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(54) **METHODS DEVICES AND SYSTEMS FOR DETECTING EYE DISEASE**

VERFAHREN, VORRICHTUNGEN UND SYSTEME ZUM NACHWEIS VON AUGENERKRANKUNGEN

PROCEDES, DISPOSITIFS ET SYSTEMES DE DETECTION DE MALADIE DES YEUX

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Description

FIELD OF THE INVENTION

[0001] This invention relates to systems and methods for administering eye tests.

BACKGROUND OF THE INVENTION

[0002] US 5,892,570 and US 5,589,897 disclose an apparatus e.g. evaluating metamorphopsia in a subject, the apparatus comprising a display that displays a line pattern suitable for detecting metamorphopsia as a distortion in the line pattern, a visual fixation target associated with the line pattern, and an input device that selectively deforms portions of the line pattern that appear distorted to the subject, to provide a deformed pattern that neutralizes the distortion perceived by the subject.

[0003] Age-related macular degeneration (AMD) is the leading cause of blindness among people over the age of 50 in the western world. It is a bilateral, although asymmetric disease, and comes in two forms. Dry or non-neovascular AMD is the more common and milder form of AMD, accounting for 85 - 90 % of all AMD. The key identifier for dry AMD is small, round, white-yellow lesions (also known as Drusen) in the macula. Vision loss associated with dry AMD is far less dramatic than in the case of wet AMD. There is currently no treatment available for dry AMD. It is estimated that as many as 14 million people suffer from dry AMD in the United States alone.

[0004] Wet AMD is less prevalent than the dry form, accounting for about 10 - 15 % of AMD cases. The term "wet" denotes choroidal neovascularization (CNV), in which abnormal blood vessels develop beneath the retinal pigment epithelium (RPE) layer of the retina. Wet AMD is characterized by the development of choroidal angiogenesis which causes severe, and potentially rapid, visual deterioration. The visual distortion typically consists of perceiving straight lines as curved due to deformation of the retina in a region overlying the choroidal angiogenesis. The wet form of AMD accounts for about 60 % of all cases of adult blindness in the United States. In the U.S. alone there are 200,000 new cases of wet AMD every year and a total of 1.7 million blind people from AMD.

[0005] Treatment modalities for a wet AMD may include conventional treatments such as laser photocoagulation and newer treatment modalities such as

[0006] Photodynamic therapy (PDT). Experimental treatments that are under current investigation include feeder vessel coagulation and trans-pupillary thermotherapy (TTT). All these proven or experimental therapies may halt or slow progression of the disease only if detected at an early stage and will not reverse existing retinal damage. Therefore, early detection is crucial to prevent severe visual loss.

[0007] Since approximately 12% of dry AMD cases develop wet AMD and subsequent blindness within 10 years, a patient diagnosed with dry AMD must be routinely examined by an ophthalmologist once or twice a year, depending on the severity of his condition. The patient is usually also given a so-called *"Amsler grid"* for weekly self-examination at home for symptoms of wet AMD. The patient is advised to consult an ophthalmologist immediately in the event that symptoms are noticed. The Amsler grid and its modifications (such as the *"threshold Amsler"* or the *"red Amsler"*) have been shown to be poor detectors of early changes associated with wet AMD for several reasons. One reason is the phenomenon of *"filling-in"* whereby the brain fills in missing parts in the pattern or corrects defects or distortions in the pattern. The subject thus fails to perceive a distorted pattern as being distorted. Another problem with the Amsler grid is the inability of patients to adequately fixate their vision on a fixed point while taking the test. The Amsler test also suffers from low compliance stemming from the non-interactive nature of the test.

[0008] The degree of visual deterioration is a function of the size of the lesion and its proximity to the fovea at the time of diagnosis. Although most lesions probably start outside the foveal area, 70% are already foveal and large (>1500 microns) at the time of diagnosis. It is therefore crucial to identify the lesions at the earliest possible stage, while they are still small and have not reached the fovea. It is known that 70% of lesions diagnosed as treatable become untreatable within less than three months, which indicates that the progression of the disease is relatively rapid. As many as 70-80% of patients with wet AMD are already ineligible for treatment when they first consult their ophthalmologist because the disease has progressed considerably. This is due to the poor validity of existing self-assessment methods for detecting an AMD-related lesion at an early stage, and the time lapsed between noticing the symptoms and seeing an ophthalmologist.

[0009] A reliable method for diagnosing wet AMD at the earliest possible stage, in conjunction with a referral system aimed at lowering the incidence of visual deterioration in this devastating disease, are imperative. If detected early, laser therapy to destroy the abnormal blood vessels may prevent additional vision loss. It is therefore crucial to detect the transition from dry to wet AMD as early as possible.

SUMMARY OF THE INVENTION

[0010] This object is solved by the method as outlined in claims 1 to 28 and by the system as outlined in claims 29 to 36.

[0011] The eye testing method in accordance with the present invention comprises the steps of:

(a) displaying to the individual a first pattern at a first location on a surface;
(b) fixating the individual's vision on a part or component in the first pattern;
(c) hiding the first pattern;
(d) displaying a second pattern to the individual at a second location on the surface so as to allow the individual to form a perceived image of the second pattern, such that said first pattern appears to said individual to jump from said first location to said second location;
(e) obtaining data representing the location of a distortion or alteration perceived as the individual shifts his vision from said first pattern to said second pattern, the location of said distortion or alteration being marked by said individual on said second pattern as compared to a predefined reference pattern; and
(f) repeating steps (a) to (e) a number of times while changing the location of the second pattern.

[0012] The system for eye testing in accordance with the present invention comprises:

a surface configured to display a first pattern to the individual;
a device for fixating the individual's vision on a part or component in said first pattern displayed on the surface and hiding the first pattern after the individual's vision has been fixated on a part or component of the post pattern; a device for selecting a portion of a pattern displayed on the surface; and
a processor configured to carry out steps of:

(i) displaying to the individual a first pattern at a first location on said surface;
(ii) determining when the individual's vision is fixated on a part or component in the first pattern;
(iii) hiding the first pattern upon the individual fixating his vision on a part or component in the first pattern;
(iv) displaying a second pattern to the individual at a second location on the surface so as to allow the individual to form a perceived image, such that said first pattern appears to said individual to jump from said first location to said second location;
(v) obtaining data representing the location of a distortion or alteration perceived as the individual shifts his vision from said first pattern to said second pattern, the location of said distortion or alteration being marked by said individual on said second pattern as compared to a predefined reference pattern; and
(vi) repeating steps (i) to (v) a number of times while changing the location of the second pattern.

[0013] The present invention provides an eye test for detecting retinal lesions such as those associated with AMD, diabetes, or the like. The method involves showing a subject a first test pattern displayed on a surface. The test pattern may be, for example, one or more straight lines or one or more straight segmented lines, but other types of test patterns may also be used. The subject then fixates his vision on a fixation target. The fixation target is a part or a component of the test pattern . The first test pattern is then hidden (or made to disappear) and a second test pattern is displayed at a different location on the surface. The second test pattern may be substantially identical to the first pattern, or the two patterns may be different. For example, the second test pattern may have one or more component or region that is modified or mis-aligned of blurred or spatially shifted in a way that makes the test pattern different than a predefined reference pattern. Test pattern which are different than the predefined reference pattern are referred to as artificially modified or artificially distorted test patterns. The subject is then asked to compare the second pattern and the predefined reference pattern.

[0014] In accordance with one embodiment of the invention, the predefined reference pattern may be the first test pattern shown to the subject, In accordance with another embodiment of the invention, the predefined reference pattern may be a virtual pattern mentally conceived by the subject based on the visual experience of the subject. For example, in accordance with one possible non-limiting example of the invention, the subject may be told in a training session that he is going to be presented with test patterns which may or may not differ from a straight segmented line and that he is to indicted which if any of the segments of the presented test patterns appear to be different than a straight segmented line. In accordance with this embodiment, the subject may conceive an idea of what the reference pattern is before he is shown any test patterns.

[0015] If the second test pattern and the predefined reference pattern were identical, but the subject has perceived them to be different, this may be indicative of a lesion of the retina (or another eye disease or abnormality). The subject indicates a region in the second test pattern that appears to him to be different or to change in appearance or position as compared to the corresponding region in the predefined reference pattern. The location of the lesion on the retina is

determined from the location of the region in the second test pattern on the surface relative to the fixation target where the subject's vision was initially fixated. If the second test pattern and the predefined reference pattern were not identical, but the subject reports that the two patterns were identical, this may indicate that he is not responding reliably to the test.

[0016] In accordance with an embodiment of the present invention, a quantitative test reliability criterion may be established. For example, if the subject does not correctly identify the location of the modification or distortion in a predefined percentage of all the artificially modified or artificially distorted test patterns, the test results may be declared or classified as unreliable. Various different quantitative criteria may be used to determine the correctness of localization of the modification or distortion by the subject.

[0017] Thus, the second test pattern may be obtained by modifying the predefined reference pattern to simulate the predefined reference pattern as perceived by a person with a retinal lesion or an eye disease. For example, the second test pattern may be obtained from the reference pattern by displacing one or more components of the reference pattern relative to the remaining components, removing one or more components of the predefined pattern, blurring a component, or altering an optical property of a component of the predefined pattern, such, for example as color or brightness of the component. Such artificially modified or artificially distorted test patterns may also be used to demonstrate to subjects various types of visual disturbances associated with retinal lesions.

[0018] Since the subject will spontaneously shift his vision from the fixation target to the second pattern within about 200 milliseconds after it appears, the subject may additionally or alternatively be asked to indicate whether any motion occurred of part of the second pattern relative to other parts of the second pattern as he shifted his vision, and if so, where in the second pattern the motion occurred. For example, a segment of a line that appears curved when in the periphery of the subject's field of vision may appear to straighten as the subject shifts his vision and brings the pattern into the center of his field of vision. This apparent movement at the particular location in the pattern as the subject shifts his vision is indicative of a retinal abnormality in the corresponding region of the retina.

[0019] The test is repeated several times, each time presenting the second pattern in a different region in the subject's field of view. This allows a retinal abnormality or lesion to be mapped on the retina.

[0020] In a preferred embodiment, the method is performed by displaying the patterns on a display device such as a computer monitor, television, or stand-alone device. In this embodiment, the subject can be made to fixate his vision on a point of the screen of the display device which is used by having him bring a cursor to the point on the screen using any computer input device such as a computer mouse, a keyboard, joystick or touch-screen. This causes the first test pattern to disappear from the screen and the second test pattern to appear on the screen. The test patterns may consist of one or more broken lines consisting of a plurality of segments. The subject indicates a segment in the second pattern that appears different to him than the corresponding segment in the first pattern by bringing the cursor to the point and clicking the mouse. For example, if the first and second test patterns are broken or segmented lines, and the subject may perceive the first test pattern as being straight, but may perceive the second test pattern as having one or more unaligned segments, the subject would click the unaligned segments with the mouse.

[0021] The results of the test may be typically transmitted in real time over a communications network to a processor or a computer. The network may be a computer network such as a local area network (LAN), a wide area network (WAN), a private area network (PAN). The network may also be a telephone network based on the public service telephone network (PSTN) and using a modems and TCP/IP protocols such as the internet, or any other such network using any suitable communication protocols known in the art. The processor or computer may analyze the subject's responses and may generate a diagnosis of the subject's condition. The diagnosis and a recommendation for follow-up or referral for prompt examination may then be transmitted over the communication system or network to the subject and to his health care provider. The subject's compliance may be monitored regularly by the processor or computer by storing in a memory the dates that the subject is to perform the test. Failure to perform the test on schedule may result in a reminder being sent to the subject over the communication network or by telephone or by any other suitable messaging means to perform the test. A notice may also be sent to the health care provider.

[0022] In accordance with another embodiment of the present invention, the test may be applied by explaining to the subject that he is about to be presented with test patterns which may be identical to or may differ from a predetermined reference pattern. For example, the subject may be told that the reference pattern is a straight segmented line, to enable the subject to mentally conceive how the reference pattern should look like.

[0023] The test may then be performed by presenting a fixation target at a fixed position on the screen of the display device used. The subject may, for example, then fixate a tested eye on the fixation target and may indicate fixation by bringing a cursor to point at the fixation target and clicking a button on a mouse to indicate fixation. Other fixation methods may also be used. After the subject indicated fixation, a test pattern may be briefly presented to the subject on the screen at a location different than the location of the fixation target. The presented test pattern may be, for example, a straight segmented line, or an artificially distorted or modified segmented line as disclosed hereinabove. The patient may or may not perceive a change or distortion or other modification in the perceived image of the presented test pattern as compared to a predefined reference pattern The subject may then mark the part or parts or regions on the presented at which a difference or modification was observed as compared to the predefined reference pattern. Artificially distorted or artificially

modified test patterns may or may not be used as disclosed hereinabove, If such artificially modified patterns are used they may be used as test reliability criteria as disclosed hereinabove. The results of the tests are stored as the positions along the presented test patterns at which differences were perceived by the patient. The results may then be analyzed or processed according to various different diagnostic methods applying selected diagnostic criteria to find if the patient is diagnosed positive or negative. Positive diagnosis may result in the patient being referred to an ophtalmologist or other eye expert to test whether a retinal lesion is present or whether there is any worsening in the patient's condition such as the beginning of retinal lesions due to wet AMD or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The invention is herein described, by way of example only, with reference to the accompanying drawings, in which like components are designated by like reference numerals, wherein:

Fig. 1 is a schematic diagram illustrating a system for carrying out an eye test to detect an eye disease according to one embodiment of the invention;

Fig. 2 is a schematic flow chart diagram illustrating a method of executing an eye test for detecting an eye disease using a system such as the system illustrated in Fig. 1

Fig. 3 schematically illustrates selected exemplary screen representations including exemplary test patterns which may be presented to a tested subject, in an exemplary embodiment of the testing method , and selected schematic representations of how the test patterns may be perceived by a tested subject in selected stages of the testing;

Figs. 4A-4B are schematic diagrams illustrating some exemplary types of line series which may be useful for mapping retinal lesions in accordance with some exemplary embodiments;

Figs. 5A-5J are schematic diagrams illustrating patterns displayed at various different exemplary steps of another embodiment of an eye test performed by the system illustrated in Fig. 1, and the possible appearance of the test patterns as they may be perceived by the test subject at some exemplary steps of the eye test;

Fig. 6 is a schematic diagram useful in understanding an exemplary positioning accuracy criterion which may be used in the eye testing method ;

Figs. 7A and 7B are schematic diagrams useful in understanding exemplary diagnostic criteria which may be used in exemplary embodiments ;

Fig. 8 is a schematic flow diagram useful in understanding a method for performing a test session and analyzing the results of the test session, in accordance with one possible embodiment ;

Fig. 9 which is a bar graph representing experimental results comparing the performance of the standard Amsler grid test with the performance of the eye test ; and

Fig. 10 is a schematic diagram illustrating a system including a scanning laser device or another eye scanning device usable for carrying out an eye test.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The following terms are used throughout the application:

Term	Definition
AMD	Age-related macular degeneration
RPE	Retinal pigment epithelium
TTT	Trans-pupilary Thermotherapy
PDT	Photodynamic Therapy
CNV	Choroidal Neovascularization
LAN	Local area network

(continued)

Term	Definition
WAN	Wide area network
PAN	Private area network
PSTN	Public service telephone network
SLO	Scanning Laser Ophtalmoscope
HRC	High risk characteristics
GA	Geographic atrophy
MCPT	Macular computerized psychphysical test

[0026] It is noted that the test or tests for eye disease of the present invention disclosed hereinbelow may also be generally referred to as the Macular computerized psychphysical test (MCPT) hereinafter.

[0027] Fig. 1 is a schematic diagram illustrating a system for carrying out an eye test to detect an eye disease according to one embodiment of the invention. A subject **100** performs an eye test using a computer system **105.** The computer system 105 may comprise a computer **110,** a display device **115** having a screen **112** and one or more computer input devices such as a keyboard **120** or a computer mouse **125.** The computer system **105** may communicate over a communication network schematically indicated by the cloud labeled **130.** The network **130** may be, for example, the Internet, a local area network (LAN), a wide area network (WAN), an Intranet, a private area network (PAN), virtual networks implemented over the Internet, other private and/or commercial communication networks, or any other suitable type of communication network known in the art.

[0028] A processor **135** in a network server **140** stores data relating to execution of an eye test to be performed by the subject **100** to be described in detail below. The eye test is communicated from the server 140 to the subject's computer **110** over the network **130.** The subject **100** inputs responses to the eye test using one or more of the computer input devices such as the keyboard **120** or the mouse **125.** The subject's responses are communicated over the network **130** to the processor **135,** and stored in the memory **145.** The processor **135** is configured to analyze the subject's response, to make a diagnosis of the subject's conditions and to recommend future follow-up or recommend prompt examination, all in real time, for the subject. The diagnosis and recommendation may be communicated over the network **130** to the subject's computer system **105** and/or to a terminal **150** of a health care provider **155.** The processor **135** is also configured to store in the memory **145** dates on which the subject is to perform an eye test executed by the processor **135.** If, for example, the subject **100** has been instructed by the health and provider **155** to perform the test once per week, the processor **135** may send a message over the communication network **130** when 10 days have elapsed since the last time he took the test, informing the subject of his failure to take the test as instructed. A similar message may be sent to the health care provider **155.** A responsible individual may be designated, in such a case, to contact the subject **100,** for example, by telephone to clarify why the subject **100** has not performed the test as instructed and to impress upon the subject the importance of performing the test as indicated.

"Moving pattern" test method

[0029] The method disclosed hereinbelow is based on the presentation of a first pattern at a first location on the surface of a display device (such as, but not limited to the screen **112** of the display device **115**) to the patient or the test subject. After the patient fixated on a fixation target presented on or adjacent to the first pattern, the first pattern disappears from the first location of the display device and a second pattern is presented at a second location on the display device. The second pattern may be identical to the first pattern (except for the fact that it appears at a different location on the display device) or it may be different from the first pattern by having one or more portions thereof changed or altered. Such changes or alterations may include distortion of the shape or elimination of one or more portions of the first pattern, or changes in the color or appearance of one or more portions of the first pattern. Because the first pattern is made to disappear from the first location on the display device and the second pattern appears at a second location of the display device different than the first location, the patient or test subject may visually perceive this as a movement or jump of the pattern from the first location to the second location on the display device, in other words, the patient may perceive a pattern "jumping" on the screen of the display device from a first to a second location even though the pattern does not actually move on the display device (the pattern actually disappears from a first location on the display device and appears at a second location on the display device). This is why this particular embodiment of the testing method is referred to as the "moving pattern" or "jumping pattern" test hereinafter.

[0030] Fig. 2 is a schematic flow chart diagram illustrating a method of executing an eye test for detecting an eye disease using a system such as the system illustrated in Fig. 1

[0031] Fig. 3 schematically illustrates selected exemplary screen representations including exemplary test patterns

which may be presented to a tested subject, in an exemplary embodiment of the testing method, and selected schematic representations of how the test patterns may be perceived by a tested subject in selected stages of the testing.

[0032] Fig. 3 includes schematic screen diagrams **300, 320, 330** and **360** (also referred to as screens **300, 320, 330** and **360** hereinafter) which schematically illustrate the patterns displayed on the screen **112** of the subject's display device **115** at various different exemplary steps of the eye test performed by the system illustrated in Fig. 2, and schematic screen diagrams **340** and **350** (also referred to as screens **340,** and **350** hereinafter) which schematically illustrate the possible appearance of the screen **112** as may be perceived by the tested subject at some exemplary steps of the eye test. It is noted that screen **300** of Fig. 3 which does not include test patterns, schematically represents a possible log-on screen which may be presented to the test subject.

[0033] It is noted that the exemplary schematic screens **300, 320, 330, 340, 350,** and 360 of Fig. 3 are schematically drawn for illustrative purposes only and are not drawn to scale. Additionally, the sizes of the various patterns, pattern segments, fixation targets, are not drawn to scale, and their sizes and their relation to the screen size are arbitrarily shown for illustrative purposes only.

[0034] Turning to Fig. 2, in step **200,** the subject **100** may log onto the computer system **105.** The processor **135** may cause log-on screen **300** to be displayed on the subject's display device **115** (step **205**). The log-on screen **300** prompts the subject to input his name into a field **302** and to input a previously assigned password into a field **304** for accessing the processor **135.** In step **210** the subject inputs his name and password using computer input devices such as the keyboard **120** or the mouse **125.** The processor **135** then checks whether the inputted name and password are stored in the memory **145** (step **215**). If the inputted name and password do not match a corresponding name and password which are stored in the memory **145,** the processor **135** determines whether the number of attempts the subject has made to input a name and password is less than a predetermined number of attempts such as, for example, three attempts (step **220**). If yes, the process returns to step **205.** If no, the process terminates.

