CONTINUOUS VARIFOCAL GLASSES

TECHNICAL FIELD

The present disclosure relates to the technical field of glasses, and in particular, to continuous varifocal glasses.

BACKGROUND

Nowadays, the number of myopic people is increasing, and an increasingly number of adolescents have myopia problems. A main cause of myopia is excessive near vision. Therefore, changing the bad way of using eyes and relieving visual fatigue, to restore the self-adjustment function of the eyeballs, is currently an effective way to alleviate myopia. In addition, performing vision training through an assistive device is also an effective means of quickly correcting pseudomyopia. Therefore, in recent years, more and more devices have been used to improve vision.

Usually, a device used for vision training is an optometric technology product having a core of "intelligent varifocal vision training", a support from "the Internet, the Internet of Things, and big data services", and a basis of dynamic eye adjustment training and visual perception training. The product is aimed at implementing effective prevention and control of myopia in the field of myopia prevention and control through scientific and proper adjustment function training and dynamic visual perception training.

In an "intelligent varifocal vision training" system, the left eye and the right eye each correspond to one lens group. The one lens group is formed by two varifocal lenses that overlap front and rear and that are movable relative to each other. Such a relative movement may be an up and down movement or a left and right movement. Each varifocal lens has free-form surfaces on both sides, and some lenses have a flat surface on one side and a free-form surface on the other side.

The intelligent varifocal glasses includes a free-form-surfaced linear varifocal lens

group and a digital control system. The free-form-surfaced linear varifocal lens group includes two left and right-eye conjoined lenses. Left and right-eye parts of each conjoined lens are free-form surfaces designed with a same geometric function. Two left-right eye conjoined lenses are combined into a lens group. During left and right horizontal movement, in a central overlapping region, the lens group can achieve linear zooming performance measurable by a device. The digital control system is formed by combining a microcontroller, a network communication module, an APP interaction application module, and a mechanical transmission mechanism, so that the mechanical transmission system can implement horizontal movement according to requirements of a set program, where movement parameters include a step distance, a speed, and a reciprocation cycle, and a system for switching a focus during operation progression is also implemented. In addition, all operation data and movement trajectories may be uploaded to a cloud database through an APP interaction system, and a corresponding feedback mechanism is formed, so that an operation state matching a current visual capability of a user is adjusted timely.

A free-form surface of a varifocal lens includes a point P, a region C, a point N, and a region A. The point P is an optical center point corresponding to a maximum positive number of degrees, that is, a position corresponding to a highest point of the free-form surface. The point N is an optical center point corresponding to a maximum negative number of degrees, that is, a position corresponding to a lowest point of the free-form surface. The region C is a continuous zoom channel and is a transition region from the point P with the maximum positive number of degrees to the point N with the maximum negative number of degrees, that is, a transition region of a connecting line between the highest point and the lowest point. The region A is a peripheral aberration region, that is, a region, other than the highest point, the lowest point, and the transition region between the highest point and the lowest point, of the lens.

The Chinese patent (2015202467920, ARBITRARY VARIFOCAL LENS GROUP) provides a lens group, where one surface of each lens is a horizontal surface, and the other surface of the lens is a non-horizontal curved surface that is corrugated in

accordance with mathematical change laws. A highest point and a lowest point are arranged on all non-horizontal curved surfaces of the lenses. A plurality of continuously varying optical centers are evenly distributed between the highest point and the lowest point of the non-horizontal curved surface of the lens and along the non-horizontal curved surface of the lens. Diopters of the plurality of optical centers decrease or increase in sequence.

The Chinese patent (2018104826466, MIRROR IMAGE-DESIGNED DOUBLE-SIDED VARIFOCAL LENS COMBINATION APPARATUS AND COMBINATION METHOD) discloses a mirror image-designed double-sided varifocal lens combination apparatus and a combination method. The apparatus includes two groups of double-sided varifocal lenses. Each group of double-sided varifocal lenses includes two double-sided varifocal lenses. Each double-sided varifocal lens includes two symmetrical mirror image-designed varifocal curved surfaces. In the combination method, two groups of double-sided varifocal lenses are combined and driven by a motor.

The Chinese patent (2021100687112, ZOOM DRIVING APPARATUS FOR INTELLIGENT GLASSES AND INTELLIGENT GLASSES) discloses a zoom driving apparatus for intelligent glasses and intelligent glasses. The apparatus includes a transmission case body, a transmission module, and a lens mounting assembly. The transmission module is mounted to be transmission-connected to the lens mounting assembly, and is mounted into the transmission case body together with the lens mounting assembly. The lens mounting assembly includes a sliding table and a lens mounting table. The sliding table is mounted on a screw rod driving assembly. The lens mounting table is detachably arranged on a slide groove at the bottom of the transmission case body and is slidable along a direction of the slide groove. The bottom of the sliding table is connected to the top of the lens mounting table by a snap-fit member. The transmission module drives the sliding table to actuate the lens mounting table to slide, to change a degree of overlapping between two, front and rear groups of lenses mounted on the lens mounting table, thereby achieving zooming of the glasses.

