United States Patent Application Publication	20250258381
Kind Code	A1
Publication Date	August 14, 2025
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Electronic Devices With Optical Assembly Positioning Systems

Abstract

A head-mounted device may include optical assemblies for presenting images to a user. Optical assembly positioning systems may be used to adjust the spacing between the optical assemblies to accommodate different interpupillary distances. The optical assembly positioning systems may have motors, shafts rotated by the motors, nuts that receive the shafts and that are moved as the shafts are rotated, and clutches that couple the nuts to the optical assemblies. The clutches may be spring-loaded clutches, magnetic clutches, electrically adjustable clutches, clutches that exhibit fixed clutch holding forces as a function of optical assembly position, and clutches that exhibit varying clutch holding forces as a function of optical assembly position. Electrically adjustable brakes may be used to help secure the optical assemblies in place.

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Family ID: **1000008575263**

Appl. No.: **19/196624**

Filed: **May 01, 2025**

Related U.S. Application Data

parent US continuation 18464172 20230908 parent-grant-document US 12320987 child US 19196624
us-provisional-application US 63502592 20230516

Publication Classification

Int. Cl.: **G02B27/01** (20060101); **G02B7/02** (20210101); **G02B7/12** (20210101); **G02B27/00** (20060101)

U.S. Cl.:

CPC **G02B27/0176** (20130101); **G02B7/022** (20130101); **G02B7/026** (20130101); **G02B7/12** (20130101); G02B27/0093 (20130101); G02B2027/0154 (20130101)

Background/Summary

[0001] This application is a continuation of U.S. patent application Ser. No. 18/464,172, filed Sep. 8, 2023, which claims the benefit of provisional patent application No. 63/502,592, filed May 16, 2023, which are hereby incorporated by reference herein in their entireties.

FIELD

[0002] This relates generally to electronic devices, and, more particularly, to electronic devices such as head-mounted devices.

BACKGROUND

[0003] Electronic devices have components such as displays and lenses. It can be challenging to customize such devices for different users.

SUMMARY

[0004] A head-mounted device may include optical assemblies for presenting images to a user. Optical assembly positioning systems may be used to adjust the spacing between the optical assemblies to accommodate different interpupillary distances.

[0005] Optical assembly positioning systems may have motors to move the optical assemblies. The position systems may have shafts rotated by the motors, nuts that receive the shafts and that are moved as the shafts are rotated, and clutches that couple the nuts to the optical assemblies.

[0006] The clutches may disengage when excess forces are generated on the optical assemblies during unexpected drop events or when the optical assemblies encounter resistance to their movement due to contact with nose surfaces. Positioning system clutches may include spring-loaded clutches, magnetic clutches, electrically adjustable clutches, clutches that exhibit fixed clutch holding forces as a function of optical assembly position, and clutches that exhibit variable clutch holding forces as a function of optical assembly position. If desired, electrically adjustable brakes may be used to help secure optical assemblies in place.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a diagram of an illustrative head-mounted device in accordance with an embodiment.

[0008] FIG. **2** is a diagram of an illustrative clutch with a profiled guide that generates a variable clutch holding force when coupling to an optical assembly in accordance with an embodiment.

[0009] FIG. **3** is a graph showing how the amount of force exerted on an optical assembly due to stretching of housing materials around the optical assembly at the rear of a head-mounted device may vary as a function of optical assembly position within the head-mounted device in accordance with an embodiment.

[0010] FIG. **4** is a diagram of an illustrative variable-force magnetic clutch for coupling an optical assembly to an actuator in accordance with an embodiment.

[0011] FIG. **5** is a cross-sectional side view of an illustrative friction clutch for coupling an optical assembly to an actuator in accordance with an embodiment.

[0012] FIG. **6** is a cross-sectional side view of an illustrative arrangement for mounting an optical assembly positioning motor to a housing with flexible mounts in accordance with an embodiment.

[0013] FIG. **7** is a cross-sectional side view of an illustrative compressible coupler arrangement that adds compliance to an optical assembly positioning system in accordance with an embodiment.

[0014] FIG. **8** is a cross-sectional side view of an illustrative optical assembly positioning system with a brake to help prevent back driving of a leadscrew in accordance with an embodiment.

