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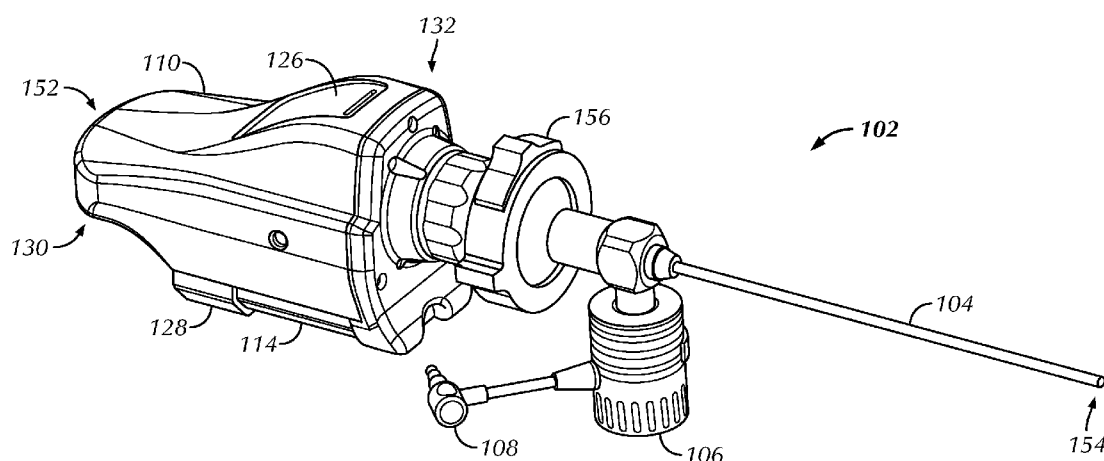


FIG. 2

(57) Abstract: Disclosed embodiments relate to an endoscopic camera and methods for operating the camera. In one embodiment, the endoscopic camera includes a grip region to facilitate holding by a user. The camera may also include a mechanism for correcting improperly exposed video signals by modulating illumination parameters.



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## WIRELESS ENDOSCOPE

### Related Application

[0001] This Application claims priority to U.S. Provisional Patent Application No. 62/385,892 filed on September 9, 2016, which is hereby incorporated by reference in its entirety. Priority is claimed pursuant to 35 U.S.C. § 119 and any other applicable statute.

### Background

[0002] The present disclosure relates generally to endoscopes and components thereof. Although existing endoscopes can be used to visualize a scene of interest during a procedure, there remains a need for new and improved designs. In particular, there remains a need for new systems, devices, and techniques that provide a more ergonomic user experience during endoscopy. There is also a need for systems, devices, and techniques that can reduce excess heat and power consumption of an endoscope. At the same time, there is also a need for systems, devices, and techniques that can offer these advantages without incorporating the same limitations as the existing art.

### Summary

[0003] In one aspect of the present disclosure, a method for visualizing a scene of interest using an endoscope involves advancing a distal end of an endoscope to a scene of interest, illuminating the scene of interest using an illumination source coupled to the endoscope, and capturing a video signal of the scene of interest using a camera coupled to the endoscope. The camera may have one or more video capture characteristics affecting exposure. The method may further include determining that the scene of interest is overexposed or underexposed in the video signal and changing the light output of the illumination source, while maintaining the same video capture characteristics affecting exposure, thereby correcting the overexposure or underexposure.

[0004] Examples of the video capture characteristics affecting exposure of the video signal include, but are not limited to, shutter speed, exposure time, and imaging sensor sensitivity to light. In some embodiments, the video capture characteristics may be set to maximize exposure. Optionally, the method may also involve wirelessly transmitting the video signal to a receiver coupled to a monitor. In some embodiments, the video signal may

be uncompressed. In some embodiments, the camera and the light source are cordless, so that the endoscope is not attached to a separate light box via a cord.

**[0005]** In another aspect of the present disclosure, a method of gripping an endoscope involves gripping the endoscopic camera by placing a hand on a grip member at a first end of the camera. The transmitter of the camera can be located near a second end of the camera, opposite the first end, and the distance between the grip member and the transmitter can be at least 5 cm. The balance point of the camera and the endoscope, when they are coupled together, may be located at the grip member.

**[0006]** In some embodiments, the grip member may include a shoulder, and gripping the endoscopic camera may involve placing a part of the hand against or along the shoulder, thereby facilitating rotation of endoscopic camera. In some embodiments, the grip member may include a ledge extending from the grip member, and gripping the endoscopic camera may involve placing a part of the hand against or along the ledge, thereby facilitating desired distal or proximal motion of endoscopic camera. In some embodiments, the grip member may include an attachment collar, and gripping the endoscopic camera may involve gripping the attachment collar, thereby facilitating user control of the endoscopic camera. In some embodiments, the grip member may include an attachment collar, a shoulder, and a ledge extending from the grip member, and gripping the endoscopic camera may involve gripping the attachment collar, placing a part of the hand against the shoulder, and placing a part of the hand against the ledge, thereby facilitating control of the endoscopic camera.