[0035] If at step 215 the processor determines that the name and password are in the memory **145,** the process continues in step **248** by the subject being instructed to cover an eye, so that the test is performed using one eye only. The subject may be instructed to cover an eye by displaying appropriate text (not shown) or a drawing (not shown) or an icon (not shown), or a graphic element (not shown) or any combination thereof on the screen of the display device **115.**

[0036] It is noted that the tested subject **100** may be asked to cover a specific eye (for example, the subject may be asked to cover the right eye and to view the screen **112** with the uncovered left eye for testing the left eye). In this way the computer system **110** may automatically record that the left eye is being tested. Alternatively, the tested subject **100** may be asked to mark or input or otherwise indicate which eye is to be tested, such as, for example, by clicking a cursor on one of two boxes (not shown) which may be presented on the log-on screen **300** or on any other suitable screen presented to the subject before the test begins. In such a case the test results may be labeled as taken from the eye selected by the subject **100.**

[0037] In step **250** a form screen **320** is displayed in which a pattern such as the segmented line **322** is displayed. This is by way of example only, and other suitable patterns may be used within the scope of the invention. The pattern may comprise a single component, or may comprise several components which may or may not be all identical. Thus, the pattern may comprise several lines, one or more circles, lines and circles together, or any other suitable combination of pattern elements, including but not limited to one or more straight lines, dotted lines, curved lines, linear or non linear segments, dots, and other various geometrical patterns such as but not limited to circles, arcs, rectangles, squares, triangles, and the like. The screen **112** of the display device 115 may display a visually noisy background to the displayed pattern. The line **322** may be composed of several short segments **229** separated by gaps **227.** Alternatively, the displayed line may be continuous (not shown).

[0038] Preferably, the length of the line **322** is such that when the tested subject's eye is at a distance of approximately 50 centimeter from the screen **112** of the display device **115** the length of the line **322** corresponds to a cone angle of 1-20°. It is noted that while in most tests the length of the lines used corresponded to a cone angle of 14°, other different line lengths may be used. At these viewing conditions, each of the gaps **227** between the segments **229** (the distances separating two adjacent segments **229**) may correspond to a cone angle of between 1 minutes arc to about 2° (two degrees). Other, different line lengths and gap sizes may however also be used. For example, if the test pattern is a continuous line there are no gaps.

[0039] It is also noted that if test patterns which comprise a continuous line are used, no segments are used and there are therefore no gaps.

[0040] If the pattern consists of two or more parallel lines, the spacing between the lines corresponds, preferably, to a cone angle from about 10 to about 600 minutes arc. The test patterns may be horizontal patterns such as, but not limited to the horizontal line **322** illustrated in screen **300,** but may also be vertical patterns such as but not limited to a vertical segmented line (not shown) or slanted patterns such as but not limited to a slanted segmented line (not shown). A fixation target **228** may be displayed on the screen adjacent to one of the segments **229.** The fixation target may be a circular pattern such as the circular fixation target **228** of screen **320** of Fig. 3, or may have any other shape or pattern suitable for serving as a fixation target for focus the tested eye thereon, such as but not limited to a square pattern, a

triangular pattern, or any other suitable pattern which is suitable for functioning as a fixation target.

[0041] It is noted that while the fixation target **228** illustrated in Fig. 3 is a circular pattern which appears close to the middle segment of the line **322,** other different forms of the fixation target may be used. For example, the fixation target may be implemented as a hollow (unfilled) circle (not shown) surrounding the middle segment of the line **322** or superimposed thereon, or as any other suitable pattern which is positioned close to or is superimposed upon the line **322.**

[0042] Generally, the shape of the fixation target may depend, inter alia, on the shape and dimensions of the test pattern which is being used in the test. The fixation target may have the same color of the test pattern (such as, for example, the segmented line **322**) or may have a different color than the color of the test pattern. In accordance with another variation, the fixation target may be the central (middle) segment of the line **322,** in which case the middle segment may or may not have a color which is different than the color of the remaining segments **229** of the line **322** in order to make it easily identifiable by the test subject.

[0043] In the example in which a single segmented line serves as the test pattern, the subject may be instructed to bring a cursor **225** appearing on the screen to the fixation target **228.** In order to aid the subject, the movement of the cursor **225** may be restricted to a line (not shown) which is parallel to the line **322** so that the cursor **225** always points to one of the segments **229.**

[0044] The subject **100** may be asked (for example, by an instructor, a physician an ophtalmologist or any other person training the subject in performing the test) or otherwise instructed (such as for example by displaying appropriate messages or text an the screen **112** of the display device **115**) to point the cursor **225** at the fixation target **228.** The subject **100** may perform this pointing in step **255** by using a computer device such as the keyboard **120,** or more preferably the mouse **125.** Other pointing devices may also be used for pointing, such as but not limited to, a digitizing tablet in conjunction with a stylus, a finger, a light pen in conjunction with a touch screen, or any other suitable pointing device or suitable input device known in the art.

[0045] The fixation target **228** may be sized so that it is large enough to be seen by the patient or test subject but small enough so that bringing the cursor **225** to the fixation target **228** is a demanding task for the test subject. This causes the subject to fixate his vision on the fixation target **228.** Upon bringing the cursor to the segment **229,** the subject may provide a suitable indication that he has positioned the cursor **225** to point at the fixation target **228.** For example, the patient or test subject **100** may provide the indication by clicking on the mouse **125** or by depressing a predetermined key on the keyboard **120** (step **260**). This input may serve as an indication or a verification that visual fixation has been achieved. It is noted that the size of the fixation target **228** may depend, inter alia, on the distance of the tested eye from the screen **112.**

[0046] It is noted that if the subject is using a pointing device and/or an input device which is different than the mouse **125** or the keyboard **120,** the subject may indicate fixation on the fixation target **228** by performing any other suitable action. For example, if a touch screen (not shown) is used as an input device, the subject may touch the touch screen (not shown) with a light pen (not shown), or with a stylus (not shown) or with a finger (not shown) at the position at which the fixation target is displayed. Other suitable forms of indicating or confirming fixation may be used, depending, inter alia, on the input device or pointing device which is being used.

[0047] When the subject signals (for example, by clicking a button on the mouse **125,** or by any other suitable way) that the cursor **225** is positioned to point at the fixation target **228,** indicating that his vision is fixated on the fixation target **228,** the line **322** is made to disappear from the screen **320** (step **265**). After a predetermined delay time interval (for example a delay interval in the range of 0 to 200 milliseconds), a second pattern such as the segmented line **332** is made to appear (displayed) on the screen **112** at a location different than the location of the line **322** as shown in screen **330** (step **270**) so as to allow the subject to form a perceived image of the segmented line **332.** In this example, the segmented line **332** is similar to the line **322** but appears on the screen **112** at a location which is different than the location of the line **322.**

[0048] It is noted that if the duration of the delay time interval is zero, the line **332** is presented on the screen **112** immediately after (or within the short time required by the computer **100** to process the subject's input and display the line **332** on the screen **112**) the subject **100** indicated fixation. In most of the experimental eye tests conducted in patients no delay was used (the delay time interval was zero).

[0049] The line **332** may, for example, be parallel to the line **322.** Since the subject's vision had been fixated on the fixation target **228,** the line **332** will appear in the periphery of the subject's field of vision. Any disturbance in his vision due to a retinal lesion (such as but not limited to a lesion caused by AMD or diabetes or by other different pathological eye conditions) may be apparent to the test subject as a difference between the perceived image of the second pattern and a pre-defined reference pattern, which in this example is provided by the first pattern (the segmented straight line **322**).

[0050] Additionally, or alternatively, the tested patient or subject **100** may have been told by a trainer (such as, for example, by an ophtalmologist or other medical or paramedical personnel) before the beginning of the test that he or she is going to be presented with test patterns which will look like a segmented straight line. In such a case, the subject **100** may conceive a "virtual" predetermined reference pattern which in this particular example of the test is a conceived image of a straight segmented line. The word "virtual" is used herein to indicate that the predetermined reference pattern

is mentally conceived by the patient or test subject without having to actually present the patient with the test pattern. In other words the understanding of the patient of how the reference pattern (such as, for example, the straight segmented line of the example illustrated in Fig. 3) is supposed to look like may be based on the previous visual experience of the patient or test subject.

[0051] The explanation to the patient of what the reference pattern is going to look like may be advantageous, since in a small percentage of patients it may happen that in the first presentation of the first test pattern (such as for example in the initial presentation of the line **322**) the image of the test pattern may fall on a lesioned retinal region. In such a case, the perceived image of the test pattern may be distorted. Therefore, in such a case, the perceived image of the initially presented line **322** is not usable as a reference pattern and the patient may see or detect a difference between the perceived image of the line **322** and the (virtual) reference image which the patient has been told to expect.

[0052] The difference between the perceived image of any of the test patterns (including, but not limited to, the lines **322** and **332**) which may be presented to the patient and the reference pattern may be perceived by the test subject **100** in various different ways. Thus, as the line **322** is perceived by the subject to jump or move to the new location on the screen **112** one or more of the segments **229** of the line may seem to the subject not to arrive at their new position on the line **332** (of the screen **330**) at exactly the same pace or contour as the other segments. In other words, one or more portions or segments of the line may temporarily seem to lag or to move differently relative to the other parts or segments of the perceived line. This may also be perceived by the subject as if one or more portions of the perceived line were wavy or moved or bulged for a short while or as if one or more of the segments or line portions deviated from the reference pattern (which is a straight segmented line, in the exemplary and non-limiting example of Fig. 3) before assuming again the perceived appearance of the reference pattern. Additionally or alternatively, depending, inter alia, on the nature of the retinal lesion present, one or more portions or segments of the perceived image of the test pattern (such as, for example, one or more the segments **229** of the perceived line **322**) may appear to temporarily change their apparent brightness (such as becoming brighter or becoming darker), or change their color temporarily as the line moves or jumps, and then return to their originally perceived brightness or originally perceived color, respectively. Additionally or alternatively, one or more of the segments 229 or portions of the test pattern may appear to momentarily or temporarily become blurred or smeared.

[0053] Additionally, various different combinations of this differences may also be perceived by the subject. For example one or more of the segments or portions of the test pattern may appear to lag or move differently than the other segments or portions of the pattern and also to change their perceived brightness. Other different combinations of differences may also be perceived by some patients.

[0054] For example, when the subject's vision is fixated at the location where the fixation target **228** had previously appeared (represented by the crossed lines **342** in screen **340**), a segment 344 of the line **332** may appear to be out of line with other segments in the line **332** or may be otherwise distorted, blurred, shifted or discolored. It is noted that the screen labeled **340** of Fig. 3 represents the screen **112** and the pattern **332** as perceived by the tested subject. In other words, the illustrated line **332** with the shifted segment **344** are shown as perceived by a subject or patient having a retinal lesion and not as actually displayed on the screen **112.** Thus, while the screen **330** of Fig. 3 schematically represents the image as actually presented to the subject **105** on the screen **112,** the screen **340** of Fig. 3 represents the image perceived by a subject having a retinal lesion (in the tested eye) after the line 332 of screen 320 is made to disappear (hidden) and the line **332** of screen **330** is presented (or displayed) to the subject at a different location on the screen **112.**

[0055] Screen **340** (of Fig. 3) illustrates a possible appearance of the line **332** (of screen **330**) to an individual having a retinal lesion. The perceived line **352** of the perceived screen **340** represents the image of the line **332** presented in screen **330** as it may be perceived by an individual having a retinal lesion. The segment **342** of the perceived line **352** may typically be temporarily perceived as being out of line with other segments in the line **352.** This is by way of example only, and other differences between the perceived image and the pre-defined reference pattern may be perceived, such as, but not limited to, one or more segments in the second pattern appearing to the subject as being shifted or wavy or lagging behind, or blurred, or dimming, or smeared, or bent, or otherwise distorted, or discolored. Additionally, one or more of the segments in the second pattern may be perceived by the subject to disappear or to be missing from the second pattern. As the subject subsequently shifts his vision from the fixation target **228** to the presented line **332,** the segment **344** in the image of the perceived line **352** may appear to move into alignment with other segments in the line **332** as shown in screen **350.** Thus, the line **363** of screen **350** (Fig. 3) schematically represents the perceived image of the line **322** as possibly perceived by the subject having a retinal lesion after the subject re-fixates his vision on the line **332.** Thus, the segment **344A** schematically represents the new perceived position of the previously perceived segment **344** after the patient shifted his eye to refixate on the new position of the line **332.** The perceived segment **344A** may now be perceived as realigned again with the rest of the perceived segments of the perceived line **363.**

[0056] Typically, the reason for the presented line **332** being perceived as straight again (as illustrated in the perceived line **363** of screen **350**) after the patient refixated his vision at the new position at which the line **332** appeared after the line **322** disappeared from the screen, is that in most cases when the subject shifts his vision from the fixation point **228**

to the new location on the screen at which the line **332** appeared, after a certain time (typically a few hundred milliseconds or longer) the *"filling-in"* phenomenon disclosed hereinabove may occur.

[0057] The subject, in step **275,** may indicate which, if any, of the segments in the line **332** appeared different or were perceived to behave differently than corresponding segments in the predefined reference pattern. This may be done by the subject bringing the cursor **225** to the segment or segments that appeared to move or to blur or to distort or to disappear, or to otherwise change (the segment **344** in this example) and clicking a button on the mouse **125** or a key on the keyboard **120,** or by otherwise performing an action with a pointing device (not shown) or any other suitable input device. The data representing the location(s) on the screen **112** of the segment or segments in the region pointed to by the subject may thus be stored by the system (step **277**) in the memory of the computer system **105,** and/or in the memory **145** of the server **140** or by any other suitable storage means, such as but not limited to, a fixed or removable magnetic media storage device (Hard disc drive or floppy disc drive), optical storage device, magneto-optical storage device, holographic storage device or any other suitable storage device known in the art. This stored data may be used to locate and/or report and/or display and/or symbolically represent (in hard copy or otherwise), the region in the subject's retina in which the retinal lesion is located, as disclosed in detail hereinafter. It is noted that the storage device or memory used for storing the test results data may be included in or suitably linked or coupled to the computer system **105** or the computer **110,** or the server **140.** Alternatively, the storage device may be a shared device which is shared by or accessible to one or more of the computer system **105** or the computer **110,** or the server **140,** over a communication network. Thus, while the test results data may be stored locally on the system **105,** this is not obligatory and the test results may be stored elsewhere as disclosed hereinabove.

[0058] In step **280** it is determined whether adequate mapping of the field of vision was achieved. For example, it may be checked whether the number of lines **322** presented to the subject is less than a predetermined number, such as, for example, 40 (or any other suitable predetermined number). If the number of lines **322** presented to the subject is less than the predetermined number, the process may return to step **250** and a new line **322** is presented to the subject. Steps **250** to **280** may be repeated several times, for example 40 times (or any other suitable predetermined number of times suitable for such a test). In each repetition the line **332** may be presented at a different location of the screen **112** until the region of the subject's macular visual field has been appropriately mapped.

[0059] It is noted that such mapping may be achieved in more than one way. For example, after the line **332** is presented or displayed to the subject **100,** and the subject has finished marking the segments which appeared different than the corresponding segments of the line **322,** or alternatively to mark the segments which appeared different than the "virtual" predetermined reference pattern (a straight segmented line mentally conceived by the subject), the subject may visually fixate the tested eye on a fixation target **228A** (see screens **330, 340, 350** and **360**) in the vicinity of the line **332,** by bringing the cursor **225** to point at the fixation target **228A** and clicking a button on the mouse **125** to indicate fixation as disclosed in detail hereinabove. This may trigger the repeating of steps **265** and **270** which will result in the disappearing of the line **322** and the showing of a new line (not shown) at a new position on the screen **112** which is different than the position at which the line **332** was previously presented. The subject may then proceed to mark any segments at which a difference was perceived as disclosed hereinabove. The presentation may be similarly continued until adequate mapping of the field of vision has been performed.

[0060] Alternatively, in accordance with another embodiment of the present invention, after the line **332** is presented or displayed to the subject **100,** and the subject has finished marking the segments which appeared different than the corresponding segments of the line **322,** or alternatively to mark the segments which appeared different than the "virtual" predetermined reference pattern (a straight segmented line mentally conceived by the subject), the line **332** may be caused to disappear from the screen **112,** and the line **322** and the fixation target **228** may be again presented to the subject **110** in the same positions illustrated in screen **320.** The subject may then again fixate on the fixation target **228** by bringing the cursor **225** to point at the fixation target **228** and click the mouse **125** to indicate fixation. The computer **100** may then present a new test pattern (not shown) at another new position relative to the position of the line **322** and the process may repeat after the subject marked any segments for which a difference was observed. By randomly or pseudo-randomly selecting a new line position for each new repetition the process may thus achieve adequate mapping of the desired macular area.

[0061] It is noted that if the first test pattern (such as for example the straight segmented line **322**) which is presented to the subject happens to be projected on a region of the retina which is lesioned, the subject **100** may initially perceive the pattern to be distorted or modified but after a certain time the test pattern may be perceived to be identical with the predetermined reference pattern (such as for example a straight non-distorted segmented line due to the *"filling in"* phenomenon disvclosed hereinabove. In such a case, the subject **100** may indicate or mark the location of the initially perceived distorted or modified region or component of the first test pattern, by using the mouse **125** and the cursor **225** as disclosed hereinabove. Alternatively, the subject **100** may be instructed (before or during the test) to ignore the initially perceived distortion or modification and to proceed to perform the fixation on the fixation target **228** as disclosed hereinabove by bringing the cursor **225** to point at the fixation target **228** and clicking a button on the mouse **125.** When the second test pattern, such as the line 332 is then presented at another location on the screen **112** (see screen **330** of

Fig. 3), the subject **100** may temporarily perceive a modification or distortion as the subject **100** shifts his vision from the fixation target towards the location of newly presented test pattern (which in this example is the location of the line **332** of screen **330** of Fig. 3). Therefore, in such cases in which the image of the first test pattern falls on a lesioned retinal area, the subject may perceive a distortion or modification in each of the repetitions or iterations of the test, irrespective of the location at which the second test pattern is presented on the screen **112.** The distortion will be perceived after the patient shifted his vision from the fixation target towards the test pattern presented at the new location due to the fact that the shifting causes the image of the newly presented test pattern to be projected on the lesioned retinal area. Because of this phenomenon, the subject may mark a distortion or modification on all the second test pattern repetitions, and all of the marked distortions will tend to be marked at positions along the test pattern which approximately correspond to the position of the distortion or modification which was initially perceived at the first time of presentation of the first test pattern due to the presence of the retinal lesion.

[0062] It is noted that if the test results do exhibit such an approximate "alignment" of multiple markings of perceived distortions or modifications at approximately similar positions on the test pattern, irrespective of the location of the presented second test patterns, this may be taken as an indication that there is at least one suspected retinal lesion at a position in the retina on which the image of first test pattern was projected.

[0063] It is further noted that while the presence of a retinal lesion may be detected in the above case, it may be advisable to test the same eye of subjects exhibiting such a spurious marking "alignment" using the "flash test" embodiment of the invention as disclosed in detail hereinafter, since this test does not show this spurious marking "alignment" phenomenon.

[0064] It is noted that while it is possible to perform the testing by mapping the field of view of the patient using only horizontal line patterns (such as the line **322**) and moving the horizontal line patterns vertically to different positions on the screen **112,** the mapping may also be performed using vertical lines (not shown in Fig. 3) which may be moved horizontally to different positions on the screen **112.** It may also be possible to use a plurality of orthogonal horizontal and vertical lines in the same mapping test, in which case the mapping coverage of the field of vision may resemble a grid of intersecting lines (not shown).

[0065] Furthermore, the mapping of the field of view may also be done using a series of lines that are inclined at an angle to the horizontal or vertical orientation (slanted lines), or combination of series of slanted lines which may intersect each other either orthogonally or non-orthogonally, such that if these lines were all displayed at the same time on the screen **112** they may form a grid of intersecting lines (not shown).

[0066] It is noted that in step **280** it is checked whether adequate mapping of the field of vision of the tested eye has been achieved. For example, if the location of presentation of the test pattern is different at each repetition or iteration of the test, adequate mapping may be ensured by checking that the number of lines presented to the subject has reached a predetermined number of iterations ensuring that data has been collected which suitably covers or maps the entire field of vision at a desired resolution.

[0067] Other different methods may however also be used to check adequate mapping. For example, if the testing of each location needs to be repeated more than one time and the location of presentation of test patterns is randomly or pseudo-randomly selected, the locations of performed tests may be compared with a look-up table to verify that the desired number of test repetitions for each test pattern location has been performed. If adequate mapping has not been achieved the process may return control to step **250** to present the next test pattern.

[0068] If adequate mapping of the field of vision of an eye has been achieved, the process may proceed by determining whether only one eye has been examined so far (step **282**). If only one eye has been examined, the subject may be instructed to uncover the non-examined eye and to cover the examined eye (**285**). The process may then return to step **250** with the subject testing his other eye as disclosed in detail hereinabove. If both eyes have been examined, the process may terminate (step **290**).

[0069] The position of the line **322** presented or displayed to the subject on the screen **112** may thus be varied in order to appropriately cover the macular area at a desired resolution so as to detect lesioned retinal regions. It is noted that in accordance with one preferred embodiment of the invention, the mapping may be performed more than once, and that the central part or fovial region of the macular area of the retina may also be mapped at a higher resolution than the rest of the macular area. This may be accomplished by presenting to the subject test patterns such as the line **322** at locations which are relatively close to one another on the screen **112.** This may result in higher lesion mapping resolution in the fovial region.