DETAILED DESCRIPTION

[0015] Electronic devices such as head-mounted devices may have displays for displaying images and lenses that are used in presenting the images to eye boxes for viewing by a user. Different users have different spacings between their eyes, which are sometimes referred to as interpupillary distances. To accommodate users with different interpupillary distances, a head-mounted device may be provided with movable optical assemblies.

[0016] FIG. **1** is a schematic diagram of an illustrative electronic device of the type that may include movable optical assemblies to accommodate different interpupillary distances. Device **10** of FIG. **1** may be a head-mounted device (e.g., goggles, glasses, a helmet, and/or other head-mounted device). In an illustrative configuration, device **10** is a head-mounted device such as a pair of goggles (sometimes referred to as virtual reality goggles, mixed reality goggles, augmented reality glasses, etc.).

[0017] As shown in the illustrative cross-sectional top view of device **10** of FIG. **1**, device **10** may have a housing such as housing **12** (sometimes referred to as a head-mounted support structure, head-mounted housing, or head-mounted support). Housing **12** may include a front portion such as front portion **12**F and a rear portion such as rear portion **12**R. When device **10** is worn on the head of a user, rear portion **12**R rests against the face of the user and helps block stray light from reaching the eyes of the user and nose bridge portion NB of housing **12** rests on the nose of the user.

[0018] Main portion **12**M of housing **12** may be attached to head strap **12**T. Head strap **12**T may be used to help mount main portion **12** on the head and face of a user. Main portion **12**M may have a rigid shell formed from housing walls of polymer, glass, metal, and/or other materials. When housing **12** is being worn on the head of a user, the front of housing **12** may face outwardly away from the user, the rear of housing **12** (and rear portion **12**R) may face towards the user. In this configuration, rear portion **12**R may face the user's eyes located in eye boxes **36**.

[0019] Device **10** may have electrical and optical components that are used in displaying images to eye boxes **36** when device **10** is being worn. These components may include left and right optical assemblies **20** (sometimes referred to as optical modules). Each optical assembly **20** may have an optical assembly support **38** (sometimes referred to as a lens barrel, optical module support, or support structure) and guide rails **22** along which optical assemblies **20** may slide to adjust optical-assembly-to-optical-assembly separation to accommodate different user interpupillary distances.

[0020] Each assembly **20** may have a display **32** that has an array of pixels for displaying images and a lens **34**. Lens **34** may optionally have a removable vision correction lens for correcting user vision defects (e.g., refractive errors such as nearsightedness, farsightedness, and/or astigmatism). In each assembly **20**, display **32** and lens **34** may be coupled to and supported by support **38**. During operation, images displayed by displays **32** may be presented to eye boxes **36** through lenses **34** for viewing by the user.

[0021] Rear portion **12**R may include flexible structures (e.g., a flexible polymer layer, a flexible fabric layer, etc.) so that portion **12**R can stretch to accommodate movement of supports **38** toward and away from each other to accommodate different user interpupillary distances. These flexible portions may sometimes be referred to as a curtain, stretchable fabric curtain, etc.

[0022] The walls of housing **12** may separate interior region **28** within device **10** from exterior region **30** surrounding device **10**. In interior region **28**, optical assemblies **20** may be mounted on guide rails **22**. Guide rails **22** may be attached to central housing portion **12**C. If desired, the outer ends of guide rails **22** may be unsupported (e.g., the outer end portions of rails **22** may not directly contact housing **12**, so that these ends float in interior region **28** with respect to housing **12**).