**[0007]** In another aspect of the present disclosure, a wireless endoscopic camera may include a grip region, a ledge and a wireless transmitter. The grip region is located at a first end of the endoscopic camera and includes a face and an attachment collar extending from the face in a first direction perpendicular to the grip region. The attachment collar is adapted to couple the endoscopic camera to an endoscope. The ledge extends from the grip region in the first direction, below the attachment collar, and is configured to resist movement of the endoscopic camera in a user's hand. The first ledge may include a first concavity and a second concavity separated by a first convexity, where the first and second concavities are adapted to accommodate the user's fingers. The wireless transmitter may be located near a second end of the camera opposite the first end of the camera.

**[0008]** In some embodiments, a distance between the grip region and the wireless transmitter may be at least 5 centimeters. In some embodiments, a balance point of the camera, when attached to the endoscope, is located at the grip member. In some

embodiments, the grip region may include two shoulders. The two shoulders may be configured to resist unwanted rotation of the endoscopic camera in the user's hand.

[0009] In yet another aspect of the present disclosure, a wireless endoscopic camera system may include an endoscopic camera as described above and a light source directly couplable to an endoscope and not requiring connection to a separate light box device. The system may also include a cable for connecting the light source to the endoscopic camera. In one embodiment, the light source is in the form of a cylindrical canister with a port for attaching to the endoscope.

[0010] These and other aspects and embodiments of the present disclosure are described in more detail below, in reference to the attached drawing figures.

### **Brief Description of the Drawings**

[0011] FIG. 1 is a block diagram of an endoscopic camera system, including a wireless endoscope and a viewing station, according to one embodiment;

[0012] FIG. 2 is a perspective view of an endoscopic camera system, according to one embodiment;

[0013] FIG. 3 is a perspective view of an endoscopic camera, according to one embodiment;

[0014] FIG. 4 is a front view of a grip region of the endoscopic camera of FIG. 3;

[0015] FIG. 5 is a side view of a grip region of the endoscopic camera of FIG. 3; and

[0016] FIG. 6 illustrates a front view of the endoscopic camera with labels showing example sizes of various components and portions, according to one embodiment.

[0017] FIG. 7 illustrates a side view of the endoscopic camera with labels showing example sizes of various components and portions, according to one embodiment.

[0018] FIG. 8 illustrates a first example grip on an endoscopic camera, according to one embodiment.

[0019] FIG. 9 illustrates a second example grip on an endoscopic camera, according to one embodiment.

[0020] FIG. 10 illustrates a third example grip on an endoscopic camera, according to one embodiment.

[0021] FIG. 11 illustrates a process for visualizing a scene of interest with an endoscopic camera system, according to one embodiment.

### Detailed Description

[0022] Devices, systems, and methods for endoscopy are disclosed. Endoscopy can be used during medical procedures to visualize a scene of interest and aid a healthcare professional in conducting the procedure. For example, endoscopy can be used to facilitate positioning of a balloon dilation catheter during a procedure to treat sinusitis, such as described in U.S. Patent No. 9,370,650, entitled “Method and Articles for Treating the Sinus System,” which is hereby incorporated herein by reference for any and all purposes.

[0023] Proper visualization of a scene of interest during a procedure can be vitally important. Endoscopes having improved ergonomics can facilitate proper visualization and can contribute to improved patient outcomes. Because wires can limit user mobility, one way to improve ergonomics is to make the endoscope wireless, but the added weight and bulk from batteries and wireless transmitters can present their own ergonomic challenges.

[0024] Embodiments described herein are relevant to improving user control and ergonomics of an endoscope by providing an improved grip region, by which the user can control the device. Further, in some embodiments, the endoscope modulates illumination of the scene of interest to control exposure of the scene, thereby decreasing power consumption and heat output.

[0025] In one embodiment, an endoscopic camera includes a grip region having an attachment collar to which a scope can be coupled. The grip region further includes shoulders and a ledge having concavities. These features can provide points by which a user can grasp and manipulate the device to provide improved control. The grip region can be located a particular distance away from a wireless transmitter of the endoscopic camera.

[0026] In one embodiment, the endoscopic camera has camera settings that control exposure (e.g., exposure time and sensor gain). These settings can be kept at a relatively high level (e.g., tending to overexpose the captured images), and the endoscopic camera can modulate illumination provided by a light connected to the endoscope to correct for improper exposure. Because endoscopes are typically used inside a body cavity, the illumination provided by the endoscope is substantially the only source of illumination to the scene of interest. Therefore, controlling illumination can effectively correct exposure without needing to adjust camera exposure settings. In addition, by keeping camera exposure settings relatively high, the illumination output can be kept relatively low, which can reduce power draw from the light and heat generation. These improvements can allow for a decrease in battery size and lessen the need for heat sinks, thereby contributing to a lighter and less bulky endoscope.