The existing varifocal glasses have the following defects:

1. Although the existing varifocal glasses can achieve zooming, lenses are usually multi-focal lenses and cannot zoom continuously. During cross movement of front and rear lenses, image jumping occurs in an edge region of a specific focal point. In addition, when a lens has different diopters in different regions, which is intolerable to human eyes, large optical aberrations, such as distortions and field curvatures, are presented.

2. For the existing varifocal glasses, a transmission mechanism usually needs to be controlled manually, resulting in a low degree of automation. It is difficult for transmission stability and transmission accuracy in a motor-driven transmission mechanism to meet requirements of precise transmission, which affects stability and motion accuracy of lenses during motion, and affects vision recovery training.

3. When looking at a distant view and a near view, a user requires different numbers of degrees. For the existing varifocal glasses, a varying range of a number of degrees of the smart varifocal glasses cannot be adjusted according to a distance between a target gazed by a user and the eyes, resulting in poor training results, which, therefore, needs to be improved.

SUMMARY OF THE INVENTION

The technical problems to be resolved by the present disclosure are that lenses of existing varifocal glasses cannot continuously zoom, and it is difficult for transmission stability and transmission accuracy of a transmission mechanism to meet requirements of precise transmission, which affects stability and motion accuracy of lenses during movement, and affects vision recovery training.

To resolve the foregoing technical problems, the present disclosure provides continuous varifocal glasses. Lenses are continuous varifocal lenses. Sliders have high stability and motion accuracy during motion. Two lenses have good stability and high movement accuracy during movement, and are more comfortable to use, which is conducive to vision recovery training.

A technical solution adopted by the present disclosure to resolve the foregoing

technical problems is as follows: Continuous varifocal glasses include a body, a transmission mechanism, a control module, two, left and right temples, and nose pads. The two, left and right temples are both connected to the body.

The control module is arranged inside the body. A distance sensor is arranged on a front side of the body. A wear sensor and a three-axis acceleration sensor are further arranged inside the body. The distance sensor, the wear sensor, and the three-axis acceleration sensor are all electrically connected to the control module. The control module is electrically connected to a driving member, to monitor a use status of the continuous varifocal glasses in real time and control the transmission mechanism.

A circuit board is mounted on the body. Two limit switches are arranged on the circuit board. The two limit switches are respectively located at two, front and rear limit positions of motion of one of sliders. Both the limit switches are electrically connected to the control module.

At least one lens group is mounted on the body. Each lens group includes two, a front lens and a rear lens, that are arranged in an overlapping manner and that are movable crosswise. The lenses are both single-sided free-form-surfaced continuous varifocal lenses. Each lens has a flat surface on one side and a free-form surface on the other side. The free-form-surfaced continuous varifocal lens is generated using an inner B-spline surface fitting mathematical model. A surface diopter of a continuous zoom channel of the lens varies continuously.

The control module drives, through the transmission mechanism, the front lens and the rear lens in the lens group, to move crosswise in opposite directions at a same speed, to implement zooming.

A mounting cavity is provided inside the body. The transmission mechanism is arranged inside the mounting cavity. The two lenses are both transmission-connected to the transmission mechanism.

A housing for mounting the transmission mechanism is arranged inside the body. The housing includes an upper shell and a lower shell. The mounting cavity is formed inside the upper shell and the lower shell. The transmission mechanism is arranged

inside the mounting cavity, and the two lenses are both transmission-connected to the transmission mechanism. The transmission mechanism includes the driving member and a transmission member. The transmission member includes two screw rods. Transmission between the driving member and the transmission member is implemented through gear meshing. Sliders threadedly connected to the screw rods are arranged on both the screw rods. The slider includes a slider body and a lens mounting seat. The two lenses are connected to the two lens mounting seats respectively.

In the continuous varifocal glasses of the present disclosure, the two screw rods are transmission-connected to the driving member by gears, leading to high transmission accuracy, and good motion stability of the sliders. In a process in which the sliders move to actuate the two lenses to move, movement stability and movement accuracy of the lenses are also higher. Therefore, in use of the glasses, higher comfort is provided, which is conducive to vision recovery training.

Further, directions of threads of the two screw rods are opposite to each other, to enable the two sliders to move in opposite directions at a same speed under the driving action of the driving member, to actuate the front lens and the rear lens to move in opposite directions at a same speed.

Further, a guiding apparatus and/or an auxiliary guiding apparatus for limiting movement of the lenses is arranged inside the mounting cavity, the guiding apparatus and/or the auxiliary guiding apparatus is arranged parallel to the screw rods, and the guiding apparatus and/or the auxiliary guiding apparatus is slidably connected to the two sliders.