[0023] Device **10** may include control circuitry and other components such as components **40**. The control circuitry may include storage, processing circuitry formed from one or more microprocessors and/or other circuits. The control circuitry may be used to control any adjustable components in device **10** such as motors, actuators, displays, light-emitting components, audio components, etc. To support communications between device **10** and external equipment, the control circuitry may include wireless communications circuitry. Components **40** may include sensors such as force sensors (e.g., strain gauges, capacitive force sensors, resistive force sensors, etc.), audio sensors such as microphones, touch and/or proximity sensors such as capacitive sensors, optical sensors such as optical sensors that emit and detect light, ultrasonic sensors, and/or other touch sensors and/or proximity sensors, monochromatic and color ambient light sensors, image sensors, sensors for detecting position, orientation, and/or motion (e.g., accelerometers, magnetic sensors such as compass sensors, gyroscopes, and/or sensors such as inertial measurement units that contain some or all of these sensors), radio-frequency sensors, depth sensors (e.g., structured light sensors and/or depth sensors based on stereo imaging devices), optical sensors such as self-mixing sensors and light detection and ranging (lidar) sensors that gather time-of-flight measurements, humidity sensors, moisture sensors, visual inertial odometry sensors, current sensors, voltage sensors, and/or other sensors. In some arrangements, devices **10** may use sensors to gather user input (e.g., button press input, touch input, etc.). Sensors may also be used in gathering environmental motion (e.g., device motion measurements, temperature measurements, ambient light readings, etc.).
[0024] Optical assemblies **20** may have gaze trackers **62** (sometimes referred to as gaze tracker sensors). Gaze trackers **62**, which may operate through lenses **34**, may include one or more light sources such as infrared light-emitting diodes that emit infrared light to illuminate the eyes of a user in eye boxes **36**. Gaze trackers **62** also include infrared cameras for capturing images of the user's eyes and measuring reflections (glints) of infrared light from each of the infrared light sources. By processing these eye images, gaze trackers **62** may track the user's eyes and determine the point-of-gaze of the user. Gaze trackers **62** may also measure the locations of the user's eyes (e.g., the user's eye relief and the user's interpupillary distance).
[0025] To accommodate users with different interpupillary distances (eye-to-eye spacings), the spacing between the left and right optical assemblies **20** in device **10** can be adjusted (e.g., to match or nearly match the user's measured interpupillary distance). Device **10** may have left and right actuators (e.g., motors) such as motors **48**. Each motor **48**, which may include internal gears, may be used to rotate an elongated threaded shaft (screw) such as shaft **44**. A nut **46** is provided on each shaft **44**. The nut has threads that engage the threads on that shaft **44**. When a shaft is rotated, the nut on the shaft is driven in the +X or −X direction (in accordance with whether the shaft is being rotated clockwise or counterclockwise). In turn, this moves the optical assembly **20** that is attached to the nut in the +X or −X direction along its optical assembly guide rail **22**. Each assembly **20** (e.g., support **38**) may have portions that receive one of guide rails **22** so that the assembly is guided along the guide rail. By controlling the activity of motors **48**, the spacing between the left and right optical assemblies of device **10** can be adjusted to accommodate the interpupillary distance of different users. For example, if a user has closely spaced eyes, assemblies **20** may be moved inwardly (towards each other and towards nose bridge portion NB of housing **12**) and if a user has widely spaced eyes, assemblies **20** may be moved outwardly (away from each other).
[0026] When device **10** is being worn by a user, the user's head is located in region **68**. The presence of the user's head (and therefore a determination of whether device **10** is being worn or is unworn) may be made using one or more sensors (e.g., gaze trackers **62**, which may detect the presence of the eyes of the user in eye boxes **36**, rear-facing sensors such as sensor **66** on main housing **12**M, head-facing sensors mounted on strap **12**T such as sensor **64**, and/or other head presence sensors). These sensors may include cameras, light sensors (e.g., visible light or infrared sensors that measure when ambient light levels have dropped due to shadowing by the head of a

user), proximity sensors (e.g., sensors that emit light such as infrared light and that measure corresponding reflected light from a user's head with an infrared light sensor, capacitive proximity sensors, ultrasonic acoustic proximity sensors, etc.), switches and/or other force-sensing sensors that detect head pressure when a user's head is present, and/or other head presence sensors.

[0027] Output from head presence sensors and/or output from gaze trackers **62** may be used in controlling motors **48** to automatically adjust the spacing of optical assemblies **20**. Optical assembly spacing may also be adjusted manually (e.g., by controlling motors **48** using a button such as button **71**).