[0070] Reference is now made to Figs. 4A-4B which are schematic diagrams illustrating some exemplary types of line series which may be useful for mapping retinal lesions.

[0071] Fig. 4A schematically represents a mapping grid which may be formed if all the linear test patterns used in the were to be simultaneously presented on the screen **112.** The grid **500** thus formed may include parallel vertical lines, such as for example the vertical lines **502A, 502B, 502C, 502D,** and **502E** and parallel horizontal lines, such as for example the vertical lines **504A, 504B, 504C, 504D,** and **504E .** It is noted that the horizontal lines need not be equally spaced from each other. For example while the line pairs **502A** and **502B, 502B** and **502C,** and **502C** and **502D** may

be separated from each other by a cone angle **D1,** the line pairs **502D** and **502E** may separated from each other by a cone angle **D2.** Preferably **D1** is larger than **D2,** such that the density of grid lines at the central region of the grid **500** is higher than the density of the lines at more peripheral regions of the grid **500.** This may enable mapping of the central fovial region at a higher mapping resolution than the mapping of more peripheral fovial regions. It is noted however, that the horizontal and vertical lines of the grid **500** may be also equally spaced from each other or may be arranged differently than the arrangement of the lines illustrated in Fig. 4A. Furthermore, it is noted that while the lines of the grid **500** may be contiguous lines as shown in Fig. 4A (for the sake of clarity of illustration), the lines of the grid **500** may also be segmented lines (not shown) or dotted lines (not shown) or the like. Orthogonal or non-orthogonal slanted lines may also be used (not shown) to map the retina.

[0072] The grid used for mapping may also include only the horizontal lines shown in grid 500 or only the vertical lines of grid **500.** Furthermore, It is noted that the number and the density of the lines shown in Fig. 4A is only shown by way of example and the number of the lines as well as the separation between the lines may be modified may be changed depending, inter alia on the required retinal mapping resolution.

[0073] Fig. 4B schematically represents a mapping grid **510** which may be formed if all the linear test patterns used in the were to be simultaneously presented on the screen **112.** The grid **510** thus formed may include a plurality of lines **S12-517** which intersect at a point. While the lines **512-517** are illustrated as having identical lengths, their lengths may also vary. The angles $\alpha 1$, $\alpha 2$, $\alpha 3$, $\alpha 4$, $\alpha 5$, and $\alpha 6$ may be identical to each other and may be all equal to 60°. It is noted, however that the number of lines in the grid and the angle at which each line is inclined relative to the horizontal line **515** may vary and may be different than the values illustrated in Fig. 4B. Additionally, the number of the lines may vary such that the grid may include more or less than the six lines **512-517.** While the lines **512-517** are illustrated as contiguous (for the sake of clarity of illustration, the lines may also be segmented or dotted lines, or the like.

[0074] The number of the test patterns forming the mapping grid may vary as may their separation from each other, their angular inclination within the mapping grid.

[0075] It will be apparent to those skilled in the art that the exemplary mapping grids **500** and **510** do not represent the form or shape of a single test pattern but are rather virtual representations of the images that would result if all the test patterns of exemplary possible tests were to be projected simultaneously on a surface.

[0076] In accordance with another embodiment of the invention, it is also possible to present to the subject test patterns which include a distortion or other modification of the predefined reference pattern . For example, while the line **332** of screen **330** of Fig. 3 comprises segments which are all arranged or aligned in a straight line, a line **362** actually having a displaced segment **364** may also be presented to the subject on the screen **112** as illustrated in screen **360** of Fig. 3. The line **362** may be presented, for example, for a duration of up to about 300 milliseconds, but other suitable presentation duration time values may also be used.

[0077] Generally, test patterns, such as for example the line **362** of screen **360** (Fig. 3) may be regarded as test patterns which include an intentionally introduced distortion which may be similar to distortions which may be seen or perceived by a patient having a retinal lesion when a non-distorted test pattern (such as, but not limited to the line **332** of screen **330**) is presented to the patient. Such test patterns including a distortion may also be referred to hereinafter as "artificially distorted" test patterns. The presentation of such artificially distorted test patterns may be used, inter alia, to ascertain that the subject is aware of the visual distortion associated with a retinal lesion, and that his responses reliably reflect the perceived appearance of lines presented to him.

[0078] It is noted that while in the exemplary artificially distorted line **362** illustrated in screen **360** of Fig. 3 only one segment **364** is shifted relative to the other segments of the line **362,** other different types of distortions may be used. In accordance with other exemplary embodiments of the inventions such distortions may comprise but are not limited to displacing or mis-aligning more than one segment relative to the rest of the segments (not shown), tilting or changing the orientation of one or more segments relative to the orientation of the remaining segments (not shown), bending or otherwise changing the shape of one or more segments segment, removing one or more of the segments (not shown), blurring one or more of the segments (not shown), changing the hue or color or brightness of one or more segments of the test pattern (not shown), or introducing other types of alterations to the test pattern which may resemble distortions or alterations which may be perceived by a person having a retinal lesion when such a person is presented with a non-distorted test pattern or reference pattern.

[0079] It is noted that if the test patterns used in the test are non-segmented, such as for example if the test pattern comprises a contiguous (non-segmented) straight line (not shown), the artificially distorted test patterns may include but are not limited to bending one or more portions of the contiguous line such that these portions are not straight (for example, such distorted portions of the test pattern may be curved or wavy), blurring or smearing one or more portions of the test pattern (not shown), hiding (not presenting) one or more portions or parts of the test pattern (not shown) or changing the hue or color or brightness of one or more portions of the test pattern, or the like. Other suitable visually perceivable types of distortions or alterations of test patterns may also be used.

[0080] The presentation of such artificially distorted or otherwise intentionally altered or modified test patterns to the patient or test subject may also be advantageously used to detect cases in which the patient is not paying attention to

the test patterns due to fatigue or due to any other reason. This may enable the assessment of the degree of reliability of the test result. For example, if the patient does not reliably and/or accurately report the presence of the distortion or alteration in such artificially distorted or otherwise altered test patterns presented to him during the testing, this may be taken as an indication of a problem and may indicate a possible need to repeat the test or alternatively to label the test results as unreliable. Additionally, the degree of correlation between the location of the distortion or alteration on the presented test pattern and the location of the distortion or alteration perceived and marked (or reported) by the patient may be a used to assess the accuracy of perceiving and/or of the reporting of the location of the distortion or alteration by the patient or tested subject.

[0081] It is noted that in the exemplary screen **320** of Fig. 3, the segmented line **322** may be regarded as a pre-determined "reference pattern" of the test. The patient may be asked and/or trained to relate to the perceived image of the presented straight segmented line **322** as the reference pattern against which to compare the perceived images of the later presented test patterns. When the test is first presented to a patient, the patient may be told by the trainer or the individual administering the test that he is about to be shown a straight segmented line (or any other reference test pattern which is being used for the test). In this way, the patient becomes aware of the reference pattern against which he is expected to compare the perceived images of the test patterns which are going to be presented to him as the testing proceeds. It is noted that the patient may also be told before the testing begins that he is to be presented with straight segmented lines (without initially presenting to him such a line) and asked to compare the perceived image of each of the lines presented to him with a reference pattern which is a straight segmented line.

"Flash test" method

[0082] In this embodiment a fixation target is presented to the tested individual on a display device, such as but not limited to the screen **112** of the display device **115** (Fig. 1). After the tested patient has fixated on the fixation target, a test pattern is briefly presented (flashed) at a first location on the display device for a time duration which is sufficient to allow the patient to perceive an image of the presented test pattern. The image perceived by the patient in also referred to as a "perceived image" of the test pattern. The patient may then be requested to indicate whether he or she detected a difference between the perceived image of the presented test pattern and a reference pattern.

[0083] The tested patient may be informed by the trainer, or ophtalmologist or the person delivering the test, before the test is performed that he is going to be presented with patterns similar to or different than a reference pattern. The patient may or may not be actually presented with the reference pattern before the test begins. For example, if the reference pattern is a straight segmented line, the patient may be verbally told that he is going to be presented with a variety of test patterns that may be similar to or may be different from a straight segmented line, without showing the patient a straight segmented line (which is the reference pattern in this non-limiting exemplary test) prior to the presentation of the actual test patterns to the patient. In such a case, the reference pattern is based on the prior acquaintance of the patient with the reference pattern which is used. In other words, previous knowledge of the patient of how a straight segmented line looks is relied upon.

[0084] It is also possible (though not obligatory), however, to present the reference pattern the patient before the actual test patterns are presented in order to give the patient an idea of how the reference pattern is supposed to look like. While this may help the patient to understand and familiarize himself or herself with the form of the reference pattern, it is not a necessary part of the test, since most patients may adequately perform the test just by being told verbally what the reference pattern is without being presented with the actual reference pattern prior to the presentation of the test patterns.

[0085] After the patient is presented with a test pattern, if a difference was detected by the patient between the pattern perceived by the patient as a result of the presentation of the test pattern and the reference pattern, the patient may indicate the region or regions or segments or components of the perceived pattern at which a difference or differences were noticed. The presence and the location of the difference(s) which are detected and indicated by the patient may be stored for further processing and analysis as disclosed hereinabove. This procedure may be repeated several times while changing the location of the test pattern relative to the fixation target on the screen **112.** The number of repetitions and the location of the presented test patterns are such that a suitable area of the visual field of the tested eye of the patient is mapped for detection of possible retinal lesions or pathologies.

[0086] Reference is now made to Figs. 5A-5J which are schematic diagrams illustrating the patterns displayed on the screen **112** of the subject's display device **115** at various different exemplary steps of another embodiment of an eye test performed by the system illustrated in Fig. 1, and the possible appearance of the test patterns as they may be perceived by the test subject at some exemplary steps of the eye test.

[0087] In performing the flash test, the patient or test subject may be positioned before the screen **112** with the distance of the tested eye being preferably approximately 50 centimeters from the screen **112.** Other different distances may however also be used depending, inter alia, on the dimensions of the screen **112,** and on the size of the displayed test patterns.

[0088] The "flash test" method may begin by presenting to the patient or test subject one or more log-on screens, such as but not limited to the screen **300** schematically illustrated in Fig. 3. Other additional screens (not shown) may also be presented for entering other patient demographic data or the like. Once the patient identity has been established, screen **370** (Fig. 5A) may be presented to the patient.

[0089] A fixation target **372** is displayed on the screen 112. The fixation target **372** may be a circular pattern or may be any other suitably shaped pattern as disclosed in detail hereinabove for the fixation target **228** of Fig. 3. A cursor **373** may also be displayed on the screen **370.** If the patient is trained to take the test, the trainer or test supervisor may explain to the patient that he or she should cover one eye (by hand or by using a suitable eye occluding device or patch), look at the screen **370** with the non-covered eye, and bring the cursor **373** to point at the fixation target **372.**

[0090] Preferably, but not obligatorily, the movement of the cursor **373** may be restricted to the horizontal direction. For example, in accordance with one possible implementation of the method, the tip of the arrowhead-like pointing part **373A** of the cursor **373** may be pointed upwards and it's movement may be restricted along an imaginary non-visible horizontal line (not shown) intersecting the fixation target **372.** The patient may bring the cursor **373** to point at the fixation target **372** by using a mouse or any other suitable pointing device, as disclosed in detail hereinabove for the moving line method.

[0091] Similar to the fixation target **228** of Fig. 3, the fixation target **372** may be sized so that it is large enough to be seen by the patient or test subject but small enough so that bringing the cursor **373** to the fixation target **372** is a demanding task for the test subject. This causes the subject to fixate his vision on the fixation target **372.** Upon bringing the cursor **373** to the fixation target **372,** the subject may provide a suitable indication that he has positioned the cursor 373 to point at the fixation target **372.** For example, the patient or test subject may provide the indication by clicking on a button of the mouse **125** or by depressing a predetermined key on the keyboard **120** (or by suitably using any other suitable pointing device known in the art or disclosed hereinabove). This patient input may serve as an indication or verification that visual fixation on the fixation target **372** has been achieved.

[0092] After the patient indicates fixation as disclosed hereinabove, a test pattern in the form of a segmented straight line **382** is presented to the patient (see screen **380** of Fig. 5B). It is noted that while the exemplary test pattern illustrated in Fig. 5B is a segmented straight line **382** as disclosed hereinabove for the moving line test method, other types of different test patterns (not shown) may however also be used. The segmented straight line **382** may be presented on the screen **112** immediately after the patient clicks the mouse **125** or may be presented after a delay. If a delay is used, the duration of the delay may preferably be in the range of approximately 0 - 200 milliseconds, but other higher values of the duration of the delay may also be used. The segmented straight line **382** may be displayed on the screen **112** for a short duration. Preferably, the duration of presentation of the test pattern (the line **382**) on the screen **112** may be in the range of approximately 100-160 milliseconds. It was practically found that most patients perform the test well with the test pattern presentation duration in this range which enables to keep the duration of a test in the approximate range of 2-3 minutes (for a typical test including the presentation of 23 vertical segmented lines and 23 horizontal segmented lines).

[0093] It is noted that duration of presentation may also be shorter or longer. Typically, a duration of approximately 10-20 milliseconds may be on the threshold of observation for most patients. Thus, presentation duration values which are longer than 10-20 milliseconds may have to be used for most patients. The threshold of observation may however vary, inter alia, with the patient's age, visual acuity, or the like.

[0094] It is also noted that the test pattern presentation duration may also be longer than 160 milliseconds, but this may increase the overall test duration.

[0095] One advantage of the relatively short duration of the presentation of the test pattern (also referred to herein as "flashing" of the test pattern) may be that the eye/brain system of the patient may not have enough time to "fill-in" the distorted or missing or different parts of the perceived image of the test pattern, as it may do when the test pattern is static or is presented for a relatively long period of time. This may advantageously reduce or prevent such *"filling-in"* phenomena disclosed in detail hereinabove, which may decrease the probability of the patient not observing or not detecting (and therefore not reporting) a difference in the appearance of the perceived test pattern (as may often occur in the use of the Amsler test).

[0096] It may be further explained to the patient either before performing the test or while the test is being taken) that he is going to be presented with test patterns on the screen **112.** The patient may, for example, be told that the presented test patterns are going to be segmented straight lines, and that the reference pattern against which he is to compare what he actually perceives on the screen **112** is a segmented straight line.

[0097] The patient may further be instructed that if he or she detects any difference between the perceived form of the presented test pattern or of one or more parts or portions thereof and the reference pattern (which is a straight segmented line in the non-limiting example illustrated in Figs. 5A-5J), he or she is requested to indicate the approximate location of the part or parts which were perceived to differ from the reference pattern as is disclosed in detail hereinafter. For example, it may be explained to the patient that one or more of the segments of the straight line may deviate from linearity or may appear to move, or may appear wavy, or may appear to bulge or to deviate or to be distorted such they

are not perceived to be arranged as a straight line, and that other differences may also be observed such as, for example, a movement of one or more segments or parts of the perceived image of the test pattern relative to other parts or segments or portions of the perceived test pattern, or a dimming or brightening of some segments relative to the rest of the segments, or a change in the hue or color of some segments relative to the hue or color of other segments, or a fuzziness or blurring of one or more segments relative to the other segments, or that one or more segments or portions of the segmented straight line may appear to be missing, and that other differences may also be perceived.

[0098] Fig. 5C schematically illustrates a screen **390** which is a representation of how the presented screen **380** (Fig. 5B) may be perceived by a patient having a retinal lesion while the patient's tested eye is fixated on the fixation target **372.** The perceived image perceived by the patient may be a distorted segmented line **392** (Fig. 5C). In the perceived distorted line **392,** the segments **392A, 392B,** and **392C** are perceived as shifted or distorted, or moving, or forming a bulge such that they are not arranged in a straight line. This may be due to the presence of a retinal lesion.

[0099] After the presentation of the test pattern is terminated, the test pattern **382** disappears from the screen **112** by terminating the displaying thereof on the screen **112.** The patient may then indicate or mark the approximate location of the perceived region of difference or distortion on the perceived image. This marking or indicating may be performed, for example by the patient using the mouse **125** to move the cursor **373** to the region of the screen **112** where the difference was observed or detected. Fig. 5D illustrates the appearance of a screen **400** after the patient moved the cursor **373** to the approximate position on the screen at which the patient observed the distortion in the perceived image illustrated in Fig. 5C. This position roughly matches the region where the segments **392A, 392B,** and **392C** (of Fig. 5C) were perceived by the patient as shifted or distorted. After the positioning of the cursor **373** at the approximate position at which the difference or distortion was observed the patient may click a button on the mouse **125.** The computer system **105** may thus determine from the position of the cursor **373** in screen **400** (Fig. 5D) the location on the test pattern at which a difference or distortion was observed or detected by the patient in the perceived image **392** of the test pattern **382** which was presented in screen **380** (of Fig. 5B). This location may be stored as data in the computer system **105.**

[0100] It is noted that while in screens **370** and **380** (of Figs. 5A and 5B, respectively) the movement of the tip of the arrowhead-like **373A** of the cursor **373** was restricted along an imaginary non-visible horizontal line (not shown) intersecting the fixation target **372,** after the termination of the presentation of the test pattern 382, the cursor is preferably not restricted and may be moved to any point on the screen **400.** Alternatively, the moving of the cursor **373** may remain vertically restricted as disclosed hereinabove, in which case the patient may mark the location of the observed distortion or difference by moving the cursor **373** horizontally (not shown) until it reaches a location which is above or below the region at which the difference or distortion was observed on the perceived test pattern, (depending on whether the location of the appearance of the test pattern was below or above the fixation target **372,** respectively).

[0101] The computer system **105** may thus store data representative of the location (or locations) marked by the patient. In accordance with one exemplary embodiment the data may include the position of the test pattern **382** on the screen **380** and the position on the test pattern **382** which is equivalent to the horizontal position marked by the cursor **373** on the screen **400** (which is indicative of the location which was marked by the patient as the approximate region of the distortion perceived by the patient). Other different methods of storing the data may also be used as may be apparent to those skilled in the art.

[0102] It is noted that the computer **105** may also store other information or data associated with the presented test pattern. For example, the stored data may include, but is not limited to, the number of the test pattern (which may be indicative of the order of presentation of the particular test pattern within the test), the orientation of the test pattern (for example, vertical or horizontal, or the like), or any other data related to other parameters of the test pattern.

[0103] After the marked position of the distortion is stored, the patient may initiate the presentation of a new test pattern by repositioning the cursor **373** to point at the fixation target **372** and clicking a button on the mouse **125** as disclosed for screen **380** (of Fig. 5B) to indicate the achieving of fixation. This may cause the presentation of a new test pattern **402** as illustrated in the screen **410** of Fig. 5E. In this exemplary screen , the test pattern **402** is briefly presented at a new location on screen **410,** different than the location of the test pattern **382** on screen **380** (Fig. 5B). The patient may perceive the presented test pattern **402** as a segmented straight line with no distortion (or no difference from the reference pattern) if there is no retinal lesions in the retinal region on which the image of the test pattern **402** is projected when the patient maintains visual fixates on the fixation target **372.** The patient does not mark any position on the screen **410** since no distortion or difference from the reference pattern were observed by the patient. The patient may then proceed by visually fixating on the fixation target **372** and clicking on the mouse **125** to initiate the presenting of a new test pattern (not shown).

[0104] It is noted that in accordance with one embodiment, the cursor **373** may be automatically shifted to a new position away from the fixation target **372** following the termination of the presentation of the test pattern. This may be advantageous since it may force the patient to bring the cursor **373** again to point at the fixation target **372** which may ensure proper visual fixation before the presentation of each new test pattern. This however is not mandatory, because it may be possible to train the patient to perform visual fixation on the fixation target **372** prior to clicking the mouse to initiate the presentation of an additional test pattern, and because it may also be possible to independently monitor

patient fixation by the presentation of artificially distorted test pattern as disclosed hereinabove and hereinafter.

[0105] In accordance with one embodiment, after a sufficient number of test patterns at appropriate locations have been presented to the patient to adequately map the desired field of vision with a desired resolution, the test may be terminated, In accordance with another embodiment , the test may further continue by changing the orientation of the presented test patterns such that a new sequence of test patterns is presented to the patient which test patterns are vertically oriented segmented straight line.

[0106] In screen **420** of Fig. 5F a vertically oriented test pattern **422** is illustrated. Preferably, but not necessarily, the shape, length and number of segments of the vertically oriented test pattern **422** may be similar to the shape, length and number of segments of the horizontally oriented test patterns previously presented to the patient (such as, for example, the horizontally oriented test pattern **382** of Fig. 5B). This, however is not mandatory, and the shape, or the length or the number of segments of the vertically oriented test patterns may be different than those of the horizontally oriented test patterns.

[0107] If the patient noticed no difference or distortion in the perceived pattern (not shown) of the test pattern **422** presented to the patient, the patient may re-fixate on the fixation target **372,** and indicate visual fixation by clicking the mouse **125** to cause the presentation of a new (vertically oriented) test pattern.

[0108] Fig. 5G illustrates an exemplary (vertically oriented) test pattern presented to the patient during a part of the test. The test pattern **432** is presented in a location of screen **430** as illustrated in Fig. 5G.