Further, the guiding apparatus includes two guiding shafts arranged parallel to the screw rods, and the two guiding shafts are respectively slidably connected to the two screw rods.

Further, the auxiliary guiding apparatus includes two guiding bars arranged parallel to the screw rods, the slider is provided with a slide groove matching the guiding bar, and the slider slidably matches the guiding bar.

In some embodiments, no guiding shaft is arranged in the guiding apparatus, and

guiding plates are arranged on side surfaces of the lower shell. The guiding apparatus includes sliding blocks arranged on two side surfaces of the slider body and the guiding plates arranged on the side surfaces of the lower shell. The screw rods are parallel to the guiding plates. The guiding plates are arranged at positions corresponding to the sliding blocks. The sliding block snugly fits a neighboring guiding plate and is slidable in an axial direction of the screw rod, to guide the slider.

Further, the slider body is provided with sockets on both left and right side surfaces. The sliding block includes an insert. The insert is formed as an elastic plate. A tab is fixed to a surface of the insert close to the guiding plate. The insert is inserted into the socket. The tab snugly fits the neighboring guiding plate and is slidable in the axial direction of the screw rod.

Further, the slider body is provided with roller mounting cavities on both left and right side surfaces. The sliding block is a roller. The roller is mounted in the roller mounting cavity of the slider body. The roller is rotatably connected to the slider body in the roller mounting cavity. An axis of the roller is perpendicular to an axis of the screw rod, and a rolling surface of the roller snugly fits the neighboring guiding plate and is rollable in the axial direction of the screw rod.

Further, the slider is connected to the lens by two magnetic members.

Further, the lens is fixedly connected to a magnet, another magnet is mounted on the slider, the lens mounting seat of the slider is provided with an assembly groove for assembling a magnetic material, and the lens mounting seat is connected to the lens by magnetic attraction.

Further, the control module is arranged inside the body, a distance sensor is arranged on a front side of the body, a wear sensor is arranged on a rear side of the body, and a three-axis acceleration sensor is further arranged inside the body. The distance sensor, the wear sensor, and the three-axis acceleration sensor are all electrically connected to the control module, and the control module is electrically connected to the driving member, to monitor a use status of the continuous varifocal glasses and control the transmission mechanism.

Further, a circuit board is mounted on the body. Two limit switches are arranged on the circuit board. The two limit switches are respectively located at two, front and rear limit positions of motion of one of the sliders. Both the limit switches are electrically connected to the control module.

Further, the lens group includes two, front and rear, left and right-eye conjoined lenses, and left and right-eye parts of each conjoined lens have free-form surfaces designed with a same geometric function.

Further, the front lens and the rear lens are both single-sided varifocal lenses. Each lens has a flat surface on one side and a free-form surface on the other side.

The continuous varifocal glasses of the present disclosure have the following beneficial effects:

1. Since lenses of the continuous varifocal glasses are both single-sided free-form-surfaced continuous varifocal lenses, when a lens is moved to any fixed position, all diopters of the lens from an optical center of the lens to a zoom channel are equal in both horizontal and vertical directions, and there is no diopter change or image jumping in the pupil regions, and no diopter is zero in the vertical direction.

2. Through cooperation of the control module, the wear sensor, the distance sensor, and the three-axis acceleration sensor, the control module can control the transmission mechanism to automatically adjust positions of the front lens and the rear lens, to make the use more convenient, and also, monitor a use status of the continuous varifocal glasses in real time, to automatically adjust and control an operation mode of the transmission mechanism, thereby enhancing the effect of vision training.

3. Transmission is implemented between the driving member and the two screw rods through gears, and during assembly, it is only necessary to mesh the driving gear with the driven gears, leading to high transmission stability and transmission accuracy, and convenient assembly and disassembly, which is conducive to maintenance of a device and replacement of parts, reduces assembly and disassembly time, and leads to a simple structure and lower costs.

4. Two travel switches are arranged on the circuit board. Initial positions of the

two sliders are located at middle positions of the two screw rods respectively. The two sliders move simultaneously in opposite directions. When the sliders move to the limit positions, that is, positions of the two limit switches, the control module stops moving or controls the driving member to perform driving in an opposite direction, which, compared with limiting by some mechanical structures, has high limitation accuracy, good limitation stability, and low costs.

5. The lens and the slider are connected by magnetic attraction conveniently and detachably, which facilitates assembly, maintenance, and replacement of the device.

6. The slider is guided on both upper and lower sides of the screw rod by the guiding shaft and the guiding bar simultaneously, which improves movement stability and movement accuracy of the slider, and prevents the slider from shaking slightly in the body, to further improve motion stability of the slider, thereby further improving movement stability of the lens and improving comfort of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is further described below with reference to accompanying drawings and embodiments.

FIG. 1 is a schematic diagram of an overall structure of continuous varifocal glasses according to the present disclosure.