[0028] When device **10** is being worn and a user's head is present in region **68**, the nose of the user will be present under nose bridge portion NB of housing **12**. When optical assemblies **20** are moved towards each other so that assemblies **20** are spaced apart by an amount that matches or nearly matches the user's interpupillary distance, inner side surfaces **60** of support structures **38** in assemblies **20** will move toward opposing outer side nose surfaces **61** of the user's nose. With sufficient inward movement of assemblies **20**, surfaces **60** may contact and press against nose surfaces **61**. As a result, an outward force on assemblies **20** is created by nose surfaces **61**. To avoid discomfort that might arise if the user's nose is pressed against by more than a desired amount, device **10** may be provided with clutch features to limit inward nose pressure (e.g., to limit inward force by assemblies **20**). For example, a clutch-based coupling system may be used to couple each motor **48** to its corresponding optical assembly **20**.

[0029] With clutch-based coupling systems, clutches are used to limit the amount of inward force that is applied by optical assemblies **20** when assemblies **20** are moved towards nose surfaces **61** by motors **48**. Clutches can also disengage when excessive forces are generated during drop events. Clutches may be based on permanent magnets, electromagnets, springs, electrically controlled electromagnetic components such as solenoids, friction pads, and/or other clutch mechanisms. The clutches may exhibit a fixed holding force or may use variable-force designs to alter the clutch holding force as a function of optical assembly position within device **10**. The optical assembly positioning systems of device **10** may also be provided with electronically controlled brakes to help secure the optical assemblies after position adjustments have been made.

[0030] In the example of FIG. **2**, clutch **70** is a variable force clutch. Variable-force clutch **70** is being used to couple nut **46** to support **38** with a variable holding force. The variable holding force is generated by using a profiled guide to adjust the compression on a spring-loaded pin in the clutch as a function of optical assembly position along the X axis.

[0031] As shown in FIG. **2**, clutch **70** may have an elongated slot or other opening such as opening **80** in which coupling pin **72** slides (e.g., pin **72** may move within opening **80** parallel to the Z axis in this example). Pin **72**, spring **82**, and ball **78** form a spring-loaded pin. Tip **74** of pin **72** is forced towards corresponding recess (notch) **76** of support **38** by spring **82**. This releasably couples pin **72** to support **38**, so that as nut **46** is moved in the +X or −X direction, pin **72** will, in turn, move support **38** in the +X or −X direction. The compression of spring **82** is controlled by the position of ball **78**, which, in turn, is dictated by the shape of profiled guide **86**.

[0032] In the event that more than a threshold amount of force is exerted between pin **72** and support **38** (e.g., due to a drop event on contact between surfaces **60** and **61** during optical assembly positioning operations), the holding force exerted by spring **82** will be momentarily overcome and pin **72** will be released from recess **76**. As a result, support **38** will become decoupled from nut **46** and threaded shaft (leadscrew) **44**. With this type of spring-loaded clutch arrangement, drop events and other unexpected events that lead to excessive force will cause clutch **70** to disengage, thereby helping to prevent damage (e.g., pin **72** will slide out of engagement with support **38**, rather than imparting excessive force on support **38**). Clutch **70** can also disengage when optical assemblies **20** are moved towards each other sufficiently to cause contact between surface **60** and nose surface **61**.

[0033] As shown in FIG. **2**, one end of spring **82** may be coupled to pin **72** and an opposing end of spring **82** may be coupled to ball **78**. As the lateral position of structure **38** is adjusted, ball **78** rides along profiled guide **86**, which may be formed from a non-planar surface in housing **12**. Profiled guide **86** is characterized by profiled (curved) guide surface **84**. At center portions of profiled guide **86**, such as portion P**2**, ball **78** will move in the −Z direction to decompress spring **82** in the spring-loaded pin. This lowers the force exerted by pin **72** on recess **76** of structure **38** and thereby lowers the amount of holding force exhibited by clutch **70**. At the end portions of guide **86**, such as portions P**1** (to the left in FIG. **2**) and P**3** (to the right in FIG. **2**), ball **78** will be forced in the +Z direction to increase the compression of the spring-loaded clutch pin. In particular, the movement of ball **78** will further compress spring **82** and thereby increasing the holding force of clutch **70** (e.g., by more forcefully pressing pin **72** into recess **76**). As this example demonstrates, profiled guide **86** (e.g., a profiled guide formed from housing **12** and/or a guide structure rigidly coupled to housing **12**) may be used to provide clutch **70** with a variable (lateral-position-dependent) coupling force.