[0027] The visual data captured by the endoscopic camera can be wirelessly transmitted to a receiver for display on a monitor. A user can view the image on the monitor to visualize the scene of interest. The parameters of the endoscopic camera, receiver, and monitor can be selected to reduce a delay between the visual data being generated by a camera sensor and the visual data being displayed at the monitor. For example, the visual data can be uncompressed data, thereby reducing the delay caused by compressing and uncompressing the data. The visual data can be transmitted with limited error correction and limited redundancy, without waiting for missing data and without breaking down large data into individual packets, thereby reducing overhead and latency. In one embodiment, for example, the data is transmitted using the uniform datagram protocol (UDP), rather than the transmission control protocol (TCP), to reduce latency.

[0028] FIG. 1 is a block diagram of one exemplary embodiment of an endoscopic visualization system 100, which includes a wireless endoscopic camera system 102 and a viewing station 160. In general, in this application, the phrase “endoscopic camera system” will refer to an endoscope attached to an endoscopic camera and a light source. However, in various embodiments an endoscopic camera system according to the present application may be provided as only an endoscopic camera, a coupler for attaching the camera to an endoscope, and a light source. In other embodiments, the coupler might not be included in the system. In other words, in some embodiments, an endoscopic camera system may not include the endoscope itself, as this may be provided or available as a separate component. The embodiment shown in FIG. 1 of endoscopic visualization system 100 is a more inclusive system, because it includes endoscopic camera system 102 and viewing station 160. System 100 can be used for visualizing scenes of interest during an endoscopic procedure, such as the examination of sinus passages and cavities. Endoscopic camera system 102 captures video, images and/or other data and transmits the information to viewing station 160 for display.

[0029] Endoscopic camera system 102 includes an endoscope 104, a light 106, a cable 108, and an endoscopic camera 110. Endoscope 104 guides light from a distal end of endoscope 104 near a scene of interest to a proximal end of endoscope 104, to provide a view for capture by endoscopic camera 110. Endoscope 104 includes a port for receiving illumination from light 106, which endoscope 104 uses to illuminate the scene of interest. In various embodiments, endoscope 104 may be flexible or rigid and may have any of a variety shapes and sizes. For example, endoscope 104 can take the form of a scope from the FocESS™ line of sinusscopes, provided by Entellus Medical™ of Plymouth, Minnesota. Because endoscopes are generally well known, and because endoscopic camera system 102

may, in various embodiments, be used with any suitable endoscope 104, this application will not describe endoscope 104 in further detail.

**[0030]** Light 106 is a source of illumination and can be coupled to endoscope 104. Light 106 can include light emitting diodes (LEDs) or other sources of illumination. Light 106 may include associated driver circuitry which is located in the endoscopic camera 110 or is external thereto. Light 106 can include its own power source or can receive power from an external source, such as endoscopic camera 110. For example, light 106 can be coupled to endoscopic camera 110 via cable 108. Light 106 can have adjustable illumination settings. For example, such illumination settings may be adjustable by a signal (e.g., a signal from endoscopic camera 110), by a control panel on light 106, or in another manner.

**[0031]** Endoscopic camera 110 captures a view (e.g., a view transmitted by endoscope 104) as video, images, or other data. Endoscopic camera 110 includes a camera 112, a battery 114, and a wireless transmitter 116.

**[0032]** Camera 112 is a portion of endoscopic camera 110 that converts visual information received from endoscope 104 into electrical information. Battery 114 is a power source for endoscopic camera 110 and can also power light 106. Battery 114 can be removable by the user or be integrated into endoscopic camera 110. Battery 114 can take various forms and can be rechargeable (e.g., battery 114 can be a rechargeable lithium-ion battery). Wireless transmitter 116 can transmit data from endoscopic camera 110 to a receiver. In some embodiments, endoscopic camera 110 can be configured to also wirelessly receive data.

**[0033]** Wireless transmitter 116 can be configured to communicate data over a variety of different protocols and may include associated hardware to transmit the data over a protocol. These protocols can include WirelessHD™, Bluetooth™, WiFi™, other protocols, and combinations thereof.

**[0034]** Endoscopic camera 110 further includes one or more computing components, including a processing unit 118 and a memory 120. Processing unit 118 can be implemented using one or more processors (e.g., CPUs) or other circuitry for performing processing tasks. Memory 120 may be implemented using any suitable electronically accessible memory, including but not limited to RAM, ROM, Flash, SSD, or hard drives.