FIG. 2 is a schematic structural diagram of a body and a lens mounting seat of continuous varifocal glasses according to the present disclosure.

FIG. 3 is a schematic structural diagram of a transmission mechanism according to the present disclosure.

FIG. 4 is a schematic diagram of assembly of a transmission mechanism according to the present disclosure.

FIG. 5 is a schematic structural diagram of a front lens and a rear lens according to the present disclosure.

FIG. 6 is a diagram of a distribution of regions of a lens according to the present disclosure.

FIG. 7 is a schematic structural diagram of a slider assembly according to Embodiment 2 of the present disclosure.

FIG. 8 is a side view of a slider assembly according to Embodiment 2 of the present disclosure.

FIG. 9 is a schematic structural diagram of a lower shell in Embodiment 2 of the present disclosure.

FIG. 10 is a schematic structural diagram of a slider body in Embodiment 3 of the present disclosure.

FIG. 11 is an enlarged view of A in FIG. 8.

FIG. 12 is a schematic structural diagram of a slider body in Embodiment 4 of the present disclosure.

In the figures: 1. body; 2. temple; 3. nose pad; 4. front lens; 5. rear lens; 6. distance sensor; 7. wear sensor; 8. upper shell; 9. lower shell; 10. motor; 11. first screw rod; 12. second screw rod; 13. first slider; 14. second slider; 15. first gear; 16. second gear; 17. third gear; 18. circuit board; 19. limit switch; 20. first magnet; 21. second magnet; 22. third magnet; 23. fourth magnet; 24. first guiding shaft; 25. first guiding bar; 26. second guiding shaft; 27. second guiding bar; 28. first guiding groove; 29. second guiding groove; 30. sliding block; 301. insert; 302. tab; 31. left side plate; 32. right side plate; 33. middle side plate; 34. guiding plate; 35. slider body; 36. lens mounting seat; 37. socket; 371. recess; 372. avoidance surface; 38. roller mounting cavity; 39. roller.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Embodiments of the present disclosure are described below in detail, and examples of the embodiments are shown in the accompanying drawings, where the same or similar elements or elements having the same or similar functions are denoted by the same or similar reference signs throughout the description. The following embodiments described with reference to the accompanying drawings are exemplary, are intended to describe the present disclosure, and cannot be construed as limitations on the present disclosure.

In the description of the present disclosure, it should be noted that orientations or positional relationships indicated by terms, such as "upper", "lower", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", and "outer", are orientations or positional relationships shown based on the accompanying drawings, are used merely for conveniently describing the present disclosure and simplifying the description, rather than indicating or implying that the indicated apparatuses or elements need to have specific orientations or be constructed and operated in specific orientations, and therefore, should not be construed as limitations on the present disclosure. In addition, a feature indicated by "first" or "second" may explicitly or implicitly include one or more features. In the description of the present disclosure, unless otherwise specified, "a plurality of" means two or more. In the description of the present disclosure, it should be noted that unless explicitly specified or limited otherwise, the terms "mounted", "connected", and "connection" should be understood broadly. For example, a connection may be a fixed connection, a detachable connection, or an integral connection, may be a mechanical connection or an electrical connection, or may be a direct connection, an indirect connection through an intermediary, or internal communication between two components. A person of ordinary skill in the art may understand the specific meanings of the foregoing terms in the present disclosure according to specific situations.

(Embodiment 1)

FIG. 1 to FIG. 6 show an optimal embodiment of the present disclosure. Continually varifocal glasses include a body 1, two, left and right temples 2, and nose pads 3. The nose pads 3 are detachably arranged on a side of the body 1 close to the human body and in the middle of the body 1. Both the left and right temples 2 are elastically hingedly connected to two sides of the body 1. A lens group is further mounted on the body 1. The lens group includes two, front and rear, left and right-eye conjoined lenses. Left and right-eye parts of each conjoined lens may be free-form surfaces designed with a same geometric function such as Zernike polynomials. The two left and right-conjoined lenses are a front lens 4 and a rear lens 5. The front lens 4

and the rear lens 5 are arranged in an overlapping manner front and rear, overlap in some regions, and can horizontally move crosswise left and right. During left-right horizontal cross movement, in a central overlapping region, the lens group can achieve linear zooming performance measurable by a device.