[0034] With this arrangement for clutch **70**, more clutch holding force is provided at the left and ends of the lateral travel of support **38** than at the center. The variable clutch force provided by clutch **70** of FIG. **2** may therefore help clutch **70** compensate for variable amounts of lateral force that may be imposed on structure **38** by rear portion **12**R of housing **12**. Rear portion **12**R, which may sometimes be referred to as a flexible curtain, may, as an example, stretch to the left and right as structure **38** is moved to the left and right. When, for example, optical assemblies **20** are moved away from each other, rear portion **12**R will stretch to accommodate this movement. This stretching creates an inward restoring force on structures **38** that may cause each structure **38** to drift inwardly from its intended position. Similarly, when optical assemblies **20** are moved towards each other, rear portion **12**R may stretch in a way that tends to pull structures **38** outwardly away from each other.

[0035] FIG. **3** is a graph showing how the magnitude of the curtain restoring force F (which tends to cause drift in the position of assemblies **20**) may be lowest when each structure **38** is at a central position along rail **22** (e.g., position X**2**, which may correspond to a position at which ball **78** of clutch **70** is at portion P**2** of the profiled guide of FIG. **2**) than when structures **38** have been moved outwardly or inwardly (see, e.g., end positions X**1** and X**3** of FIG. **3**, which may corresponding to positions at which ball **78** is located at portions P**1** and P**3** of FIG. **2**). Accordingly, the holding force of variable-force clutch **70** is larger when the potential drift-inducing force from stretched portion **12**R is larger and the holding force of clutch **70** is smaller when the potential drift-inducing force from stretched portion **12**R is smaller. Variable force clutch arrangements such as these that allow for higher clutch force at the extremes of the lateral travel of assemblies **20** compensate for variable curtain tension without using excessive holding force. This helps ensure that the clutch is not too stiff to release during drop events or events in which there is contact between surfaces **60** and nose surfaces **61**.

[0036] If desired, variable clutch coupling force for coupling nut **46** to structure **38** may be implemented using clutch based on a pair of variable-space magnets. This type of arrangement is shown in FIG. **4**. As shown in FIG. **4**, magnetic clutch **88** may have first magnet **90** and second magnet **92**. Magnets **90** and **92** may be separated by gap W. Magnets **90** and **92** may have opposing polarity. The force with which magnet **90** and magnet **92** attract each other depends on the magnitude of gap W. When gap W is small, the clutch force exhibited by clutch **88** will tend to be large, because magnets **90** and **92** will attract each other strongly. When W is larger, the attractive force between magnets **90** and **92** will be reduced. Ball **78** may be captured and guided by a profiled guide such as profiled guide **86** of FIG. **2** as structure **38** and clutch **88** are moved parallel to the X axis. As ball **78** moves parallel to the Z axis, the position of ball **78** and therefore the position of magnet **90** is adjusted and thus the spacing between magnets **90** and **92** (and therefore the holding force of clutch **88** of FIG. **4**) is adjusted. An electrically adjustable component (e.g., a solenoid coupled to ball **78** such as optional solenoid **79**) may, if desired, be used to adjust the value of gap W in place of using a profiled guide to adjust the position of ball **78** and magnet **90**.

With this type of arrangement, clutch **88** will exhibit an electrically adjustable clutch force.

[0037] If desired, clutches for device **10** may be based on friction pads. A friction clutch arrangement for coupling nut **46** to structure **38** is shown in FIG. **5**. Friction clutch **100** may exhibit a fixed or variable holding force. For example, friction clutch **100** may exhibit a variable holding force that mirrors the curtain force F of FIG. **3** and thereby helps to prevent potential drift in the position of structure **38** when rear portion **12**M of housing **12** is stretched, as described in connection with the graph of FIG. **3**. Fixed holding force arrangements may also be used.

[0038] As shown in FIG. **5**, friction clutch **100** may have a friction pad such as pad **96** coupled to a biasing device such as device **49**. Device **49** may be a non-electrically-controllable (static) biasing device such as a spring, a foam pad, a pair of opposing magnets or other biasing device that pushes pad **96** against planar surface **98** of structure **38** with a fixed biasing force and therefore creates a fixed clutch holding force based on the static friction between pad **96** and structure **38**. Alternatively, device **49** may be an electrically adjustable pad positioner such as a solenoid that pushes shaft **94** and therefore pad **96** against planar surface **98** of structure **38** with a force that is electronically controlled. In this type of variable-force clutch arrangement, the force with which device **49** presses pad **96** against structure **38** in direction Z determines that amount of friction between pad **96** and structure **38** and therefore the amount of clutch holding force exhibited by clutch **100**.