[0109] Fig. 5H schematically illustrates a screen **440** which is a representation of how the presented screen **430** (of Fig. 5G) may be perceived by the patient having a retinal lesion while the patient's tested eye is fixated on the fixation target **372.** The perceived image perceived by the patient may be a distorted segmented line **442** (Fig. 5H). In the perceived distorted line **442,** the segments **442A, 442B,** and **442C** are perceived as shifted or distorted, or forming a bulge such that they are not arranged in a straight line. This perceived distortion may possibly be due to the presence of the same retinal lesion which caused the distortion in the perceived image **392** (Fig. 5C) of the presented test pattern **382** of Fig. 5B. The distortion in the perceived image **442** may however also be due to the presence of another different retinal lesion.

[0110] After the termination of the presentation of the test pattern **432** (Fig. 5G), the patient may mark the location of the perceived distortion as illustrated in screen **450** of Fig. 5I by moving the cursor **373** to point at the approximate location of the distortion and clicking the mouse **125** which stores data representing the location of the observed distortion in the computer system 905, as disclosed hereinabove. Additional vertical test patterns at different locations may then be presented to the patient until the mapping of the retina using vertically oriented test patterns is completed at a desired resolution. Testing of the second eye of the patient may then be also performed by covering or occluding the already tested eye of the patient and repeating the same testing procedure for the uncovered non-tested eye.

The use of "artificial distortions" in the flash test method

[0111] Preferably, in accordance with an embodiment, it may be possible to include intentional distortions in the test patterns presented in the flash test method disclosed hereinabove by presenting the patient with artificially distorted test patterns. The artificially distorted patterns may include, inter alia, any of the types of distortions included in the artificially distorted test patterns disclosed hereinabove for the "moving line" test method (for one, non-limiting example of such an artificial distortion see screen 360 of Fig. 3). Thus, some of the test patterns presented to the patient may be artificially distorted, as disclosed hereinabove. For example, one out of three (approximately 30%) test patterns presented to the patient may be an artificially distorted pattern. Other different ratios of artificially distorted to non-distorted test patterns may also be used.

[0112] Among the advantages of presenting artificially distorted test patterns is, that this may train the patient in what may be the appearance of a perceived distortion if a retinal lesion is present. This training may improve the patient's ability to detect and report such distortions if such a distortion or similar distortions appear in the perceived image following the presentation of a non-distorted test pattern to the patient.

[0113] Another advantage, as explained hereinabove, may be the possibility to assess the degree of attention of the patient, and the reliability of the test results. Thus, if the patient fails to reliably report the presence and the location of the distortions displayed in the artificially distorted test patterns, this may be used as an indication of possible lack of attention of the patient, due to fatigue or other reasons, or this may also be used as an indication that something is wrong with the test presentation or with the test results, or with the patient's ability to visually perceive the test patterns, in which case the test results may be ignored (such as, for example, when the test is performed by the patient alone without the supervision of a trainer or supervisor). If a trainer or supervisor is present near the patient and such a testing non-reliability is reported, for example by an appropriate error message (not shown) appearing on the screen **112** or otherwise, the supervisor or trainer may stop the test (and may cancel the record of the test results if appropriate) and may try to find and rectify the reasons for the patient's failing to reliably report the presence and location of the distortions.

[0114] For example, the trainer or supervisor may check if the patient's tested eye is positioned at the appropriate

distance from the screen **112,** or if the patient is fatigued or not paying attention to the test patterns or not properly fixating his vision at the fixation target **373,** or the like. Such problems may be thus rectified and another test may be initiated if desired.

[0115] Fig. 5J illustrates one possible form of an artificially distorted test pattern which may be possibly used in the example of the flash testing method illustrated in Figs. 5A-5I. In screen **460** of Fig. 5J an artificially distorted line **462** is illustrated as presented to the patient on the screen **112.** The segments **462A, 462B** and **462C** of the presented line **462** are positioned and oriented such that they are not aligned (or mis-aligned) with the remaining segments of the test pattern **462.** In other words, while the remaining segments of the test pattern **462** are aligned to form a straight line, the segments **462A, 462B** and **462C** form a bulge or curved part or wavy part of the test pattern **462.** The test pattern **462** (which may be presented on the screen **112** of the display device **115**) is thus an artificially intentionally distorted test pattern. Thus, when the artificially distorted test pattern **462** is presented to the patient who is visually fixated on the fixation target **373,** the patient may perceive the distortion as a deviation of the segments **462A, 462B** and **462C** from the expected reference pattern of a straight segmented line.

[0116] The patient may then proceed to indicate or mark the approximate location of the perceived distortion by bringing the cursor **373** to the approximate location of the perceived distortion and clicking the mouse **125** as disclosed in detail hereinabove. For example, the patient may position the cursor **373** at the approximate position on the screen **112** at which the patient perceived the image of the segment **462B** while the test pattern **462** was presented (flashed) on the display device **115,** and may click on the mouse **125** to input and store the approximate location of the perceived distortion in the test pattern **462.** The location reported by the patient may be compared to the known location of the distortion in the presented artificially distorted test pattern **462.**

[0117] It is noted that if the patient detects or observes two or more spatially distinct distortions or abnormalities along the presented test pattern, the patient may mark the approximate location of all such detected distortions or visual abnormalities by suitably bringing the cursor **373** to the location at which the additional distortion or visual abnormality was observed and clicking the mouse 125. Thus, the data stored for a test pattern may include the location on the test pattern of more than one detected distortion or visual abnormality.

[0118] Typically, about a third (approximately 30%) of the test patterns presented to the patient may be artificially distorted test patterns. The percentage of the artificially distorted test pattern out of all the test patterns presented to the patient may however vary, depending, inter alia, on previous knowledge of the test performance of the same patient in past tests, or on other considerations. Additionally, the artificially distorted test patterns may be randomly or pseudo-randomly distributed among the rest of the test patterns during a test so that the patient cannot predict the time of presentation of the artificially distorted test patterns by learning the sequence of presentation of these signals.

[0119] It is noted that generally vertically oriented artificially distorted test patterns (not shown) may also be presented to the patient (the word "generally" refers to the vertical orientation of the majority of the non-distorted segments which are aligned along an imaginary straight line, even if some of the segments may be horizontally displaced in the region of the artificial distortion).

[0120] Typically, the location of the distorted portion or segments on the artificially distorted test pattern may be randomly or pseudo-randomly changed or altered in different presentations of artificially distorted test patterns performed within a test. Such random alteration of the location of the artificial distortion along the test pattern is advantageous because it makes it more difficult for a patient to cheat (either intentionally or non-intentionally) in comparison with a situation in which the distortion is always presented at a fixed location on the test pattern.

[0121] If the patient fails to reliably identify and report the presence and the location of the distortion presented in a predetermined percentage of the artificially distorted test patterns which were presented to the patient in a test, the test results may be ignored or discarded as unreliable. For example, in accordance with one non-limiting exemplary embodiment of the method of the present invention, if the patient did not report reliably the presence and the location of the artificial distortion (or another test pattern modification used in the test) in 20% of the total number of artificially distorted test patterns presented within a test, the test results may be ignored or discarded as unreliable.

[0122] Thus, in accordance with such an exemplary (non-limiting) test reliability criterion, if in a test the patient was presented with 60 test patterns, and 20 test patterns out of the 60 test patterns were artificially distorted (or otherwise modified) test patterns, the patient has to reliably report the presence and location of the artificial distortion (or of any other test pattern modification which was used in the modified test pattern) in at least four out of the twenty presented artificially distorted test patterns in order for the test results to satisfy the reliability criterion.

[0123] It is noted that in accordance with the exemplary embodiment of the reliability criterion disclosed hereinabove, it is not enough for the patient to just identify the presence of the distortion or modification which was artificially introduced in the presented test pattern, but the patient has to correctly mark the position of the artificial distortion (or other test pattern modification) in the test pattern within a specified predefined positioning accuracy criterion.

[0124] Typically, in accordance with one possible exemplary embodiment , the position marked by the patient as the position of the distortion (or other modification, if used) has to fall within a 1.5° cone angle on each side of the center point of the artificial distortion in to satisfy the position accuracy criterion, but other different cone angles may also be used.

[0125] Reference is now made to Fig. 6 which is a schematic diagram useful in understanding an exemplary positioning accuracy criterion which may be used in the eye testing method .

[0126] The segmented line 532 schematically represents an artificially distorted horizontal line 532 as presented (flashed) on the screen 112 to the subject 100. The segment 529 represents the approximated center of the artificial distortion of the line 532 as presented on the screen 112. The tips of the arrows 541, 542, 543, 544 and 545, schematically represent some possible locations where a subject may potentially mark the position of the approximate the center of the perceived distortion. It is noted that the points clicked on by the subject (which are schematically indicated by the points at the tip of the arrows 541, 542, 543, 544 and 545) need not be on the exact line 532 as perceived by the patient and may be either on or below or above the position on the screen 112 at which the line 532 was briefly presented. The dashed line 519 schematically represents an imaginary vertical line passing through the center of the segment 529 and the dashed lines 515 and 517 schematically represent two imaginary lines parallel to the vertical line 519 and extending to the end (not shown) of the screen 112. The distance S1 between each of the imaginary lines 515 and 517 and the imaginary line 519 is equivalent to a cone angle of 1.5° of the visual field of the subject when the subject's eye is positioned 50 centimeters from the screen 112.

[0127] If the position marked by the subject 100 falls on one of the imaginary lines 515 and 517 or falls anywhere between the two lines 515 and 517, the marked position passes (satisfies) the positioning accuracy criterion and the marked position is deemd to be accurate. If the position marked by the subject 100 falls on the region on the left side of the imaginary line 515 or on the screen region on the right of the imaginary line 517, the marked position does not satisfy the positioning accuracy criterion and the marked position is deems to be inaccurate. Thus, for example, the marked positions represented by the tip of the arrows 541 and 545 do not satisfy the positioning accuracy criterion while the marked positions represented by the tip of the arrows 542, 543 and 544 satisfy the positioning accuracy criterion.

[0128] It is noted that other different types of positioning accuracy criteria may also be used. For example the cone angle represented by the distance S1 may have other values which are smaller or larger than 1.5°. Furthermore, if the test patterns used are slanted lines, other positioning accuracy criteria may need to be established and used.

[0129] It is further noted that the satisfying of the of positioning accuracy criterion may be computed or evaluated by the computer **105** or by any other suitable computing device, using any suitable computational algorithm as is known in the art.

Analysis of test results

[0130] The results of the tests performed as disclosed hereinabove may need to be suitably analyzed in order to provide the patient with proper instructions, and possibly his health care provider with a report of the test results. In the case were the patient has been trained to perform the test at home using a desk-top computer or a portable computer (a laptop computer) or the like, if a possible retinal lesion is detected in the test, the patient may be preferably provided with an output which may instruct the patient to promptly visit his ophtalmologist or an eye clinic for a thorough eye examination in order to check the existence of the suspected lesion. If upon this eye examination a lesion is verified, proper therapeutic treatment may be timely administered to the patient, which may substantially improve patient's prognosis due to early detection of the lesion. If no lesion is detected or suspected, the patient may be informed after the test is finished that the results are negative (no lesion is suspected).

[0131] Theoretically, if a single occurrence of a perceived distortion of a test pattern is reported or marked by the subject after a non-distorted test pattern is presented to the patient, the patient may be diagnosed as positive and the system may recommend or instruct the patient to visit an ophtalmologist for further eye examination. Such a simple diagnostic criterion may, however, result in a relatively large percentage of false positive diagnoses. This is because many patients may report a distortion in a certain percentage of the presented non-distorted test patterns. Thus, such a simple diagnostic criterion may not be widely applicable to all patients and may possibly be used only for certain subpopulation of patients (such as for example in very high risk patients in which it may be decided that a high percentage of false positive diagnoses is tolerable).

[0132] For most patient, however, other diagnostic criteria may have to be used for reducing the probability of false positive diagnosis.

[0133] In order to establish if one or more visual disturbance was reliably detected, the data collected and stored in the test is processed as follows.

[0134] The data stored for all the non distorted test patterns are checked to see if any segment or component or portion was marked by the patient on any of the test patterns presented in the test. If such a marked segment or component or portion is found, the data for other test patterns is checked for the presence and location of marked segments in other different test patterns. While the finding of a single marked location in a single test pattern may be regarded as an indication of a suspected retinal lesion or retinal abnormality, such a single marked location may have been erroneously marked. It is therefore preferred to corroborate such a result by checking the data obtained for other different test patterns to find out if another location was marked on another test pattern. If two locations were indeed marked by the subject

in two different test patterns it may be checked or computed if these two locations satisfy a proximity criterion.

[0135] Reference is now made to Figs. 7A and 7B which are schematic diagrams useful in understanding exemplary diagnostic criteria which may be used.

[0136] It is noted that the locations of the distortions marked and stored in the computer 105 as disclosed hereinabove may be normalized since they are all known relative to the fixation target. In other words, a correction may be computed to compensate for the movement of the fixation target on the screen 112. Therefore, the coordinates of the marked locations may be normalized relative to the fixation target (if the fixation target moves on the screen 112 as is the case in the moving line test). In this way all the marked points maybe related to each other for performing the computations of the diagnostic criteria. In the flash test there is no need for normalization since the fixation point does not change its position on the screen 112, and therefore the locations (coordinates) of the marked locations of the distortions or modifications may be used directly without normalization.

[0137] Different proximity criteria were used for different combinations of test patterns. The computation is performed on pairs of marked locations in two. If the pair of marked locations came from test patterns which are orthogonal to each other (such as for example a horizontal straight segmented line and a vertical straight segmented line) The proximity criterion is satisfied if the distance between the two marked locations is equal to or smaller than a cone angle of 3° (three degrees) assuming that the subject's eye was at a distance of 50 centimeters from the screen 112 during the test.

[0138] If the point 570 of Fig. 7A schematically represents the position of a first location marked by the subject in response to the presentation of a first test pattern. The circle 572 has a radius R which is equivalent to a cone angle of 3° (three degrees) assuming that the subject's eye was at a distance of 50 centimeters from the screen 112 during the test. If a another point which represents the location marked by the subject on another test pattern orthogonal to the first test pattern falls on or within the circumference of the circle 572 the proximity criterion (for pairs of orthogonal test patterns) is met indicating the presence of a retinal lesion. If the other point falls outside of the circumference of the circle 572, the proximity criterion is not met. For example, each point of the points 576 and 578 meets the proximity criterion with respect to the point 570 , while the point 574 does not meet the proximity criterion.

[0139] It is noted that if the distance between the tested eye and the screen 112 is different than 50 centimeter, the proximity criterion may need to be changed by changing the value of the radius R.

[0140] If the two points being checked come from location marked on test patterns that are parallel (for example, two differently located straight segmented lines which are parallel, another proximity criterion is used. If the point 580 of Fig. 7B schematically represents the position of a first location marked by the subject in response to the presentation of a first test pattern. A rectangle 590 surrounding the point 580 has a horizontal side HS which is equivalent to a cone angle of 4° (four degrees) and a vertical side VS which is equivalent to a cone angle of 6° (six degrees) assuming that the subject's eye was at a distance of 50 centimeters from the screen 112 during the test. The point 580 is disposed at the geametrical center of the rectangle 590. If another point which represents the location marked by the subject on another test pattern parallel to the first test pattern falls on or within the circumference of the rectangle 590, the proximity criterion (for parallel test patterns) is met indicating the presence of a retinal lesion. If the other point falls outside of the circumference of the rectangle 590, the proximity criterion is not met. For example, each point of the points 582, 584, and 576 meets the proximity criterion with respect to the point 580, while the point 588 does not meet the proximity criterion.

[0141] It is noted that the proximity criteria disclosed hereinabove were empirically determined and that many other different types of criteria may be used, depending, inter alia, on the purpose of the test, the needed accuracy, the desired level of false positive diagnosis, and the particular group of patients for which the test needs to be applied. Thus, the proximity criteria indicated above are given by way of example only and other proximity criteria may be applied.

[0142] It is further noted that when the test includes test patterns with artificial distortions, any locations which are marked by the subject which are within 3° (three degrees) on each side of the center of the artificial distortion are removed from the data prior to performing the calculations for checking any of the proximity criteria to prevent spurious positive results. If the size and shape of the artificial distortion is changed, a different distance from the center may be used for removing data which is due to the presence of the artificial distortion.

[0143] Fig. 8 is a schematic flow diagram useful in understanding a method for performing a test session and analyzing the results of the test session.

[0144] A test session may include one or more tests and begins by the patient performing a first test (step 550). The tests may be a moving line test or a flash test but in one session all tests are of the same type. After the first test is completed, the data is analyzed (step 552). The analysis may be performed using the proximity criteria as disclosed hereinabove and may result in any of three types of analysis results as follows :

1) a **positive** result is generated if a retinal lesion is found from the results of the first test by having at least two marked locations in two separate test patterns which meet the proximity criteria disclosed hereinabove.
2) a **negative** result is generated if the patient did not mark any location in any of the test patterns presented in the test.
3) a **verify** result is generated is the patient selected and marked locations on one or more test patterns presented during the test, but the marked locations did not meet the proximity criteria.

[0145] If the results of the analysis of step 552 generate a **positive** result, the session ends with a positive result (step 564) indicating that a lesion has been detected, and the session is terminated.

[0146] If the results of the analysis of step 552 generate a **negative** or a **verify** result, a second test is run (step 554). The second test is a repetition of the first test. The results of the second test are analyzed (step 556) according to the same method as in the analysis of step 552 except that the analysis is run on the pooled results of the firs and the second test.

[0147] If the results of the analysis of step 556 generate a **positive** result, the session ends with a positive result (step 564) indicating that a lesion has been detected, and the session is terminated.

[0148] If the results of the analysis of step 556 generate a **negative** result The session ends in a negative result and is terminated (step 562). If the results of the analysis of step 556 generate a **verify** result a verification test is run (step 558). The verification test may be different than the first test and the second test in that it does not present to the patient the full complement of the test patterns which are normally included in the first and the second test, but presents to the patient only test patterns which were previously marked by the patient in the pooled results of the first and the second tests. Additionally, while the first and second tests may include artificially distorted test patterns, preferably, the verification test does not include artificially distorted test patterns.

[0149] After the verification test is performed an analysis is performed on the pooled results of the first test, the second test and the verification test (step 560).

[0150] If the results of the analysis of step 560 generate a **positive** result, the session ends with a positive result (step 564) indicating that a lesion has been detected, and the session is terminated.

[0151] If the results of the analysis of step 560 generate a **negative** or a **verify** result, the session ends with a negative result (step 562) and the session terminates.

Experimental results

[0152] Reference is now made to Fig. 9 which is a bar graph representing experimental results comparing the performance of the standard Amsler grid test with the performance of the eye test of the present disclosure.

[0153] The bar graph of Fig. 9 represents the results of testing performed on 108 eyes of patients with clinically diagnosed forms of AMD and on a group of control patients which had a normal retina (the control group).

[0154] The test was performed using the flash method as disclosed hereinabove.

[0155] The test patterns used were 23 vertical segmented straight lines and 23 horizontal straight segmented lines, each line spanning a 14° cone angle at a distance of 50 centimeters of the eye from the screen 112. The segments were rectangular white segments on a black background, each segment spanning 0.2°X 0.2° cone angle. The segments of each line were separated from each other by a cone angle of 0.6°

[0156] The results of the control group are represented in the bar pair labeled I (Normal retina).

[0157] The group with 108 patient included four subgroups. The first subgroup (labeled II) included 18 patients clinically diagnosed as having early AMD without high-risk characteristics (HRC) as in known in the art. Of this group the MCPT test resulted in a positive diagnosis in

[0158] The third subgroup (labeled III) included 35 patients clinically diagnosed as having early AMD with high-risk characteristics (HRC) as in known in the art.

[0159] The fourth subgroup (labeled IV) included 23 patients clinically diagnosed as having late AMD with geographic atrophy (GA) as in known in the art.

[0160] The fifth subgroup (labeled V) included 32 patients clinically diagnosed as having choroidal neovascularization (CNV) as in known in the art.

[0161] The results of the MCPT for the subgroups are represented by the hatched bar of each bar pair and the results of the standard Amsler grid test are represented by the unfilled bar of each bar pair. The hight of the bars represents the percent of the patients in each relevant group which was diagnosed as positive in the test (Amsler test or MCPT test)

[0162] It can be seen that for subgroups II, III, IV ,and V the MCPT test resulted in a significantly higher percentage of patients being positively diagnosed, as compared to the percentage of the patient diagnosed positive when the Amsler grid test was applied to the same group.

[0163] In the normal retina group (the control group I), the difference observed between the percentages of individuals showing positive diagnosis in the MCPT and Amsler grid test was not significant.

testing system configurations

[0164] It is noted that the testing systems and data analysis methods disclosed hereinabove may be implemented in different device and system configuration.

[0165] In accordance with one possible configuration of the system, the system may be implemented on a computer used at the patient's home. Such a computer may or may not be connectable to a network as disclosed in detail

hereinabove. A software program may be installed on a commercially available desktop computer, or portable computer or any other suitable type of computer. The computer may be preferably connectable to a network for communicating the test results to a suitable server. Such a system may have the advantages of being inexpensive, simple to operate, and being operable at the patient's home.

