein.

Claims

1. A head-mounted display device comprising: a display configured to display a tangent screen for measuring a size and a shape of a scotoma of a user; an eye-tracking sensor configured to obtain information about a gaze direction of the user; a memory storing at least one instruction; and at least one processor including a processor circuitry, wherein the at least one processor is configured to individually or collectively execute the at least one instruction stored in the memory to: identify a point of view where a gaze of the user intersects the display based on the gaze direction of the user obtained via the eye-tracking sensor; determine a position on the display at which the tangent screen is displayed, such that a center of the tangent screen corresponds to the point of view; and display the tangent screen at the determined position.
2. The head-mounted display device of claim 1, wherein the point of view where the gaze of the user intersects the display is a first point of view, and wherein the at least one processor is further configured to: identify, based on a change in the gaze direction determined by the eye-tracking sensor, a second point of view where the changed gaze of the user intersects the display; and change the position on the display at which the tangent screen is displayed, such that the center of the tangent screen corresponds to the second point of view.
3. The head-mounted display device of claim 2, wherein the at least one processor is further configured to, after displaying the tangent screen on the display such that the center of the tangent screen corresponds to the first point of view, determine whether the gaze direction of the user has changed via the eye-tracking sensor at preset tracking intervals.
4. The head-mounted display device of claim 1, wherein the at least one processor is further configured to: display at least one point on the tangent screen; receive, from the user, a user input comprising information indicating that the displayed at least one point is perceived abnormally; and measure the size and the shape of the scotoma of the user based on the received user input.
5. The head-mounted display device of claim 4, wherein the at least one processor is further configured to change a position of the at least one point displayed on the tangent screen according to a random pattern.
6. The head-mounted display device of claim 4, wherein the at least one processor is further configured to change a position of the at least one point displayed on the tangent screen according to a preset position pattern.
7. The head-mounted display device of claim 4, wherein the at least one processor is further configured to: receive an external input comprising information about a position at which the at least one point is displayed on the tangent screen; calculate a position of the at least one point displayed on the tangent screen based on the received external input; and display the at least one point at the calculated position.
8. The head-mounted display device of claim 4, wherein the at least one processor is further configured to display a shape of the at least one point corresponding to any one of a plurality of preset shapes.
9. The head-mounted display device of claim 1, wherein the at least one processor is further configured to, after measuring the size and the shape of the scotoma of the user via the tangent screen, display, on the display, visual field training content for training a visual field of the user based on the measured size and shape of the scotoma of the user.
10. The head-mounted display device of claim 9, wherein the at least one processor is further configured to: determine a position on the display at which the visual field training content is to be displayed, such that a center of the visual field training content corresponds to the identified point of view; and display the visual field training content at the determined position.
11. An operating method of a head-mounted display device comprising a display, the operating method comprising: obtaining information about a gaze direction of a user; identifying, based on the obtained gaze direction of the user, a point of view where a gaze of the user intersects the display; determining a position on the display at which a tangent screen is to be displayed, such

that a center of the tangent screen for measuring a size and a shape of a scotoma of the user corresponds to the point of view; and displaying the tangent screen at the determined position.

12. The operating method of claim 11, wherein the point of view identified in the identifying of the point of view where the gaze of the user intersects the display is a first point of view, and wherein, after the displaying of the tangent screen at the determined position such that the center of the tangent screen corresponds to the first point of view, the operating method further comprises: determining whether the gaze direction of the user has changed; identifying, based on the changed gaze direction of the user, a second point of view where the changed gaze of the user intersects the display; and changing the position on the display at which the tangent screen is displayed, such that the center of the tangent screen corresponds to the second point of view.

13. The operating method of claim 12, wherein the determining of whether the gaze direction of the user has changed is at performed preset tracking intervals.

14. The operating method of claim 11, further comprising: displaying at least one point on the tangent screen; receiving, from the user, a user input comprising information indicating that the displayed at least one point is perceived abnormally; and measuring the size and the shape of the scotoma of the user based on the received user input.

15. A non-transitory computer-readable recording medium having recorded thereon a program for causing a computer to execute the operating method of claim 11.