[0039] During a drop event or other high-stress event, sufficient force will be generated to cause pad **96** to overcome its static friction with structure **38** (e.g., clutch **100** will release as pad **96** slips along the surface of structure **38** during a drop). Clutch **100** may also disengage in response to contact between surfaces **60** and nose surfaces **61**. When device **49** is a solenoid or other electrically adjustable actuator that exhibits an electrically adjustable amount of force on pad **96**, the amount of force on pad **96** and therefore the clutch holding force of clutch **100** may be selectively increased and decreased. For example, the holding force may be increased when device **49** and structure **38** are at end positions X**1** and X**3** relative to when device **49** and structure **38** are at center position X**2**, thereby compensating for increased drift-inducing force F at end positions X**1** and X**3** relative to position X**2** that may arise due to the stretching of housing portion **12**M as optical assemblies **20** are moved.

[0040] FIG. **6** shows how motor **48** may be mounted using a flexible mounting structure (e.g., a flexible mount for motor **48** that is based on one or more flexible mounts **102**). Flexible mounts **102** may be formed from springs, elastomeric pads, or other flexible structures that flex when device **10** is subjected to high stress during a drop event. This helps prevent damage to the positioning system formed by motor **48**, threaded shaft **44**, and nut **46**.

[0041] In the example of FIG. **6**, far end FE of threaded shaft **44** is floating and is not coupled to housing **12**. If desired, a flexible spring or other flexible support such as flexible mount **104** of FIG. **7** may be used to help support far end FE of threaded shaft **44**. The example of FIG. **7** also shows how an elastomeric pad, spring, or other flexible mounting member such as flexible mount **106** may be used to mount motor **48** to housing **12**. As with the illustrative motor mounting arrangement of FIG. **6**, this mounting arrangement allows motor **48** to move slightly in the event of high stress due to a drop event, thereby helping to prevent damage to the optical assembly positioning system. As shown in FIG. **7**, motor **48** may rotate shaft **108**, which may, in turn, rotate pad **110**. Compressible coupler **112** (e.g., an elastomeric washer) may be axially compressed between pad **110** and protruding portion (flange) **114** of shaft coupler **110**. In this way, motor **48** is frictionally engaged with shaft **44** and can rotate shaft **44**. In the event that device **10** is dropped, coupler **112** may flex (and spring **104** may flex), thereby further relieving stress and helping to avoid damage.

[0042] To prevent drift in the positions of optical assemblies **20**, it is desirable to prevent back-driving of threaded shaft **44** by nut **46** when structure **38** is subjected to lateral force from a stretched portion of housing portion **12**M. To enhance driving efficiency, threaded shaft **44** may have a relatively coarse thread. This may lead to an enhanced risk of back-driving shaft **44** by nut **46**. To help prevent back-driving in this situation, the optical assembly positioning systems of device **10** may be provided with electrically controlled brakes. As shown in FIG. **8**, for example, electrically controlled brake **120** may have first and second opposing brake pads **122**. Disk **130** may be mounted to threaded shaft **44** and may protrude between pads **122**. Electrically controlled actuator **124** may be used to move pads **122** away from each other in directions **126** (thereby releasing disk **130** and allowing shaft **44** to be rotated freely by motor **48** so that nut **46** can adjust the position of support **38**) and may be used to move pads **122** towards each other in directions **128** (thereby gripping disk **130** and preventing undesired back-driving and rotation of shaft **44**). As this example demonstrates, brake **120** may be released when motor **48** is moving support **38** and may be used to help lock the position of support **38** in place after support **38** has been moved to a desired position. If desired, the surfaces of brake pads **122** and/or the opposing surfaces of disk **130** may be textured (e.g., these surfaces may be knurled). The texture may be tuned to provide sufficient braking friction between pads **122** and disk **130** during normal braking operation, while slipping (and thereby serving as a releasable friction clutch) in the event that device **10** is dropped or otherwise subjected to unexpected excess force (or when there is force on structures **38** due to contact between surfaces **60** and nose surfaces **61**).