[0166] In accordance with another configuration of the test system, the system may be meant for use at an eye clinic or at an ophtalmologist's office. Such a system may be implemented on a powerful computer station or workstation and may also provide the ophtalmologist or other eye expert with more advanced data analysis and possibly graphical reports of the test results. Such reports may advantageously provide data about the possible location of the retinal lesion(s), an indication of the lesion size or magnitude, and may possibly include a more detailed report showing the history of test results of the tested patient.

[0167] It will also be understood that the system according to the invention may be a suitably programmed computer. Likewise, the invention contemplates a computer program being readable by a computer for executing the method of the invention. The invention further contemplates a machine-readable memory tangibly embodying a program of instructions executable by the machine for executing the method of the invention.

[0168] It is noted that while the non-limiting examples of the testing system disclosed hereinabove and illustrated in Fig. 1 include a display device on the surface of which the various test patterns and the fixation target are presented to the subject, other types of systems for administering the test to the subject may be used which do not include a screen or surface. For example, the test patterns and fixation target(s) may be presented to the subject by using an optical system (not shown) similar to a scanning laser ophtalmoscope (SLO).

[0169] Reference is now made to Fig. 10 which is a schematic diagram illustrating a system including a scanning laser device usable for carrying out an eye test.

[0170] In the system 600, the images of the test patterns and fixation target(s), and possibly the log-on screen(s) may be directly projected on the retina of an eye 614 of the test subject (not shown) by suitably directing a laser beam 612 (schematically represented by the dashed line labeled 612) through the pupil of the tested eye 614 and by suitably scanning the laser beam 614 across the retinal surface to form projected images of the test patterns and/or fixation target(s) at specified locations on the retinal surface. The system 600 may include a scanning laser device 602. The scanning laser device 602 may be a scanning laser ophtalmoscope (SLO) device as is known in the art. Or any other device capable of controllably scanning a beam of coherent or non-coherent light across the retina of an eye. The scanning laser device 602 may be suitably coupled to a controller unit 604 or to a computer (not shown) for controlling the operation of the scanning laser device 602. The controller unit 604 may also be a computer such as a workstation, or mainframe, or laptop computer or a hand held or other portable computing device, or a personal computer or any other type of computing device known in the art. The controller unit 604 may be coupled to suitable pointing device(s) 610. The pointing device(s) 610 may be a mouse (not shown), and/or keyboard connected to a computer or may be any other suitable pointing device or devices as disclosed hereinabove or as known in the art. The system 600 may also include one or more output unit(s) 608, such as , but not limited to a display, a printer unit, or any other suitable output device for enabling interaction of a user with the system 600 and/or for producing hard copy output of test results or the like. The output unit(s) 608 may be suitably coupled or connected to the controller unit 604.

[0171] In operation the system 600 may be used for applying any of the tests disclosed hereinabove but instead of showing the test pattern, and the fixation targets on a screen 112 of a display device 115, the images of the test patterns and the fixation target(s) may be directly projected onto the retina of the tested eye 614 by the scanning laser device 602 by suitably scanning the laser beam 612 on the retina of the eye 614. The laser beam 612 may also be used to project an image of a cursor (similar to the cursor 225 of Fig. 3) directly on the retina of the eye. The movement of such a projected cursor may be controlled by the one or more of the pointing devices 610 ,such as but not limited to a mouse (not shown). Thus. The system 600 may be used to administer to a patient any of the tests disclosed hereinabove (including but not limited to the moving line test and the flash test) and to record and stor the responses of the patient including but not limited to the marking of parts or portions or segments at which distortions or modifications as disclosed hereinabove were perceived and marked by the patient. The system 600 may also process the test results using any of the methods and test criteria disclosed hereinabove to produce a positive or negative diagnosis. The system 600 may also be suitably connected to a communication network (such as, but not limited to the communication network 130 of Fig. 1) and may communicate with other devices or computers, or the like over the communication network.

[0172] It is noted that the laser scanning device 602 may be replaced or substituted with other scanning devices (not shown) known in the art which are capable of directing a narrow light beam having a suitably narrow beam cross-sectional area onto an eye and scanning the beam controllably across the retina. The light beam need not be a laser beam but may be any beam of non-coherent light which may be suitably scanned across a retina with sufficient speed and resolution.

[0173] It is noted that the construction and operation of laser scanning ophtalmoscopy devices is well known in the art, is not the subject matter of the present invention and is therefore not described in detail herein.

[0174] It will be appreciated that the preferred embodiments disclosed hereinabove and illustrated in the drawings are given by way of example only and that many variations and modifications of the present invention may be made.

Claims

1. Eye testing method, comprising the steps of:

   (a) displaying to the individual a first pattern at a first location on a surface;
   (b) fixating the individual's vision on a part or component in the first pattern;
   (c) hiding the first pattern;
   (d) displaying a second pattern to the individual at a second location on the surface so as to allow the individual to form a perceived image of the second pattern, such that said first pattern appears to said individual to jump from said first location to said second location;
   (e) obtaining data representing the location of a distortion or alteration perceived as the individual shifts his vision from said first pattern to said second pattern, the location of said distortion or alteration being marked by said individual on said second pattern as compared to a predefined reference pattern; and
   (f) repeating steps (a) to (e) a number of times while changing the location of the second pattern.

2. The method according to Claim 1, wherein the second pattern and the predefined pattern are not identical.

3. The method according to Claim 2, wherein the predefined pattern comprises a plurality of components and the second pattern is obtained by a modification of the predefined pattern, the modification being selected from the group comprising:

   (i) displacing at least one component of the predefined pattern;
   (ii) removing at least one component of the predefined pattern;
   (iii) blurring at least one component of the predefined pattern; and
   (iv) changing an optical property of at least one component of the predefined pattern.

4. The method according to Claim 1, wherein the predetermined or the second pattern comprises one or more lines.

5. The method according to Claim 4, wherein one or more of the lines is a broken line consisting of a plurality of segments.

6. The method according to Claim 1, wherein the predefined pattern comprises a plurality of identical components.

7. The method according to Claim 1, wherein the predefined pattern comprises a plurality of components at least two of which are not identical.

8. The method according to Claim 1, wherein the second pattern is obtained by rotation and/or translation of the predefined pattern.

9. The method according to Claim 5, wherein gaps between segments are between 0 and 120 minutes arc in length, and each segment has a height and a width between 1 and 120 minutes arc.

10. The method according to Claim 4, wherein the predetermined or the second pattern consists of two or more parallel lines.

11. The method according to Claim 10, wherein the spacing between at least one pair of adjacent parallel lines is from about 10 to about 600 minutes arc.

12. The method according to Claim 1, wherein the step of obtaining data comprises the individual's marking on said second pattern the location of a difference between the predefined pattern and the perceived image.

13. The method according to Claim 12, wherein the difference is selected from the group consisting of:

   (i) a component of the predefined pattern that is displaced in the perceived image;
   (ii) at least one component of the predefined pattern that is missing in the perceived image;
   (iii) at least one component of the predefined pattern that is blurred in the perceived image; and
   (iv) at least one component of the predefined pattern having an altered optical property in the perceived image.

14. The method according to any of claims 1-13, wherein the surface is a surface of a display device.

15. The method according to any of claims 1-14, wherein the step of fixating the individual's vision on a point on the screen comprises the individual's bringing a cursor to the point.

16. The method according to any of claims 1-15, wherein the second pattern appears on the screen upon the individual's clicking a mouse when the cursor is on the point.

17. The method according to any of claims 1-16, wherein the surface forms a visually noisy background to a displayed pattern.

18. The method according to any of claims 15-17, wherein the cursor is restricted to a path adjacent to the pattern.

19. The method according to any of claims 1-18, wherein said data is transmitted over a communication network to a processor and stored in a memory.

20. The method according to any of claims 1-19, wherein the communication network is a computer network such as local area network, a wide area network, the Internet, an intranet, a LAN, a WAN or a PAN.

21. The method according to any of claims 1-20, wherein said data is transmitted over the communication network in real time.

22. The method according to any of claims 1-21, further comprising a step of transmitting over the communication network times at which the method is performed by the individual and storing the times in a memory.

23. The method according to any of claims 1-22, further comprising a step of sending a reminder to the individual to perform the test if the individual fails to perform the test as instructed by a health care provider.

24. The method according to any of claims 1-23, further comprising a step of transmitting over the communication network in real time to a health care provider of results of an analysis of said data.

25. The method according to Claim 1, wherein the first and second patterns are displayed on a display device, the predefined pattern is a broken line comprising a plurality of segments, and the step of obtaining data comprises bringing a cursor to a segment in the second pattern perceived by the individual to be misaligned relative to other segments, blurred relative to other segments, or absent.

26. The method according to Claim 2, wherein the first and second patterns are displayed on a display device, the predefined pattern is a broken line comprising a plurality of segments, the second pattern is obtained from the predefined pattern by misalignment of a segment relative to other segments, blurring of a segment relative to other segments, altering an optical property of a segment, or absence of a segment, and the step of obtaining data comprises bringing a cursor to a segment in the second pattern perceived by the individual to be misaligned relative to other segments, blurred relative to other segments, having altered optical properties, or absent.

27. The method according to Claim 1, wherein steps (a) to (e) are repeated 40 to 80 times.

28. The method according to claim 1, wherein the second pattern and the predefined pattern are substantially identical.

29. A system (105) for eye testing in an individual (100), comprising:

a surface (112) configured to display a first pattern to the individual (100);
a device for fixating the individual's vision on a part or component in said first pattern displayed on the surface (112) and hiding the first pattern after the individual's vision has been fixated on a part or component of the first pattern;
a device (120; 125; 115) for selecting a portion of a pattern displayed on the surface (112); and
a processor (110) configured to carry out steps of:

(i) displaying to the individual a first pattern at a first location on said surface (112);
(ii) determining when the individual's vision is fixated on a part or component in the first pattern;
(iii) hiding the first pattern upon the individual fixating his vision on a part or component in the first pattern;
(iv) displaying a second pattern to the individual at a second location on the surface (112) so as to allow

the individual (100) to form a perceived image, such that said first pattern appears to said individual to jump from said first location to said second location;
(v) obtaining data representing the location of a distortion or alteration perceived as the individual (100) shifts his vision from said first pattern to said second pattern, the location of said distortion or alteration being marked by said individual (100) on said second pattern as compared to a predefined reference pattern; and
(vi) repeating steps (i) to (v) a number of times while changing the location of the second pattern.

30. The system (105) according to Claim 29, wherein the surface (112) is a surface of a display device (115).

31. The system (105) according to any of claims 29-30, wherein the device for fixating the individual's vision on a point of the surface (112) comprises a computer input device such as a computer mouse (125), keyboard (120), joystick, or touch screen (115), operatively moving a cursor (225) on the surface (112).

32. The system (105) according to any of claims 29-31, wherein the device for selecting a portion of a pattern comprises a computer mouse (125) operatively moving a cursor on the surface (112).

33. The system (105) according to any of claims 29-32, wherein the second pattern and the predefined pattern are substantially identical and an eye disease being detected when the perceived image and the predefined pattern are not identical.

34. The system (105) according to any of claims 29-33, wherein the processor (110) is also configured to carry out the step of producing an analysis of the obtained data so as to determine existence, extent, type, or location of an eye disease in the individual.

35. The system (105) according to claim 34, wherein the eye disease is a retinal lesion.

36. The system (105) according to Claim 35, wherein the retinal lesion is AMD or is diabetes related.

37. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for eye testing in an individual, comprising steps of:

(i) displaying to the individual a first pattern at a first location on a surface;
(ii) determining when the individual's vision is fixated on a part or component in the first pattern;
(iii) hiding the first pattern upon the individual fixating his vision on a part or component in the first pattern;
(iv) displaying a second pattern to the individual at a second location on the surface so as to allow the individual to form a perceived image of the second pattern, such that said first pattern appears to said individual to jump from said first location to said second location;
(v) obtaining data representing the location of a distortion or alteration perceived as the individual shifts his vision from said first pattern to said second pattern, the location of said distortion or alteration being marked by said individual on said second pattern as compared to a predefined reference pattern; and
(vi) repeating steps (i) to (v) a number of times while changing the location of the second pattern.

38. A computer program product comprising a computer useable medium having computer readable program code embodied therein for eye testing in an individual, the computer program product comprising:

computer readable program code for causing the computer to display a first pattern to the individual at a first location on a surface;
computer readable program code for causing the computer to determine when the individual's vision is fixated on a part or component in the first pattern and for hiding the first pattern when the individual's vision is fixated on the part or component in the first pattern;
computer readable program code for causing the computer to display a second pattern to the individual at a second location on the surface so as to allow the individual to form a perceived image of the second pattern, such that said first pattern appears to said individual to jump from said first location to said second location;
computer readable program code for causing the computer to obtain data representing the location of a distortion or alteration perceived as the individual shifts his vision from said first pattern to said second pattern, the location of said distortion or alteration being marked by said individual on said second pattern as compared to a predefined reference pattern; and

computer readable program code for causing the computer to repeat the above steps a number of times while changing the location of the second pattern.

Patentansprüche

1. Augentestverfahren, umfassend die Schritte:

   (a) Anzeigen eines ersten Musters an einem ersten Ort auf einer Oberfläche an die Person;
   (b) Fixieren des Blicks der Person auf einen Teil oder eine Komponente in dem ersten Muster;
   (c) Verbergen des ersten Musters;
   (d) Anzeigen eines zweiten Musters an einem zweiten Ort auf der Oberfläche an die Person, um die Person ein wahrgenommenes Bild des zweiten Musters bilden zu lassen, derart, dass der Person das erste Muster von dem ersten Ort zu dem zweiten Ort zu springen erscheint;
   (e) Gewinnen von Daten, welche den Ort einer Verzerrung oder Veränderung repräsentieren, die beim Blickwechsel der Person von dem ersten Muster auf das zweite Muster wahrgenommen wird, wobei der Ort der Verzerrung oder der Veränderung auf dem zweiten Muster im Vergleich zu einem vordefinierten Referenzmuster von der Person markiert wird; und
   (f) mehrmaliges Wiederholen der Schritte (a) bis (e) unter Veränderung des Ortes des zweiten Musters.

2. Verfahren nach Anspruch 1, wobei das zweite Muster und das vordefinierte Muster nicht identisch sind.

3. Verfahren nach Anspruch 2, wobei das vordefinierte Muster eine Mehrzahl von Komponenten umfasst und wobei das zweite Muster durch eine Modifikation des vordefinierten Musters erhalten wird, wobei die Modifikation ausgewählt ist aus der Gruppe, welche umfasst:

   (i) Verschieben mindestens einer Komponente des vordefinierten Musters;
   (ii) Entfernen mindestens einer Komponente des vordefinierten Musters;
   (iii) Verwischen mindestens einer Komponente des vordefinierten Musters; und
   (iv) Verändern einer optischen Eigenschaft mindestens einer Komponente des vordefinierten Musters.

4. Verfahren nach Anspruch 1, wobei das vorbestimmte oder das zweite Muster eine oder mehrere Linien umfasst.

5. Verfahren nach Anspruch 4, wobei eine oder mehrere der Linien eine gebrochene, aus einer Mehrzahl von Segmenten bestehende Linie ist.

6. Verfahren nach Anspruch 1, wobei das vordefinierte Muster eine Mehrzahl von identischen Komponenten umfasst.

7. Verfahren nach Anspruch 1, wobei das vordefinierte Muster eine Mehrzahl von Komponenten umfasst, von denen mindestens zwei nicht identisch sind.

8. Verfahren nach Anspruch 1, wobei das zweite Muster durch Rotation und/oder Translation des vordefinierten Musters erhalten wird.

9. Verfahren nach Anspruch 5, wobei Spalte zwischen Segmenten eine Länge zwischen 0 und 120 Bogenminuten aufweisen und jedes Segment eine Höhe und eine Breite zwischen 1 und 120 Bogenminuten aufweist.

10. Verfahren nach Anspruch 4, wobei das vorbestimmte oder das zweite Muster aus zwei oder mehr parallelen Linien besteht.

11. Verfahren nach Anspruch 10, wobei der Abstand zwischen mindestens einem Paar benachbarter paralleler Linien im Bereich von ungefähr 10 bis ungefähr 600 Bogenminuten liegt.

12. Verfahren nach Anspruch 1, wobei der Schritt des Gewinnens von Daten das Markieren des Orts eines Unterschieds zwischen dem vordefinierten Muster und dem wahrgenommenen Bild auf dem zweiten Muster durch die Person umfasst.

13. Verfahren nach Anspruch 12, wobei der Unterschied ausgewählt ist aus der Gruppe, welche besteht aus:

(i) einer Komponente des vordefinierten Musters, welche in dem wahrgenommenen Bild verschoben ist;
(ii) mindestens einer Komponente des vordefinierten Musters, welche in dem wahrgenommenen Bild fehlt;
(iii) mindestens einer Komponente des vordefinierten Musters, welche in dem wahrgenommenen Bild verwischt ist; und
(iv) mindestens einer Komponente des vordefinierten Musters, welche in dem wahrgenommenen Bild eine veränderte optische Eigenschaft aufweist.

14. Verfahren nach einem der Ansprüche 1-13, wobei die Oberfläche eine Oberfläche einer Anzeigevorrichtung ist.

15. Verfahren nach einem der Ansprüche 1-14, wobei der Schritt des Fixierens des Blicks der Person auf einen Punkt auf dem Bildschirm das Platzieren eines Cursors auf den Punkt durch die Person umfasst.

16. Verfahren nach einem der Ansprüche 1-15, wobei das zweite Muster auf dem Bildschirm erscheint, wenn die Person bei auf dem Punkt befindlichen Cursor mit einer Maus klickt.

17. Verfahren nach einem der Ansprüche 1-16, wobei die Oberfläche einen visuell rauschbehafteten Hintergrund für ein angezeigtes Muster bildet.

18. Verfahren nach einem der Ansprüche 15-17, wobei der Cursor auf einen benachbart zu dem Muster liegenden Pfad beschränkt ist.

19. Verfahren nach einem der Ansprüche 1-18, wobei die Daten über ein Kommunikationsnetzwerk an einen Prozessor übertragen und in einem Speicher gespeichert werden.

20. Verfahren nach einem der Ansprüche 1-19, wobei das Kommunikationsnetzwerk ein Computernetzwerk ist, z.B. ein lokales Netzwerk, ein Weitbereichsnetzwerk, das Internet, ein Intranet, LAN, WAN oder PAN.

21. Verfahren nach einem der Ansprüche 1-20, wobei die Daten in Echtzeit über das Kommunikationsnetzwerk übertragen werden.

22. Verfahren nach einem der Ansprüche 1-21, ferner umfassend einen Schritt des Übertragens von Zeiten, zu denen das Verfahren von der Person ausgeführt wird, über das Kommunikationsnetzwerk und des Speicherns der Zeiten in einem Speicher.

23. Verfahren nach einem der Ansprüche 1-22, ferner umfassend einen Schritt des Sendens an die Person einer Erinnerung, den Test auszuführen, wenn die Person den Test nicht wie von einem Gesundheitsdienstleister angewiesen ausführt.

24. Verfahren nach einem der Ansprüche 1-23, ferner umfassend einen Schritt des Übertragens von Ergebnissen einer Analyse der Daten in Echtzeit über das Kommunikationsnetzwerk an einen Gesundheitsdienstleister.

25. Verfahren nach Anspruch 1, wobei das erste und das zweite Muster an einer Anzeigevorrichtung angezeigt werden, wobei das vordefinierte Muster eine gebrochene, eine Mehrzahl von Segmenten umfassende Linie ist und wobei der Schritt des Gewinnens von Daten das Platzieren eines Cursors auf ein Segment in dem zweiten Muster, welches von der Person in Relation zu anderen Segmenten als fehlausgerichtet, in Relation zu anderen Segmenten als verwischt oder als nicht vorhanden wahrgenommen wird, umfasst.

26. Verfahren nach Anspruch 2, wobei das erste und das zweite Muster an einer Anzeigevorrichtung angezeigt werden, wobei das vordefinierte Muster eine gebrochene, eine Mehrzahl von Segmenten umfassende Linie ist, wobei das zweite Muster aus dem vordefinierten Muster durch Fehlausrichtung eines Segments in Relation zu anderen Segmenten, Verwischen eines Segments in Relation zu anderen Segmenten, Verändern einer optischen Eigenschaft eines Segments oder Nichtvorhandensein eines Segments erhalten wird und wobei der Schritt des Gewinnens von Daten das Platzieren eines Cursors auf ein Segment in dem zweiten Muster, welches von der Person in Relation zu anderen Segmenten als fehlausgerichtet, in Relation zu anderen Segmenten als verwischt, veränderte optische Eigenschaften aufweisend oder nicht vorhanden wahrgenommen wird, umfasst.