The lenses are all single-sided free-form-surfaced continuous varifocal lenses. Each lens has a flat surface on one side and a free-form surface on the other side. As shown in FIG. 6, a continuous zoom channel is arranged on the side of the free-form surface, and a periphery of the continuous zoom channel is a peripheral aberration region. For the free-form surface in this embodiment, mathematical model fitting is performed on surfaces of the whole free-form-surfaced lens according to a distribution of diopters of points of the single-sided free-form-surfaced lens. A surface diopter of the continuous zoom channel of the lens varies continuously, for which B-spine function fitting and radial base function fitting are suitable. Since a B-spline function fitted curve is infinitely differentiable inside all nodes, in this embodiment, mathematical expressions of a B-spline curve describing a single-sided free-form-surfaced lens are as follow:

$$f(u,\ v) = \sum_{i=0}^{m}\sum_{j=0}^{n} N_{i,k}(u)\, N_{j,k}(v) d_{i,j}$$

$$N_{i,k}(u) = \frac{u - u_i}{u_{i+k} - u_i} N_{i,k-1}(u) + \frac{u_{i+k+1} - u}{u_{i+k+1} - u_{i+1}} N_{i,k-1}(u),\ k \neq 1$$

$$N_{j,k}(v) = \frac{u - u_j}{u_{j+k} - u_j} N_{j,k-1}(v) + \frac{u_{j+k+1} - u}{u_{j+k+1} - u_{j+1}} N_{j,k-1}(v),\ k \neq 1$$

$N_{i,k}(u)$ and $N_{j,k}(v)$ are weight functions in x and y directions in a B-spline surface fitting mathematical model, $d_{i,j}$ is a control point of the free-form surface, m

and n represent quantities of control points, ranges of u and v depend on i and j (where $i \leq u < i+k$ and $j \leq v < j+k$), and in the weight functions $N_{i,k}(u)$ and $N_{j,k}(v)$, i and j are represented as the i^{th} and j^{th} functions, and k represents an order ($k \neq 1$) of the function. If an order of the function $N_{i,k}$ is k, it indicates that each function has a (k–1)-order polynomial. The B-spline function may be considered as a linear combination of a series of control points $d_{i,j}$ and the weight functions $N_{i,k}(u)$ and $N_{l,k}(v)$. In short, all the control points are multiplied by their corresponding weight functions and then summed. The weight functions are pre-designed and related to only the order k. The functions do not change due to a change in the quantities of control points, but can control the quantities of control points $d_{i,j}$, that is, m and n.

A free-form surface model of a specified diopter change is simulated by using the foregoing B-spline surface fitting mathematical model. The single-sided free-form-surfaced continuous varifocal lens is produced by mold casting and computer numerical control cutting.

In this embodiment, except for that linear zooming of the free-form surface has a jump of 0.25 D (±0.25 D) at a zero position (caused by a characteristic of the B-spline function), that is, it is not differentiable at a position of a zero-diopter point, resulting in diopter jumping, all the remaining central regions are differentiable, that is, can achieve linear zooming.

A mounting cavity is provided inside the body 1. A transmission mechanism is arranged inside the mounting cavity. Both the front lens 4 and the rear lens 5 are transmission-connected to the transmission mechanism. A driving member includes a motor 10. Under the driving of the motor 10, the transmission mechanism actuates the front lens 4 and the rear lens 5 to move left and right. The front lens 4 and the rear lens 5 move in opposite directions. The front lens 4 and the rear lens 5 are both single-sided varifocal lenses, and specifically, two surfaces thereof close to each other are flat

surfaces, and two surfaces thereof facing away from each other are free-form surfaces.

A housing for mounting the transmission mechanism is arranged inside the body 1. The housing includes an upper shell 8 and a lower shell 9. A cavity is formed inside the upper shell 8 and the lower shell 9. The transmission mechanism includes the motor 10 and a transmission member mounted inside the cavity. A driving gear is arranged on an output shaft of the motor 10. The driving gear is a first gear 15. The transmission member includes two screw rods. Driven gears are coaxially connected to the two screw rods. The driven gears are meshed with the driving gear. Sliders are arranged on both the screw rods. The slider includes a slider body 35 and a lens mounting seat 36. The lens mounting seat 36 is fixedly connected to below the slider body 35, and the two lenses are connected to the two lens mounting seats 36 respectively.

The two screw rods are a first screw rod 11 and a second screw rod 12 respectively. The driven gear on an end of the first screw rod 11 is a second gear 16. The second gear 16 is coaxially fixedly connected to the first screw rod 11. The first gear 15 is meshed with the second gear 16 to implement a transmission connection between the motor 10 and the first screw rod 11. The driven gear on an end of the second screw rod 12 is a third gear 17. The third gear 17 is coaxially fixedly connected to the second screw rod 12. The third gear 17 is meshed with the first gear 15. A first slider 13 is arranged on the first screw rod 11. The first screw rod 11 passes through the first slider 13 and is threadedly connected to the first slider 13. The first slider 13 is connected to the front lens 4. A second slider 14 is arranged on the second screw rod 12. The second screw rod 12 passes through the second slider 14 and is threadedly connected to the second slider 14. The second slider 14 is connected to the rear lens 5. The first screw rod 11 and the second screw rod 12 have opposite rotation directions. When the motor 10 drives the first screw rod 11 and the second screw rod 12 to rotate, the first slider 13 and the second slider 14 have opposite movement directions.