[0043] To help protect the privacy of users, any personal user information that is gathered by device **10** may be handled using best practices. These best practices including meeting or exceeding any privacy regulations that are applicable. Opt-in and opt-out options and/or other options may be provided that allow users to control usage of their personal data.

[0044] The foregoing is merely illustrative and various modifications can be made to the described embodiments. The foregoing embodiments may be implemented individually or in any combination.

Claims

1. A head-mounted device, comprising: a head-mounted housing; an optical assembly in the head-mounted housing that is configured to move towards and away from a nose bridge portion along a shaft of the head-mounted housing, wherein the optical assembly includes a lens and a display configured to provide an image to an eye box through the lens; and a variable-force clutch between the optical assembly and the shaft, wherein the variable-force clutch is configured to adjust a holding force between the optical assembly and the shaft based on a position of the optical assembly along the shaft.

2. The head-mounted device of claim 1, wherein the variable-force clutch comprises a spring-loaded pin.

3. The head-mounted device of claim 2, wherein the head-mounted housing comprises a profiled guide, and the spring-loaded pin is configured to move along the profiled guide to provide variable amounts of spring compression to the spring-loaded pin as the optical assembly is moved relative to the nose bridge portion.

4. The head-mounted device of claim 3, wherein the optical assembly has a recess configured to receive the spring-loaded pin, and the profiled guide is formed from a curved surface of the head-mounted housing.

5. The head-mounted device of claim 2, wherein the optical assembly is releasably coupled to the shaft with the spring-loaded pin.

6. The head-mounted device of claim 1, wherein the variable-force clutch comprises first and second magnets.

7. The head-mounted device of claim 6, wherein the first magnet is coupled to the optical assembly, the second magnet is coupled to the shaft, and the first magnet is separated from the second magnet by a gap.

8. The head-mounted device of claim 7, further comprising a profiled guide configured to move the first magnet to change a size of the gap as the optical assembly is moved relative to the nose bridge portion.
9. The head-mounted device of claim 1, wherein the variable-force clutch comprises a friction clutch.
10. The head-mounted device of claim 9, wherein the friction clutch comprises a friction pad configured to press against the optical assembly.
11. The head-mounted device of claim 10, wherein the friction clutch comprises a spring configured to bias the friction pad of the friction clutch towards the optical assembly.
12. The head-mounted device of claim 10, wherein the friction clutch comprises an electrically adjustable solenoid configured to bias the friction pad towards the optical assembly.
13. The head-mounted device of claim 1, further comprising: a motor configured to move the optical assembly along the shaft; and a flexible mount that mounts the motor to the head-mounted housing.
14. The head-mounted device of claim 13, further comprising: a rotatable pad configured to be rotated by the motor; and a compressible coupler compressed between the rotatable pad and a portion of the shaft to frictionally couple the rotatable pad to the shaft.
15. The head-mounted device of claim 1, further comprising: a flexible support coupled between the head-mounted housing and an end portion of the shaft.
16. The head-mounted device of claim 1, further comprising: an electrically adjustable brake configured to control rotation of the shaft.
17. A head-mounted device, comprising: a head-mounted housing; an optical assembly in the head-mounted housing that is configured to move along a shaft, each optical assembly including a lens and a display configured to provide an image to an eye box through the lens; a motor configured to move the optical assembly along the shaft; and a flexible mount coupled between the motor and the head-mounted housing.
18. The head-mounted device of claim 17, wherein the flexible mount comprises a spring or an elastomeric mount.
19. A head-mounted device, comprising: a head-mounted housing; an optical assembly in the head-mounted housing that is configured to move about a shaft, each optical assembly including a lens and a display configured to provide an image to an eye box through the lens; motors configured to rotate the shaft to move the optical assembly; and an electrically adjustable brake configured to control rotation of the shaft.
20. The head-mounted device of claim 19, wherein the electrically adjustable brake comprises: an actuator; at least one brake pad configured to be moved by the actuator; and a disk mounted on the shaft, wherein the actuator is configured to move the at least one brake pad towards and away from the disk.