27. Verfahren nach Anspruch 1, wobei die Schritte (a) bis (e) 40 bis 80 Mal wiederholt werden.

28. Verfahren nach Anspruch 1, wobei das zweite Muster und das vordefinierte Muster im Wesentlichen identisch sind.

29. System (105) zum Durchführen eines Augentests an einer Person (100), umfassend:

eine Oberfläche (112), welche ausgebildet ist, der Person (100) ein erstes Muster anzuzeigen;
eine Vorrichtung zum Fixieren des Blicks der Person auf einen Teil oder eine Komponente in dem auf der Oberfläche (112) angezeigten ersten Muster und Verbergen des ersten Musters nach erfolgtem Fixieren des Blicks der Person auf einen Teil oder eine Komponente des ersten Musters;
eine Vorrichtung (120; 125; 115) zum Selektieren eines Bereichs eines auf der Oberfläche (112) angezeigten Musters; und
einen Prozessor (110), der ausgebildet ist, folgende Schritte auszuführen:

(i) Anzeigen eines ersten Musters an einem ersten Ort auf der Oberfläche (112) an die Person;
(ii) Bestimmen, wann der Blick der Person auf einen Teil oder eine Komponente in dem ersten Muster fixiert ist;
(iii) Verbergen des ersten Musters, nachdem die Person ihren Blick auf einen Teil oder eine Komponente in dem ersten Muster fixiert hat;
(iv) Anzeigen eines zweiten Musters an einem zweiten Ort auf der Oberfläche (112) an die Person, um die Person (100) ein wahrgenommenes Bild bilden zu lassen, derart, dass der Person das erste Muster von dem ersten Ort zu dem zweiten Ort zu springen erscheint;
(v) Gewinnen von Daten, welche den Ort einer Verzerrung oder Veränderung repräsentieren, die beim Blickwechsel der Person (100) von dem ersten Muster auf das zweite Muster wahrgenommen wird, wobei von der Person (100) der Ort der Verzerrung oder der Veränderung auf dem zweiten Muster im Vergleich zu einem vordefinierten Referenzmuster markiert wird; und
(vi) mehrmaliges Wiederholen der Schritte (i) bis (v) unter Veränderung des Ortes des zweiten Musters.

30. System (105) nach Anspruch 29, wobei die Oberfläche (112) eine Oberfläche einer Anzeigevorrichtung (115) ist.

31. System (105) nach einem der Ansprüche 29-30, wobei die Vorrichtung zum Fixieren des Blicks der Person auf einen Punkt auf der Oberfläche (112) eine einen Cursor (225) auf der Oberfläche (112) operativ bewegende Computereingabevorrichtung umfasst, z.B. eine Computermaus (125), eine Tastatur (120), einen Joystick oder einen Berührungsbildschirm (115).

32. System (105) nach einem der Ansprüche 29-31, wobei die Vorrichtung zum Selektieren eines Bereichs eines Musters eine einen Cursor auf der Oberfläche (112) operativ bewegende Computermaus (125) umfasst.

33. System (105) nach einem der Ansprüche 29-32, wobei das zweite Muster und das vordefinierte Muster im Wesentlichen identisch sind und wobei eine Augenkrankheit detektiert wird, wenn das wahrgenommene Bild und das vordefinierte Muster nicht identisch sind.

34. System (105) nach einem der Ansprüche 29-33, wobei der Prozessor (110) ferner ausgebildet ist, den Schritt des Erzeugens einer Analyse der gewonnenen Daten durchzuführen, um Vorhandensein, Ausmaß, Typ oder Ort einer Augenkrankheit an der Person zu bestimmen.

35. System (105) nach Anspruch 34, wobei die Augenkrankheit eine Retinaläsion ist.

36. System (105) nach Anspruch 35, wobei die Retinaläsion AMD oder diabetesbezogen ist.

37. Maschinenlesbare Programmspeichervorrichtung, welche ein von der Maschine ausführbares Befehlsprogramm materiell verkörpert, um Verfahrensschritte zur Durchführung eines Augentests an einer Person auszuführen, umfassend die Schritte:

(i) Anzeigen eines ersten Musters an einem ersten Ort auf der Oberfläche an die Person;
(ii) Bestimmen, wann der Blick der Person auf einen Teil oder eine Komponente in dem ersten Muster fixiert ist;
(iii) Verbergen des ersten Musters, nachdem die Person ihren Blick auf einen Teil oder eine Komponente in dem ersten Muster fixiert hat;
(iv) Anzeigen eines zweiten Musters an einem zweiten Ort auf der Oberfläche an die Person, um die Person ein wahrgenommenes Bild des zweiten Musters bilden zu lassen, derart, dass der Person das erste Muster

von dem ersten Ort zu dem zweiten Ort zu springen erscheint;
(v) Gewinnen von Daten, welche den Ort einer Verzerrung oder Veränderung repräsentieren, die beim Blickwechsel der Person von dem ersten Muster auf das zweite Muster wahrgenommen wird, wobei von der Person der Ort der Verzerrung oder der Veränderung auf dem zweiten Muster im Vergleich zu einem vordefinierten Referenzmuster markiert wird; und
(vi) mehrmaliges Wiederholen der Schritte (i) bis (v) unter Veränderung des Ortes des zweiten Musters.

38. Computerprogrammprodukt, umfassend ein computergeeignetes Medium mit einem darin verkörperten computerlesbaren Programmcode zum Durchführen eines Augentests an einer Person, wobei das Computerprogrammprodukt umfasst:

computerlesbaren Programmcode, um den Computer zu veranlassen, der Person ein erstes Muster an einem ersten Ort auf einer Oberfläche anzuzeigen;
computerlesbaren Programmcode, um den Computer zu veranlassen, zu bestimmen, wann der Blick der Person auf einen Teil oder eine Komponente in dem ersten Muster fixiert ist, und das erste Muster zu verbergen, wenn der Blick der Person auf den Teil oder die Komponente in dem ersten Muster fixiert ist;
computerlesbaren Programmcode, um den Computer zu veranlassen, der Person ein zweites Muster an einem zweiten Ort auf der Oberfläche anzuzeigen, um die Person ein wahrgenommenes Bild des zweiten Musters bilden zu lassen, derart, dass der Person das erste Muster von dem ersten Ort zu dem zweiten Ort zu springen erscheint;
computerlesbaren Programmcode, um den Computer zu veranlassen, Daten zu gewinnen, welche den Ort einer Verzerrung oder Veränderung repräsentieren, die beim Blickwechsel der Person von dem ersten Muster auf das zweite Muster wahrgenommen wird, wobei von der Person der Ort der Verzerrung oder der Veränderung auf dem zweiten Muster im Vergleich zu einem vordefinierten Referenzmuster markiert wird; und
computerlesbaren Programmcode, um den Computer zu veranlassen, die obigen Schritte unter Veränderung des Ortes des zweiten Musters mehrmals zu wiederholen.

Revendications

1. Procédé de test de l'oeil, comprenant les étapes consistant à:

(a) afficher à l'individu un premier motif à un premier emplacement sur une surface ;
(b) fixer la vision de l'individu sur une partie ou un composant dans le premier motif ;
(c) cacher le premier motif;
(d) afficher un second motif à l'individu à un second emplacement sur la surface afin de permettre à l'individu de former une image perçue du second motif, de sorte que ledit premier motif apparaisse audit individu comme sautant dudit premier emplacement audit second emplacement ;
(e) obtenir des données représentant l'emplacement d'une distorsion ou altération perçue lorsque la vision de l'individu passe dudit premier motif audit second motif, l'emplacement de ladite distorsion ou altération étant marqué par ledit individu sur ledit second motif comparé à un motif de référence prédéfini ; et
(f) répéter les étapes (a) à (e) un certain nombre de fois en changeant l'emplacement du second motif.

2. Procédé selon la revendication 1, dans lequel le second motif et le motif prédéfini ne sont pas identiques.

3. Procédé selon la revendication 2, dans lequel le motif prédéfini comprend une pluralité de composants et le second motif est obtenu par une modification du motif prédéfini, la modification étant sélectionnée dans le groupe comprenant :

(i) le déplacement d'au moins un composant du motif prédéfini ;
(ii) la suppression d'au moins un composant du motif prédéfini ;
(iii) le fait de rendre flou au moins un composant du motif prédéfini ; et
(iv) le changement d'une propriété optique d'au moins un composant du motif prédéfini.

4. Procédé selon la revendication 1, dans lequel le motif prédéterminé ou le second motif comprend une ou plusieurs lignes.

5. Procédé selon la revendication 4, dans lequel une ou plusieurs des lignes sont une ligne brisée composée d'une

pluralité de segments.

6. Procédé selon la revendication 1, dans lequel le motif prédéfini comprend une pluralité de composants identiques.

7. Procédé selon la revendication 1, dans lequel le motif prédéfini comprend une pluralité de composants dont au moins deux ne sont pas identiques.

8. Procédé selon la revendication 1, dans lequel le second motif est obtenu par rotation et/ou translation du motif prédéfini.

9. Procédé selon la revendication 5, dans lequel les espaces entre segments ont une longueur comprise entre 0 et 120 minutes d'arc, et chaque segment a une hauteur et une largeur comprises entre 1 et 120 minutes d'arc.

10. Procédé selon la revendication 4, dans lequel le motif prédéterminé ou le second motif se compose de deux lignes parallèles ou plus.

11. Procédé selon la revendication 10, dans lequel l'espacement entre au moins une paire de lignes parallèles adjacentes est d'environ 10 à environ 600 minutes d'arc.

12. Procédé selon la revendication 1, dans lequel l'étape consistant à obtenir des données comprend l'individu marquant sur ledit second motif l'emplacement d'une différence entre le motif prédéfini et l'image perçue.

13. Procédé selon la revendication 12, dans lequel la différence est sélectionnée dans le groupe comprenant :

(i) un composant du motif prédéfini qui est déplacé dans l'image perçue ;
(ii) au moins un composant du motif prédéfini qui manque dans l'image perçue ;
(iii) au moins un composant du motif prédéfini qui est rendu flou dans l'image perçue ; et
(iv) au moins un composant du motif prédéfini ayant une propriété optique altérée dans l'image perçue.

14. Procédé selon l'une quelconque des revendications 1 à 13, dans lequel la surface est une surface d'un dispositif d'affichage.

15. Procédé selon l'une quelconque des revendications 1 à 14, dans lequel l'étape consistant à fixer la vision de l'individu sur un point sur l'écran comprend l'individu amenant un curseur jusqu'au point.

16. Procédé selon l'une quelconque des revendications 1 à 15, dans lequel le second motif apparaît sur l'écran au moment où l'individu clique sur une souris lorsque le curseur est sur le point.

17. Procédé selon l'une quelconque des revendications 1 à 16, dans lequel la surface forme un arrière-plan visuellement bruyant sur un motif affiché.

18. Procédé selon l'une quelconque des revendications 15 à 17, dans lequel le curseur est restreint à un trajet adjacent au motif.

19. Procédé selon l'une quelconque des revendications 1 à 18, dans lequel lesdites données sont transmises sur un réseau de communication à un processeur et stockées dans une mémoire.

20. Procédé selon l'une quelconque des revendications 1 à 19, dans lequel le réseau de communication est un réseau informatique comme un réseau local, un réseau étendu, Internet, un intranet, un LAN, un WAN ou un PAN.

21. Procédé selon l'une quelconque des revendications 1 à 20, dans lequel lesdites données sont transmises sur le réseau de communication en temps réel.

22. Procédé selon l'une quelconque des revendications 1 à 21, comprenant en outre une étape consistant à transmettre sur le réseau de communication les temps auxquels le procédé est effectué par l'individu et stocker les temps dans une mémoire.

23. Procédé selon l'une quelconque des revendications 1 à 22, comprenant en outre une étape consistant à envoyer

un rappel à l'individu pour effectuer le test si l'individu manque d'effectuer le test comme indiqué par un prestataire de soins de santé.

24. Procédé selon l'une quelconque des revendications 1 à 23, comprenant en outre une étape consistant à transmettre sur le réseau de communication en temps réel à un prestataire de soins de santé les résultats d'une analyse desdites données.

25. Procédé selon la revendication 1, dans lequel les premier et second motifs sont affichés sur un dispositif d'affichage, le motif prédéfini est une ligne brisée comprenant une pluralité de segments, et l'étape consistant à obtenir des données comprend le fait d'amener un curseur jusqu'à un segment dans le second motif perçu par l'individu comme étant désaligné par rapport aux autres segments, flou par rapport aux autres segments, ou absent.

26. Procédé selon la revendication 2, dans lequel les premier et second motifs sont affichés sur un dispositif d'affichage, le motif prédéfini est une ligne brisée comprenant une pluralité de segments, le second motif est obtenu à partir du motif prédéfini par désalignement d'un segment par rapport aux autres segments, flou d'un segment par rapport aux autres segments, altération d'une propriété optique d'un segment, ou absence d'un segment, et l'étape consistant à obtenir des données comprend le fait d'amener un curseur jusqu'à un segment dans le second motif perçu par l'individu comme étant désaligné par rapport aux autres segments, flou par rapport aux autres segments, ayant des propriétés optiques altérées, ou absent.

27. Procédé selon la revendication 1, dans lequel les étapes (a) à (e) sont répétées de 40 à 80 fois.

28. Procédé selon la revendication 1, dans lequel le second motif et le motif prédéfini sont sensiblement identiques.

29. Système (105) pour le test de l'oeil chez un individu (100), comprenant :

une surface (112) configurée pour afficher un premier motif à l'individu (100) ;
un dispositif pour fixer la vision de l'individu sur une partie ou un composant dans ledit premier motif affiché sur la surface (112) et cacher le premier motif après que la vision de l'individu a été fixée sur une partie ou un composant du premier motif ;
un dispositif (120 ; 125 ; 115) pour sélectionner une portion d'un motif affiché sur la surface (112) ; et
un processeur (110) configuré pour effectuer les étapes consistant à :

(i) afficher à l'individu un premier motif à un premier emplacement sur ladite surface (112) ;
(ii) déterminer quand la vision de l'individu est fixée sur une partie ou un composant dans le premier motif ;
(iii) cacher le premier motif au moment où l'individu fixe sa vision sur une partie ou un composant dans le premier motif ;
(iv) afficher un second motif à l'individu à un second emplacement sur la surface (112) afin de permettre à l'individu (100) de former une image perçue, de sorte que ledit premier motif apparaisse audit individu comme sautant dudit premier emplacement audit second emplacement ;
(v) obtenir des données représentant l'emplacement d'une distorsion ou altération perçue lorsque la vision de l'individu (100) passe dudit premier motif audit second motif, l'emplacement de ladite distorsion ou altération étant marqué par ledit individu (100) sur ledit second motif comparé à un motif de référence prédéfini ; et
(vi) répéter les étapes (i) à (v) un certain nombre de fois en changeant l'emplacement du second motif.

30. Système (105) selon la revendication 29, dans lequel la surface (112) est une surface d'un dispositif d'affichage (115).

31. Système (105) selon l'une quelconque des revendications 29 à 30, dans lequel le dispositif pour fixer la vision de l'individu sur un point de la surface (112) comprend un dispositif d'entrée informatique comme une souris d'ordinateur (125), un clavier (120), un joystick, ou un écran tactile (115), déplaçant opérationnellement un curseur (225) sur la surface (112).

32. Système (105) selon l'une quelconque des revendications 29 à 31, dans lequel le dispositif pour sélectionner une portion d'un motif comprend une souris d'ordinateur (125) déplaçant opérationnellement un curseur sur la surface (112).

33. Système (105) selon l'une quelconque des revendications 29 à 32, dans lequel le second motif et le motif prédéfini

sont sensiblement identiques et une maladie de l'oeil est détectée lorsque l'image perçue et le motif prédéfini ne sont pas identiques.

34. Système (105) selon l'une quelconque des revendications 29 à 33, dans lequel le processeur (110) est également configuré pour effectuer l'étape consistant à produire une analyse des données obtenues afin de déterminer l'existence, l'étendue, le type, ou l'emplacement d'une maladie de l'oeil chez l'individu.

35. Système (105) selon la revendication 34, dans lequel la maladie de l'oeil est une lésion rétinienne.

36. Système (105) selon la revendication 35, dans lequel la lésion rétinienne est la DMA ou est liée au diabète.

37. Dispositif de stockage de programme lisible par machine, mettant en oeuvre de manière tangible un programme d'instructions exécutable par la machine pour effectuer les étapes du procédé pour le test de l'oeil chez un individu, comprenant les étapes consistant à :

(i) afficher à l'individu un premier motif à un premier emplacement sur une surface ;
(ii) déterminer quand la vision de l'individu est fixée sur une partie ou un composant dans le premier motif ;
(iii) cacher le premier motif au moment où l'individu fixe sa vision sur une partie ou un composant dans le premier motif ;
(iv) afficher un second motif à l'individu à un second emplacement sur la surface afin de permettre à l'individu de former une image perçue du second motif, de sorte que ledit premier motif apparaisse audit individu comme sautant dudit premier emplacement audit second emplacement ;
(v) obtenir des données représentant l'emplacement d'une distorsion ou altération perçue lorsque la vision de l'individu passe dudit premier motif audit second motif, l'emplacement de ladite distorsion ou altération étant marqué par ledit individu sur ledit second motif comparé à un motif de référence prédéfini ; et
(vi) répéter les étapes (i) à (v) un certain nombre de fois en changeant l'emplacement du second motif.

38. Produit de programme informatique comprenant un support utilisable sur ordinateur ayant un code de programme lisible par ordinateur incorporé à l'intérieur pour le test de l'oeil chez un individu, le produit de programme informatique comprenant :

un code de programme lisible par ordinateur pour amener l'ordinateur à afficher un premier motif à l'individu à un premier emplacement sur une surface ;
un code de programme lisible par ordinateur pour amener l'ordinateur à déterminer quand la vision de l'individu est fixée sur une partie ou un composant dans le premier motif et pour cacher le premier motif lorsque la vision de l'individu est fixée sur une partie ou un composant dans le premier motif ;
un code de programme lisible par ordinateur pour amener l'ordinateur à afficher un second motif à l'individu à un second emplacement sur la surface afin de permettre à l'individu de former une image perçue du second motif, de sorte que ledit premier motif apparaisse audit individu comme sautant dudit premier emplacement audit second emplacement ;
un code de programme lisible par ordinateur pour amener l'ordinateur à obtenir des données représentant l'emplacement d'une distorsion ou altération perçue lorsque la vision de l'individu passe dudit premier motif audit second motif, l'emplacement de ladite distorsion ou altération étant marqué par ledit individu sur ledit second motif comparé à un motif de référence prédéfini ; et
un code de programme lisible par ordinateur pour amener l'ordinateur à répéter les étapes ci-dessus un certain nombre de fois en changeant l'emplacement du second motif.