A circuit board 18 is mounted on the lower shell 9. Two limit switches 19 are arranged on the circuit board 18. The two limit switches 19 are respectively located at two limit positions in front of and behind the first slider 13. The two limit switches 19

are both electrically connected to a control module. The control module is electrically connected to the motor 10.

The slider is connected to the lens by two magnetic members. A first magnet 20 is arranged on the first slider 13. The first slider 13 is provided with a first mounting groove for mounting the first magnet 20. A shape of the first magnet 20 matches that of the first mounting groove. Specifically, the first magnet 20 and the first mounting groove are in a shape of a dovetail, to facilitate assembly, and prevent the first magnet 20 from falling off from the first mounting groove. A second magnet 21 is arranged on the front lens 4. The first magnet 20 and the second magnet 21 are magnetically attracted to each other, to connect the first slider 13 and the front lens 4. A third magnet 22 is arranged on the second slider 14. The second slider 14 is provided with a second mounting groove. A shape of the third magnet 22 matches that of the second mounting groove. A fourth magnet 23 is arranged on the rear lens 5. The third magnet 22 and the fourth magnet 23 are magnetically attracted to each other, to connect the second slider 14 and the rear lens 5.

A guiding apparatus and an auxiliary guiding apparatus for limiting movement of the lenses are further arranged inside the mounting cavity. The guiding apparatus and the auxiliary guiding apparatus are respectively arranged on two sides of the screw rods. The guiding apparatus includes two guiding shafts, which are a first guiding shaft 24 and a second guiding shaft 2 respectively. The first guiding shaft 24 is arranged below the first screw rod 11. The first guiding shaft 24 passes through a through hole of the first slider 13 and is slidably connected to the first slider 13. The second guiding shaft 26 is located below the second screw rod 12. The second guiding shaft 26 passes through a through hole of the second slider 14 and is slidably connected to the second slider 14. The auxiliary guiding apparatus includes two guiding bars, which are a first guiding bar 25 and a second guiding bar 27 respectively. The first guiding bar 25 is located above the first screw rod 11. The first slider 13 slidably cooperates with the first guiding bar 25. The second guiding bar 27 is located above the second screw rod 12. The second slider 14 slidably cooperates with the second guiding bar 27. The upper

shell 8 is provided with three bar-shaped holes. The first guiding bar 25 and the second guiding bar 27 are formed between the three bar-shaped holes. The first slider 13 is provided with a first guiding groove 28 slidably cooperating with the first guiding bar 25, and the second slider 14 is provided with a second guiding groove 29 slidably cooperating with the second guiding bar 27.

The control module is arranged inside the body 1. A distance sensor 6 is arranged on a front side of the body 1. A wear sensor 7 is arranged on a rear side of the body 1. The distance sensor 6 and the wear sensor 7 are both electrically connected to the control module. The control module is electrically connected to the transmission mechanism, to control the transmission mechanism.

In this embodiment, a zoom range of the lens group is +5.00 D (±0.25 D) to –18.00 D (±0.25 D); a zoom mode is that the front lens and the rear lens move horizontally oppositely to each other, to achieve linear zooming in an overlapping region of the lens group; for a distance between the front and rear lenses, adjacent surfaces of the front and rear lenses are flat surfaces, and the distance is 0.2 mm (± 0.05 mm); flatness of flat surface sides of the front and rear lenses is less than or equal to 0.1mm (± 0.05); for displacements of the front and rear lenses, central lines of the front and rear lenses unilaterally move by 11.5 mm, that is, after the front and rear lenses are aligned in the center, the front lens moves leftward by 11.4 mm, and the rear lens moves rightward by 11.5 mm at the same time, and after returning to original points to overlap, the front and rear lenses then move oppositely by 11.5 mm respectively; for a relative movement zoom ratio, when the front and rear lenses move oppositely by 1 mm, the diopter changes by 1.00 D, that is, 1.00 D/mm; for a pupil distance, a designed pupil distance value is 60 mm (±0.25 mm), and a diopter change value falls within a range of 0.50 D (±0.25 D) if a center of optical power moves left and right in a range of 5 mm (±0.25 mm); in a linear zoom region, within a range of 3 mm (±0.1 mm) above and below central axes of front and rear lenses, the diopter change value does not exceed 0.25 D (±0.25); and in a non-linear zoom region, outside a range of 3 mm (±0.1 mm) above and below central axes of the front and rear lenses, the diopter change value exceeds

0.25 D (±0.25), and does not exceed 1.00 D (±0.25D).

The front lens 4 and the rear lens 5 move crosswise left and right, to obtain diopters for different movement distances on the central axes of the lenses, as shown in the following table:

Movement distance	11.5	11	10	9	8	7	6	5	4	3	2	1	
Diopter	–18.00	–17.50 D	–16.50 D	–15.50 D	–14.50 D	–13.50 D	–12.50 D	–11.50 D	–10.50 D	–9.50 D	–8.50 D	–7.50 D	
Movement distance	0 (Center)	–1	–2	–3	–4	–5	–6	–7	–8	–9	–10	–11	–11.5
Diopter:	–6.50 D	–5.50 D	–4.50 D	–3.50 D	–2.50 D	–1.50 D	–0.50 D	0.50 D	1.50 D	2.50 D	3.50 D	4.50 D	5.50 D

(Embodiment 2)

As shown in FIG. 7, FIG. 8, and FIG. 9, Embodiment 2 differs from Embodiment 1 in that: The auxiliary guiding apparatus in Embodiment 1 is not arranged inside the mounting cavity, no guiding shaft is arranged inside the guiding apparatus, and the guiding apparatus arranged inside the mounting cavity for limiting movement of the lens includes sliding blocks 30 arranged on two side surfaces of the slider body 35 and guiding plates 34 arranged on side surfaces of the lower shell 9.

The lower shell 9 includes a left side plate 31, a middle side plate 33, and a right side plate 32 sequentially arranged parallel to each other. A cavity is formed between the left side plate 31 and the middle side plate 33. Another cavity is formed between the middle side plate 33 and the right side plate 32. The two screw rods are respectively arranged inside the two cavities. The guiding plates 34 are arranged on all side surfaces of the left side plate 31, the middle side plate 33, and the right side plate 32 facing toward the two screw rods. The screw rods are parallel to the guiding plates 34.

The guiding plates 34 are arranged at positions corresponding to the sliding blocks 30. The sliding blocks 30 and the guiding plates 34 form the guiding apparatus for movement of the sliders. The sliding block 30 snugly fits a neighboring guiding plate 34 and is slidable in an axial direction of the screw rod.

(Embodiment 3)

As shown in FIG. 10 and FIG. 11, this embodiment differs from Embodiment 2 in that: The slide body 35 is provided with sockets 37 both left and right side surfaces. The socket 37 is a gate-shaped socket, and is provided with recesses 371 extending deeply into the slider body 35 on two sides, and an avoidance surface 372 recessed into the slider body 35 in the middle.

The sliding block 30 includes an insert 301. The insert 301 is formed as an elastic plate. A tab 302 is fixed to a surface of the insert 301 close to the guiding plate 34. The tab 302 is a spheric crown-shaped protrusion, and a protruding surface thereof sliding against the guiding plate 34 is a hemispherical surface. The insert 301 is inserted into the socket 37. The tab 302 snugly fits the neighboring guiding plate 34 and is slidable in the axial direction of the screw rod.

In this embodiment, because the insert 301 is an elastic plate. When the insert 301 is inserted into the socket 37, and the tab 302 abuts against the neighboring guiding plate 34, the insert 301 elastically deforms and slight protrudes toward the avoidance surface 372, to ensure that the tab 302 constantly snugly fits the neighboring guiding plate 34 during motion of the slider, thereby preventing the sliding blocks and the lenses from wobbling or shaking.

(Embodiment 4)

As shown in FIG. 12, this embodiment differs from Embodiment 3 in that: The slider body 35 is provided with roller mounting cavities 38 on both left and right side surfaces. The sliding block 30 is a roller 39. The roller 39 is mounted in the roller mounting cavity 38 of the slider body 35. The roller 39 is rotatably connected to the slider body 35 in the roller mounting cavity 38. An axis of the roller 39 is perpendicular to an axis of the screw rod, and a rolling surface of the roller 39 snugly fits the neighboring guiding plate 34 and is rollable in the axial direction of the screw rod.

In this embodiment, the roller 18 rolls on the guiding plate 5, which reduces mutual wear, and prolongs a service life.

Under the light of the ideal embodiments of the present disclosure, through the

above description, a person skilled in the art may make various changes and modifications without departing from the scope of the technical idea of the present disclosure. The technical scope of the present disclosure is not limited to the content in the description, and the technical scope thereof should be determined according to the scope of the claims.

CLAIMS

What is claimed is:

1. Continuous varifocal glasses, comprising a body (1), a transmission mechanism, a control module, two, left and right temples (2), and nose pads (3), both the temples (2) being hingedly connected to the body (1), the nose pads (3) being mounted in the middle of the body (1), and at least one lens group being mounted on the body (1), each lens group comprising two, a front lens and a rear lens, that arranged in an overlapping manner and that are movable crosswise, wherein

the lenses are both single-sided free-form-surfaced continuous varifocal lenses, each lens has a flat surface on one side and a free-form surface on the other side, the free-form-surfaced continuous varifocal lens is generated using an inner B-spline surface fitting mathematical model, and a surface diopter of a continuous zoom channel of the lens varies continuously;

the control module drives, through the transmission mechanism, the front lens and the rear lens in the lens group to move crosswise in opposite directions at a same speed, to implement zooming;