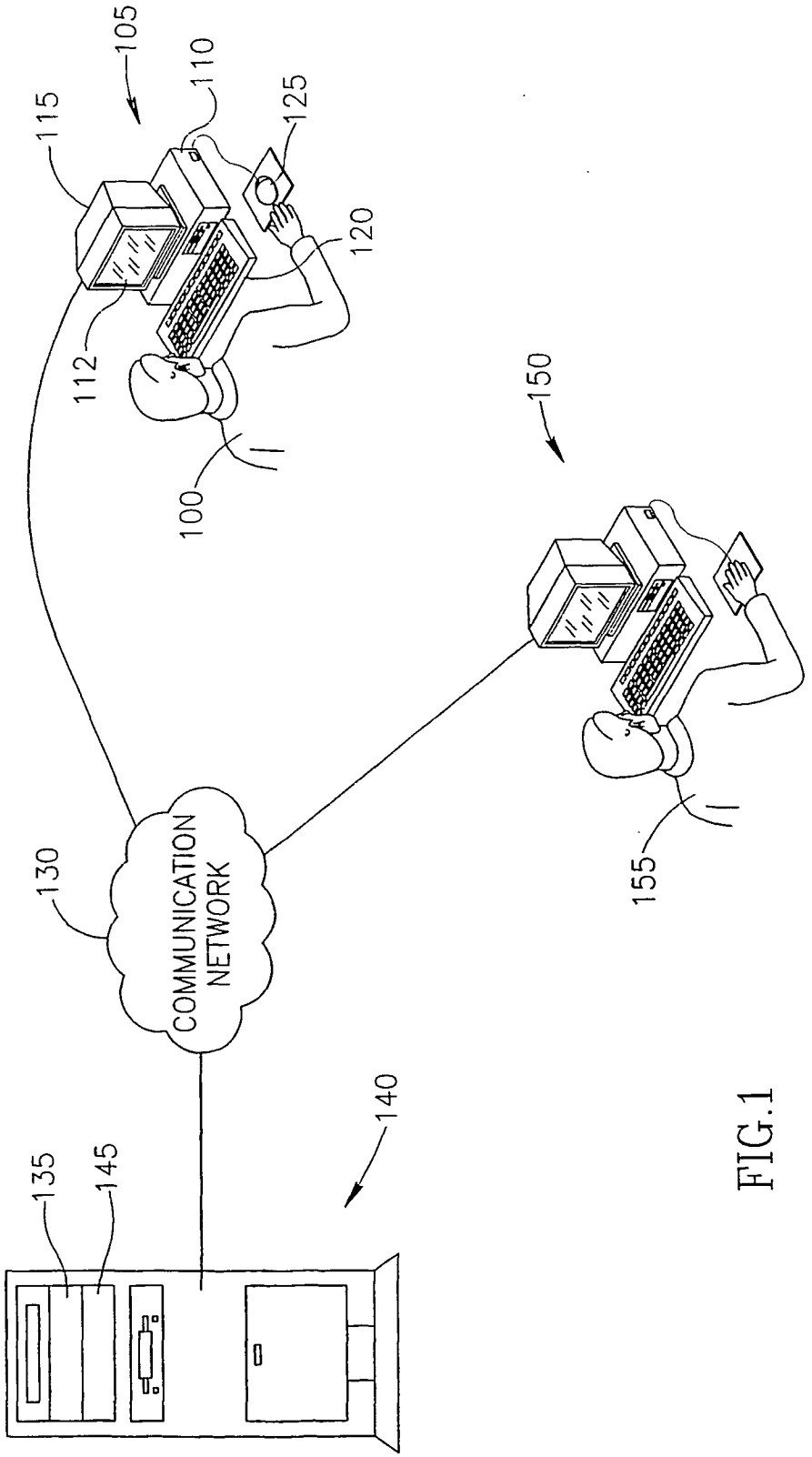
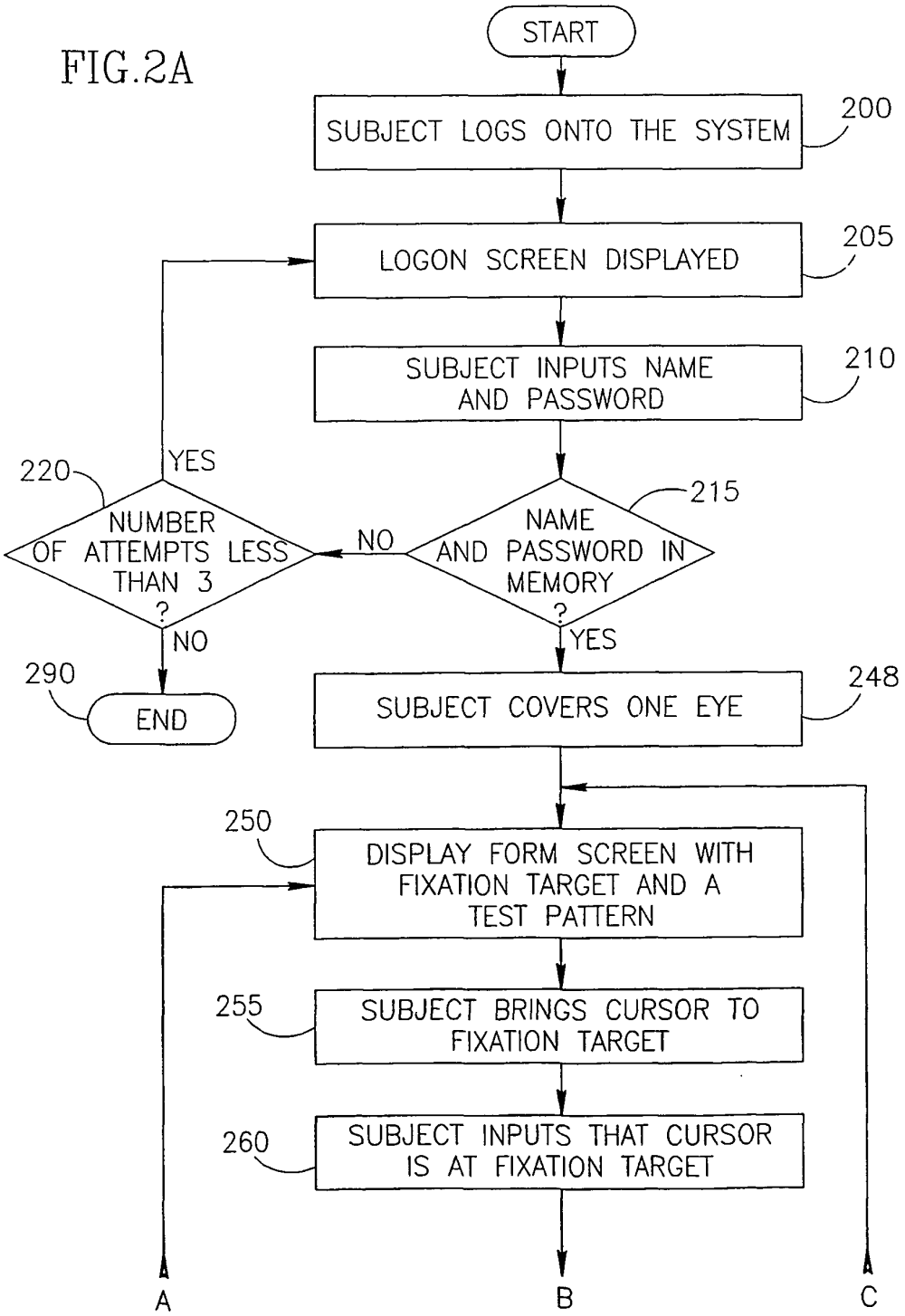

105
110
115
125
120
112
100
150
155
130
COMMUNICATION NETWORK
140
135
145

FIG.1

FIG.2A


START
SUBJECT LOGS ONTO THE SYSTEM
200
LOGON SCREEN DISPLAYED
205
SUBJECT INPUTS NAME AND PASSWORD
210
NAME AND PASSWORD IN MEMORY ?
215
NO
YES
NUMBER OF ATTEMPTS LESS THAN 3 ?
220
YES
NO
END
290
SUBJECT COVERS ONE EYE
248
DISPLAY FORM SCREEN WITH FIXATION TARGET AND A TEST PATTERN
250
SUBJECT BRINGS CURSOR TO FIXATION TARGET
255
SUBJECT INPUTS THAT CURSOR IS AT FIXATION TARGET
260
A
B
C

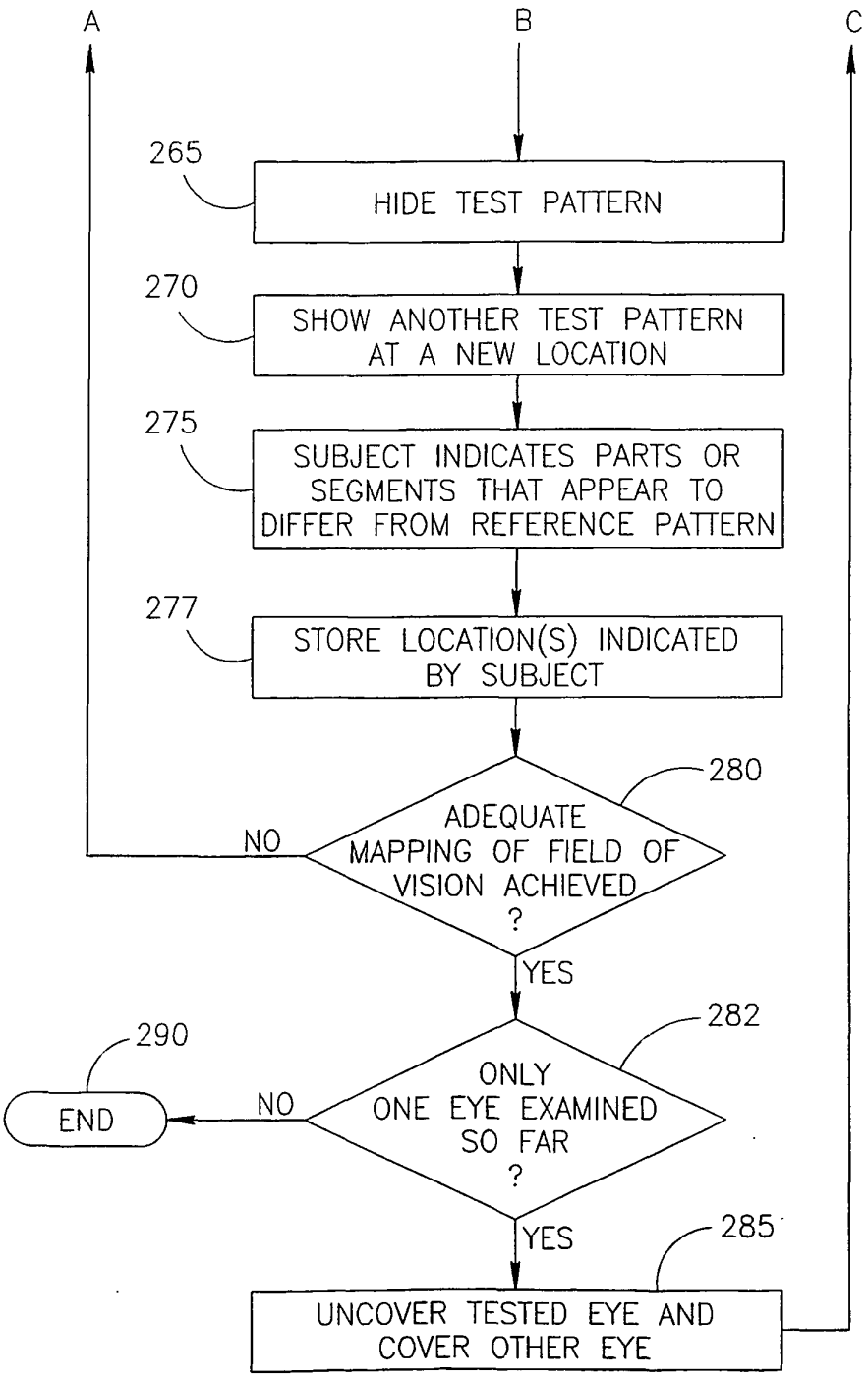

A
B
C
265
HIDE TEST PATTERN
270
SHOW ANOTHER TEST PATTERN AT A NEW LOCATION
275
SUBJECT INDICATES PARTS OR SEGMENTS THAT APPEAR TO DIFFER FROM REFERENCE PATTERN
277
STORE LOCATION(S) INDICATED BY SUBJECT
280
ADEQUATE MAPPING OF FIELD OF VISION ACHIEVED ?
NO
YES
282
ONLY ONE EYE EXAMINED SO FAR ?
290
END
NO
YES
285
UNCOVER TESTED EYE AND COVER OTHER EYE

FIG.2B

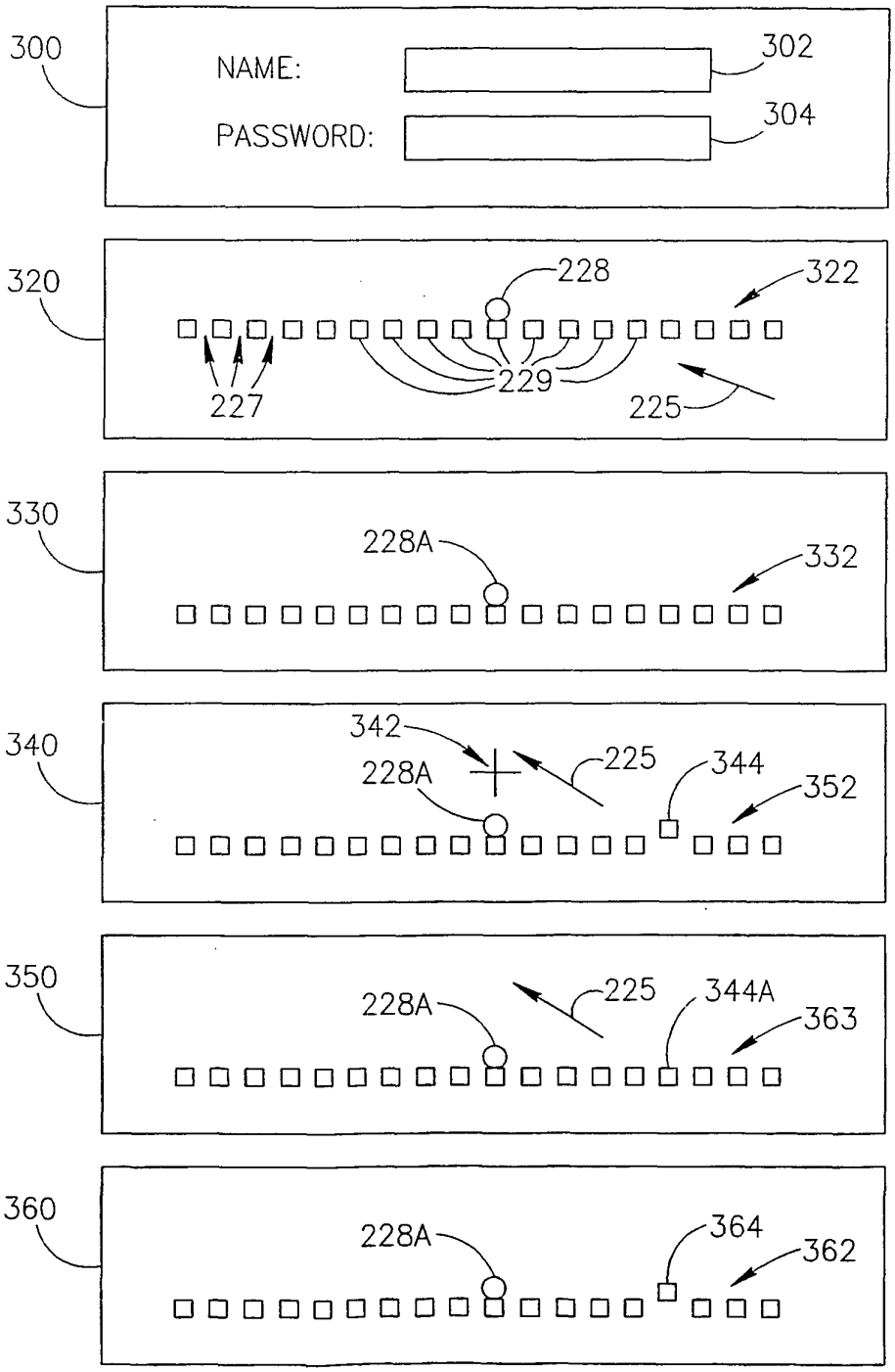

300
NAME:
302
PASSWORD:
304
320
228
322
227
229
225
330
228A
332
340
342
225
228A
344
352
350
228A
225
344A
363
360
228A
364
362