a housing for mounting the transmission mechanism is arranged inside the body (1), the housing comprises an upper shell (8) and a lower shell (9), a mounting cavity is formed inside the upper shell (8) and the lower shell (9), the transmission mechanism is arranged inside the mounting cavity, and the two lenses are both transmission-connected to the transmission mechanism; the transmission mechanism comprises a driving member and a transmission member, the driving member is connected to a driving gear, the transmission member comprises two screw rods, the two screw rods are each connected to driven gears, and the driving gear is meshed with the driven gears; sliders threadedly connected to the two screw rods are arranged on both the screw rods, the slider comprises a slider body (35) and a lens mounting seat (36), the lens mounting seat (36) is fixedly connected to below the slider body (35), and the two lenses are connected to the two lens mounting seats (36) respectively;

directions of threads of the two screw rods are opposite to each other, to enable the

two sliders to move in opposite directions at a same speed under the driving action of the driving member, to actuate the front lens and the rear lens to move in opposite directions at a same speed; and

a guiding apparatus and/or an auxiliary guiding apparatus for limiting movement of the lenses is arranged inside the mounting cavity, the guiding apparatus and/or the auxiliary guiding apparatus is arranged parallel to the screw rods, and the guiding apparatus and/or the auxiliary guiding apparatus is slidably connected to the two sliders.

2. The continuous varifocal glasses according to claim 1, wherein the guiding apparatus comprises two guiding shafts arranged parallel to the screw rods, and the two guiding shafts are respectively slidably connected to the two screw rods.

3. The continuous varifocal glasses according to claim 1, wherein the auxiliary guiding apparatus comprises two guiding bars arranged parallel to the screw rods, the slider is provided with a slide groove matching the guiding bar, and the slider slidably matches the guiding bar.

4. The continuous varifocal glasses according to claim 1, wherein the lower shell (9) comprises a left side plate (31), a middle side plate (33), and a right side plate (32) sequentially arranged parallel to each other, the two screw rods are respectively arranged a cavity between the left side plate (31) and the middle side plate (33) and a cavity between the middle side plate (33) and the right side plate (32); the guiding apparatus comprises sliding blocks (30) arranged on two side surfaces of the slider body (35), and further comprises guiding plates (34) arranged on the left side plate (31), the middle side plate (33), and the right side plate (32); the screw rods are parallel to the guiding plates (34); the guiding plates (34) are arranged at positions corresponding to the sliding blocks (30), and the sliding block (30) snugly fits a neighboring guiding plate (34) and is slidable in an axial direction of the screw rod.

5. The continuous varifocal glasses according to claim 4, wherein the slider body (35) is provided with sockets (37) on both left and right side surfaces, the sliding block (30) comprises an insert (301), the insert (301) is formed as an elastic plate, a tab (302) is fixed to a surface of the insert (301) close to the guiding plate (34), the insert (301)

is inserted into the socket (37), and the tab (302) snugly fits the neighboring guiding plate (34) and is slidable in the axial direction of the screw rod; and

the socket (37) is a gate-shaped socket, and is provided with recesses (371) extending deeply into the slider body (35) on two sides and an avoidance surface (372) recessed into the slider body (35) in the middle; and the tab (302) is a spheric crown-shaped protrusion, and a protruding surface thereof sliding against the guiding plate (34) is a hemispherical surface.

6. The continuous varifocal glasses according to claim 4, wherein the slider body (35) is provided with roller mounting cavities (38) on both left and right side surfaces, the sliding block (30) is a roller (39), the roller (39) is mounted in the roller mounting cavity (38) of the slider body (35), the roller (39) is rotatably connected to the slider body (35) in the roller mounting cavity (38), an axis of the roller (39) is perpendicular to an axis of the screw rod, and a rolling surface of the roller (39) snugly fits the neighboring guiding plate (34) and is rollable in the axial direction of the screw rod.

7. The continuous varifocal glasses according to claim 1, wherein the lens is fixedly connected to a magnet, another magnet is mounted on the slider, the lens mounting seat (36) of the slider is provided with an assembly groove for assembling a magnetic material, and the lens mounting seat (36) is connected to the lens by magnetic attraction.

8. The continuous varifocal glasses according to claim 1, wherein the control module is arranged inside the body (1), a distance sensor (6) is arranged on a front side of the body (1), a wear sensor (7) is arranged on a rear side of the body (1), a three-axis acceleration sensor is further arranged inside the body (1), the distance sensor (6), the wear sensor (7), and the three-axis acceleration sensor are all electrically connected to the control module, and the control module is electrically connected to the driving member, to monitor a use status of the continuous varifocal glasses and control the transmission mechanism.

9. The continuous varifocal glasses according to claim 1, wherein the lens group comprises two, front and rear, left and right-eye conjoined lenses, and left and right-eye

parts of each conjoined lens have free-form surfaces designed with a same geometric function.