FIG.3

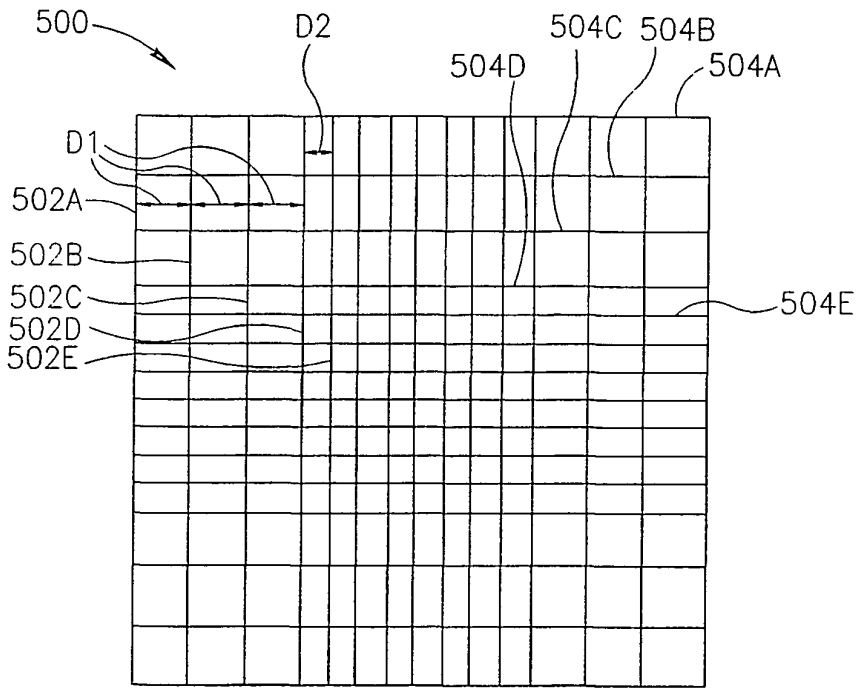

500
D2
504C
504B
504D
504A
D1
502A
502B
502C
502D
502E
504E

FIG.4A

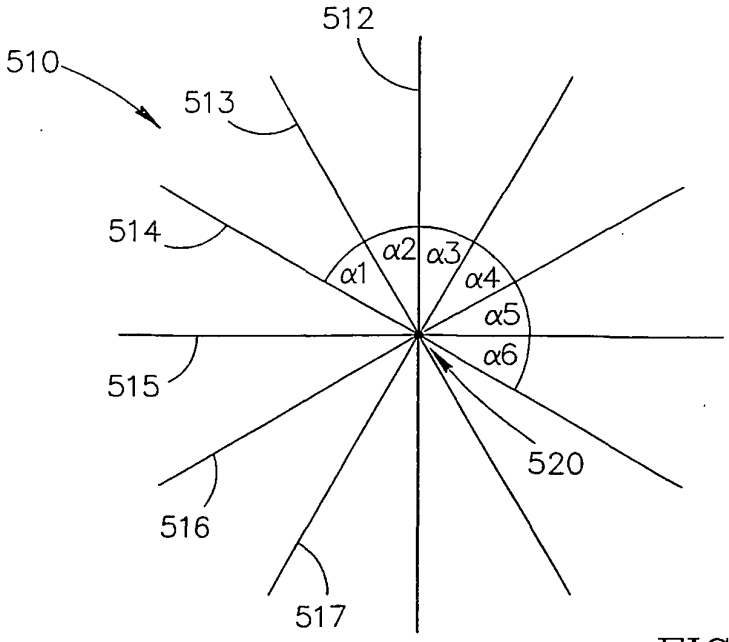

512
510
513
514
α2
α3
α1
α4
α5
α6
515
520
516
517

FIG.4B

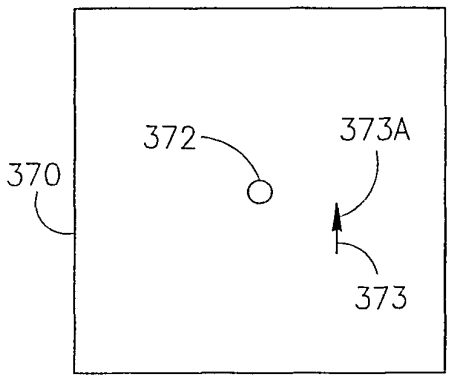


FIG.5A

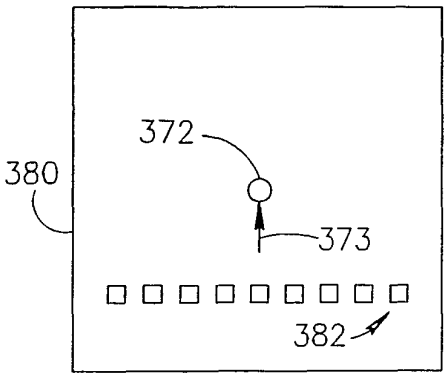


FIG.5B

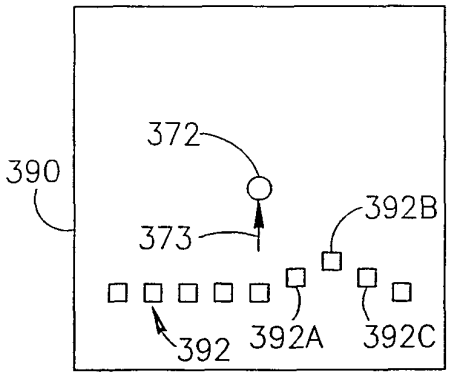


FIG.5C

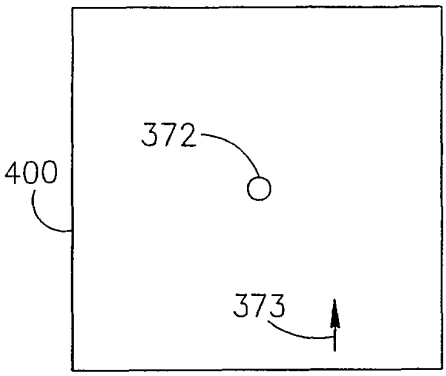


FIG.5D

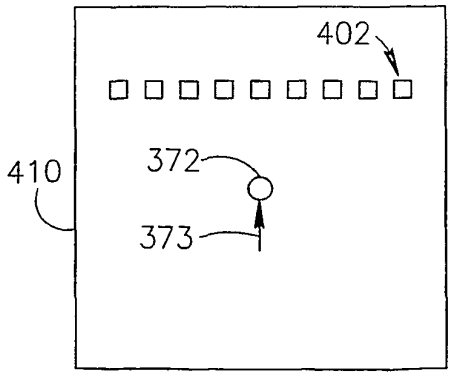


FIG.5E

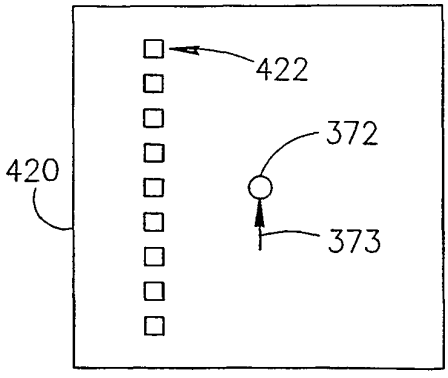


FIG.5F

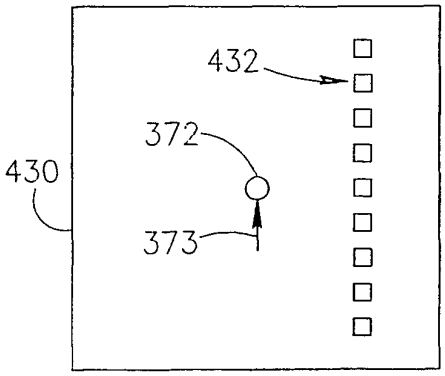


FIG.5G

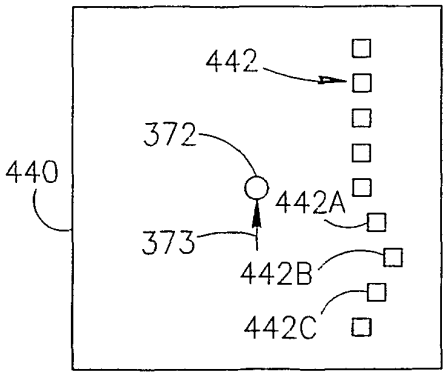


FIG.5H

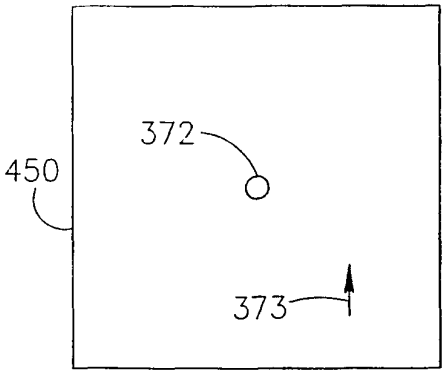


FIG.5I

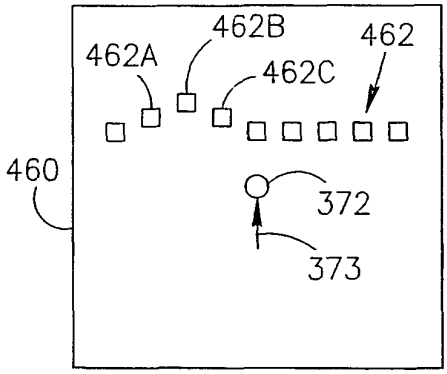


FIG.5J

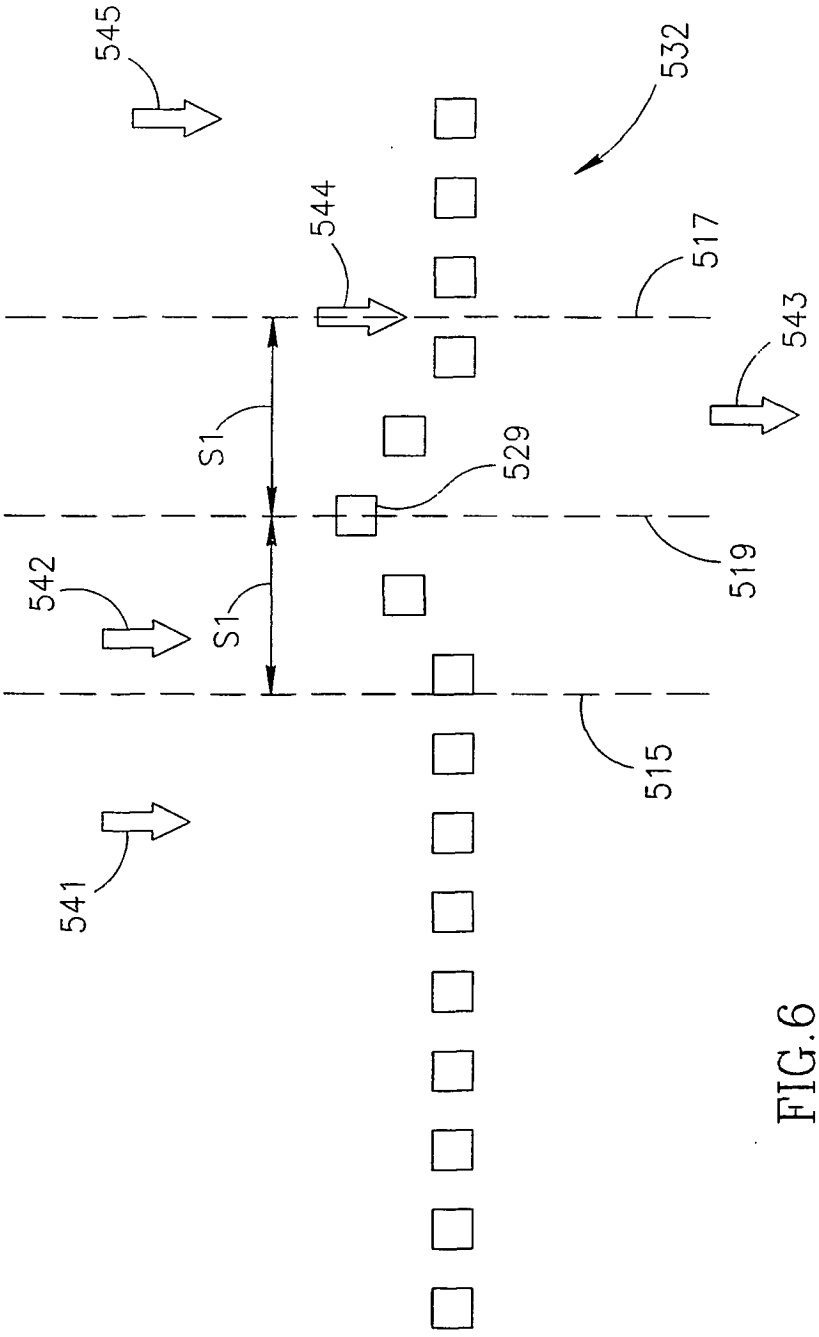


FIG.6

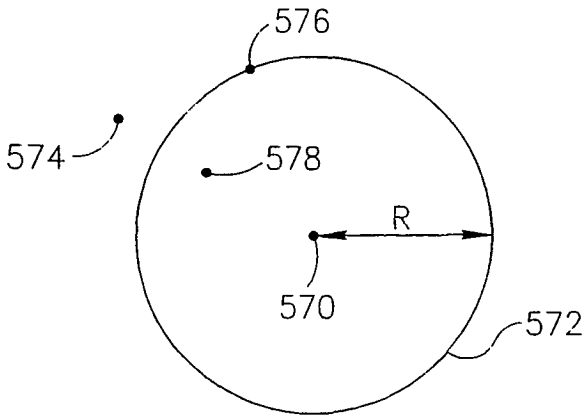


FIG.7A

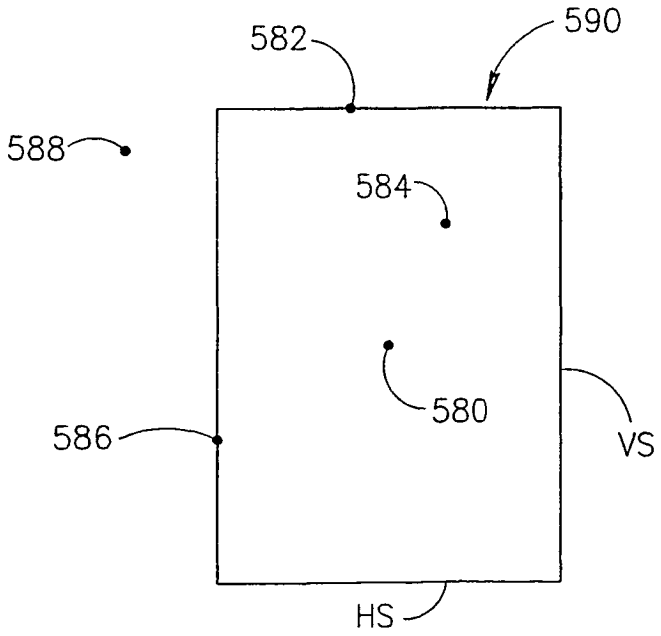


FIG.7B

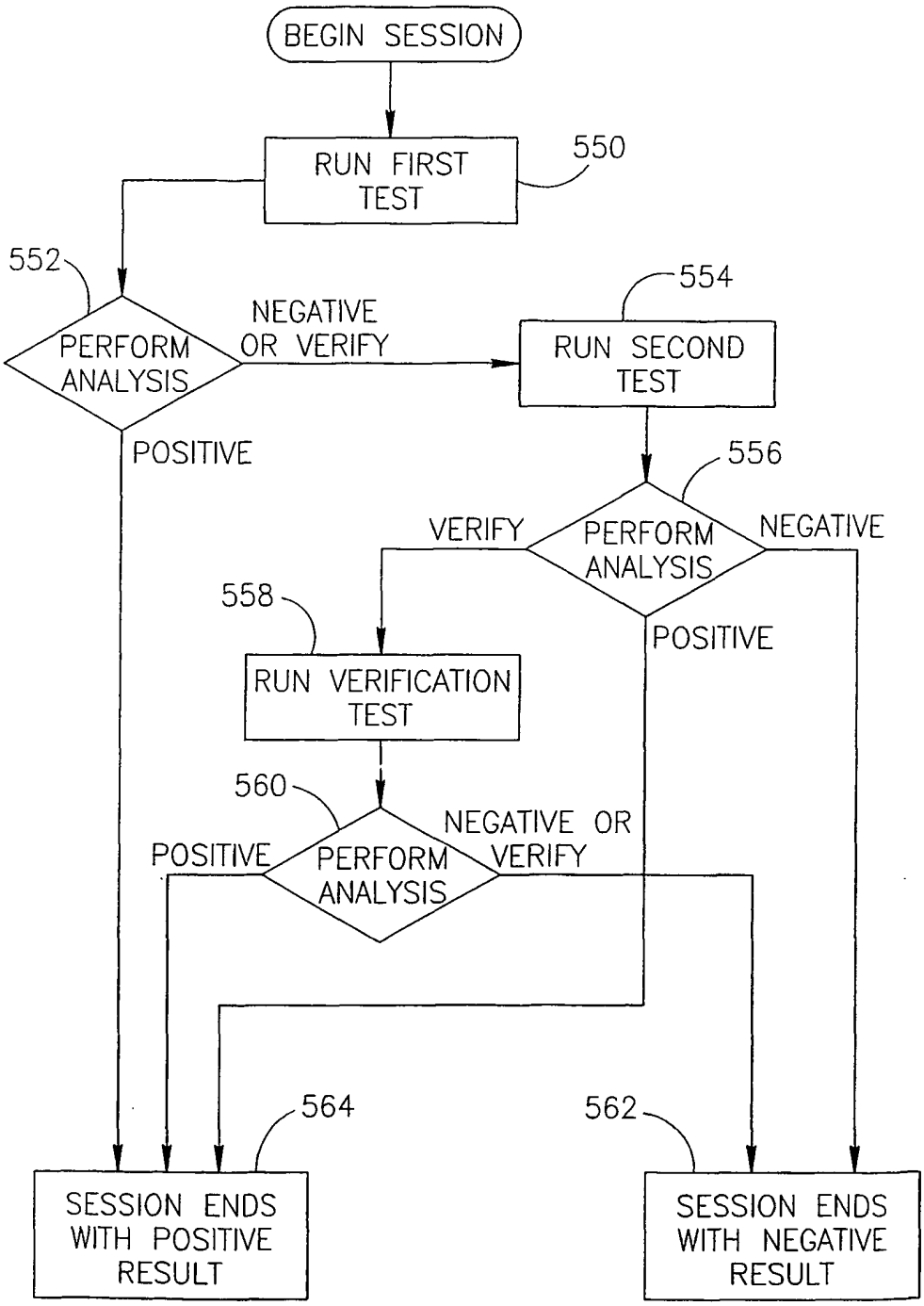

BEGIN SESSION
RUN FIRST TEST
550
552
PERFORM ANALYSIS
NEGATIVE OR VERIFY
554
RUN SECOND TEST
POSITIVE
556
VERIFY
PERFORM ANALYSIS
NEGATIVE
558
RUN VERIFICATION TEST
POSITIVE
560
NEGATIVE OR VERIFY
POSITIVE
PERFORM ANALYSIS
564
562
SESSION ENDS WITH POSITIVE RESULT
SESSION ENDS WITH NEGATIVE RESULT

FIG.8

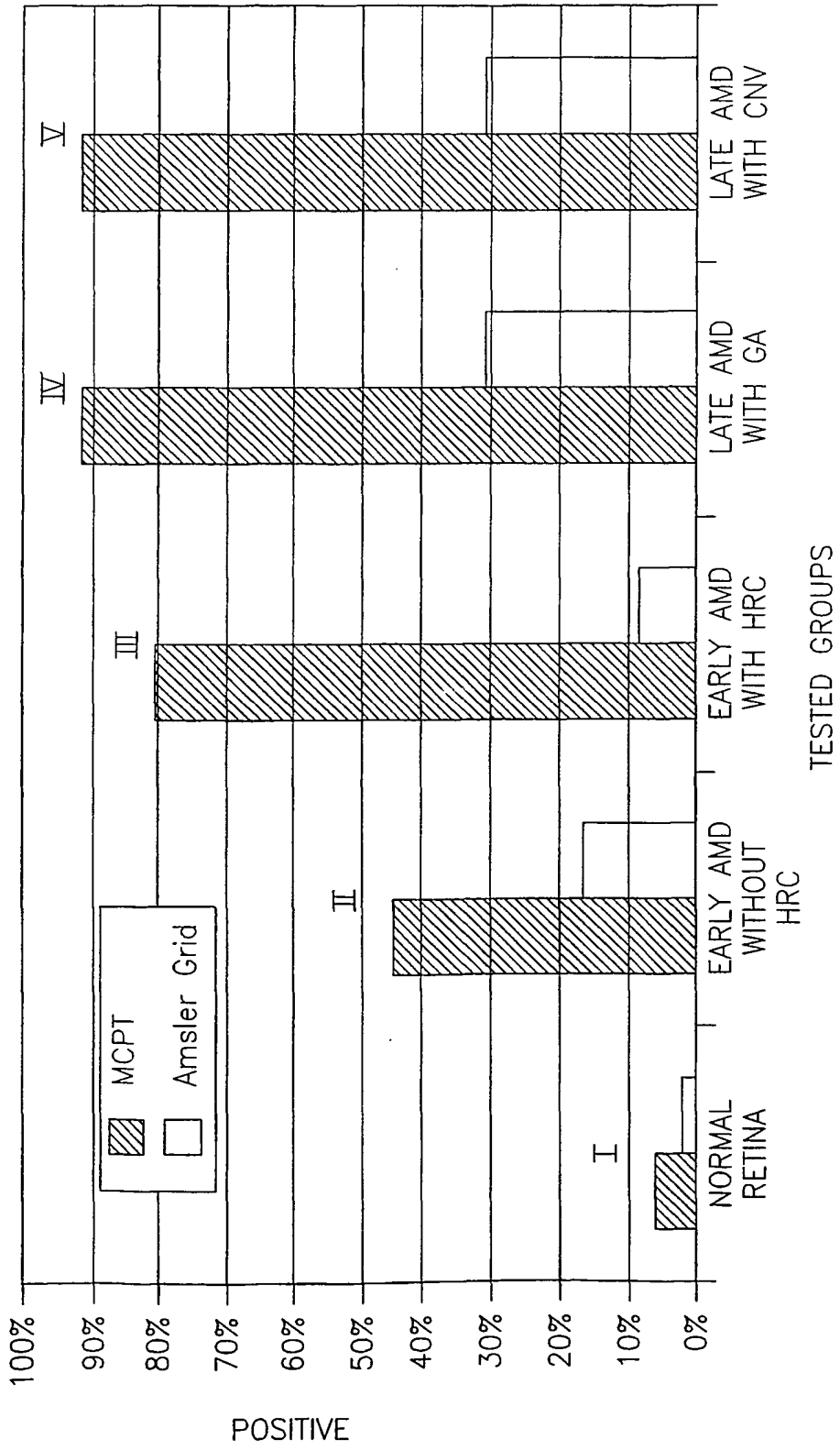

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
POSITIVE
MCPT
Amsler Grid
I
II
III
IV
V
NORMAL RETINA
EARLY AMD WITHOUT HRC
EARLY AMD WITH HRC
LATE AMD WITH GA
LATE AMD WITH CNV
TESTED GROUPS

FIG.9

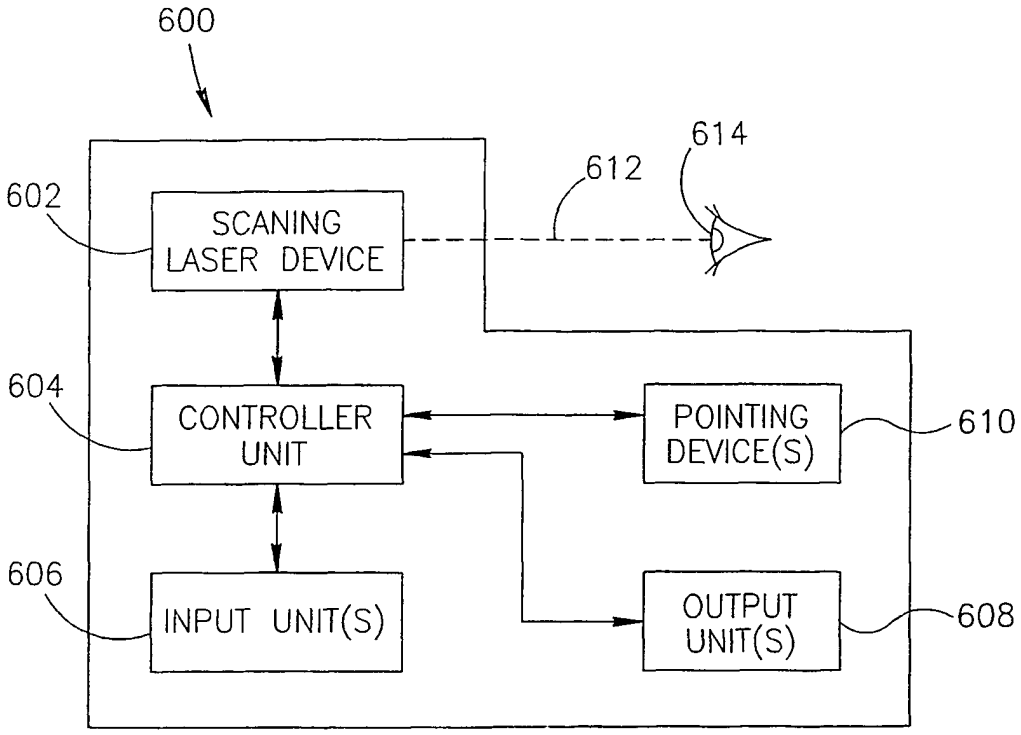

600
614
612
602
SCANING
LASER DEVICE
604
CONTROLLER
UNIT
POINTING
DEVICE(S)
610
606
INPUT UNIT(S)
OUTPUT
UNIT(S)
608

FIG.10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5892570 A **[0002]**
- US 5589897 A **[0002]**

专利名称(译)	方法用于检测眼病的装置和系统		
公开(公告)号	EP1331884B1	公开(公告)日	2011-08-10
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IPC分类号	G06F3/00 A61B3/024 A61B3/06 A61B3/00 A61B3/032 A61B3/10 A61B3/12 A61B5/00		
CPC分类号	A61B5/0002 A61B3/0091 A61B3/024 A61B3/032 A61B3/12		
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优先权	138926 2000-10-06 IL 09/781548 2001-02-13 US		
其他公开文献	EP1331884A4 EP1331884A2		
外部链接	Espacenet		

摘要(译)

一种用于检测眼病的方法和系统。向个人呈现测试模式（322）。个人将眼睛固定在固视目标上（228）。然后隐藏测试图案（322），并且在与呈现第一测试图案（322）的位置不同的位置处显示第二测试图案。然后，个人将他所感知的第二测试模式与预定义的参考模式进行比较。然后重复这些步骤几次，同时改变图案的呈现。然后基于比较确定个体是否患有眼病。或者，个人然后比较简要呈现的模式。然后在改变测试图案的呈现位置的同时重复这些步骤若干次。然后基于比较确定个体是否患有眼病。

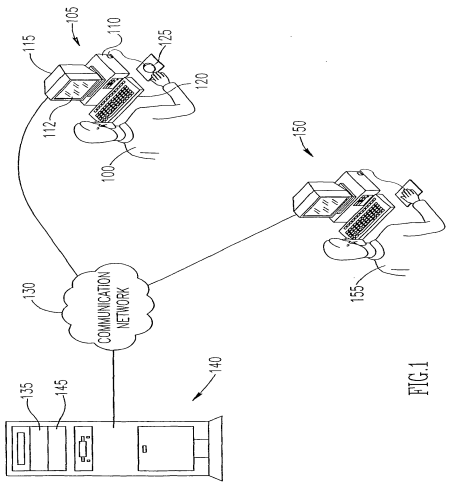

FIG.1