**[0035]** Memory 120 includes executable instructions for adjusting illumination 122 and other executable instructions 124. Executable instructions for adjusting illumination 122 may include instructions executable by processing unit 118 for controlling illumination of the scene of interest by, for example, controlling power to light 106. Executable instructions for



adjusting illumination 122 may include instructions for performing some of the steps described in relation to FIG. 11.

**[0036]** Other executable instructions 124 include other instructions for processing unit 118, including but not limited to instructions for white balancing data from camera 112, instructions for encoding data from camera 112, instructions for controlling wireless transmitter 116 (e.g., instructions for pairing wireless transmitter 116 with a receiver 162), instructions for controlling camera 112, and/or other instructions.

**[0037]** Viewing station 160 is a station for receiving and viewing data from endoscopic camera system 102. Viewing station 160 includes a receiver 162 for receiving data transmitted by wireless transmitter 116 of endoscopic camera system 102. Monitor 164 is a device for displaying, storing, and/or otherwise acting on the data received at receiver 162. In some embodiments, the receiver 162 may be physically separate from the monitor 164. Alternatively, the receiver 162 may be incorporated into the monitor 164.

**[0038]** FIG. 2 illustrates a perspective view of one embodiment of endoscopic camera system 102, including endoscope 104, light 106, cable 108, and endoscopic camera 110. In addition to the features described with regard to FIG. 1, endoscopic camera system 102 further includes a coupling 156 between endoscope 104 and endoscopic camera 110. Endoscopic camera 110 further includes a control panel 126, a battery latch 128, a tail portion 130, and a grip region 132. Endoscopic camera system 102 includes a proximal end 152 and a distal end 154. Distal end 154 may be located near the portion of endoscope 104 placed near the scene of interest. Proximal end 152 is located on an end of endoscopic camera 110.

**[0039]** Control panel 126 includes one or more buttons, switches, slides, dials, or other input mechanisms for controlling the operation of endoscopic camera system 102. Controls can include a power control, an illumination control, a white balance control, a zoom control, controls for wireless transmission settings, and/or other controls. Control panel 126 can also include controls for manipulating how data is displayed at monitor 164.

**[0040]** Battery latch 128 is a latch to hold battery 114 in place. Battery latch 128 may cooperate with other features to hold battery 114 in place. Battery latch 128 may be slidable to facilitate release of battery 114.

**[0041]** Tail 130 can be a portion near proximal end 152 of endoscopic camera 110. In the illustrated embodiment, tail 130 is an elongate portion having a relatively smaller height compared to an adjacent, more distal portion of endoscopic camera 110. In one embodiment, tail 130 may begin at the end of battery latch 128, when battery latch 128 is in a closed

position securing battery 114 in place. Tail 130 may be an area where wireless transmitter 116 or components thereof (e.g., an antenna) are located.

**[0042]** Grip region 132 is a region of endoscopic camera system 102 adapted to be held by a user. Grip region 132 may be configured to provide an ergonomic location for use of endoscopic camera system 102. In one embodiment, grip region 132 is located at or near a balance point of endoscopic camera system 102 to facilitate manipulation of endoscopic camera system 102 by a user. Grip region 132 may also be configured at a portion of endoscopic camera 110 that is a particular distance away from wireless transmitter 116. Designing camera 110 to position grip region 132 as far away as practicable from transmitter 116 may be advantageous, in that this configuration prevents the user's hand from interfering with data transmission from transmitter 116. For example, in the embodiment shown and other alternative embodiments, the grip region 132 may be located more than 5 centimeters, away from wireless transmitter 116. Grip region 132 may include one or more features to facilitate holding by the user, including but not limited to those described below, in reference to FIGS. 3-5.

**[0043]** FIG. 3 illustrates a perspective view of endoscopic camera 110, according to one embodiment. FIG. 4 illustrates a front view of grip region 132 of endoscopic camera 110 of FIG. 3. FIG. 5 illustrates a side view of a distal end of endoscopic camera 110 of FIG. 3. In these views, endoscopic camera 110 is presented without endoscope 104, light 106, cable 108, and coupling 156 of endoscopic camera system 102 to improve visibility of grip region 132 and other portions of endoscopic camera 110. Illustrated features include shoulders 134, which divide endoscopic camera 110 into a head portion 136 and a body portion 138. Illustrated features further include an attachment collar 140, a ledge 142, a first concavity 144, a second concavity 146, a divot 148, and a face 150.

**[0044]** Shoulders 134 are an area of reduced width of endoscopic camera 110. In the illustrated example, shoulders 134 are located at approximately two-thirds of the way up the height of endoscopic camera 110 from the bottom of endoscopic camera 110, and shoulders 134 are an area having a width reduced by approximately fifteen percent. Shoulders 134 can provide a region to facilitate holding endoscopic camera 110. For example, a user may grip endoscopic camera 110 with one or more fingers or another part of the hand against or along one or both shoulders 134. In one embodiment, one or more of the user's fingers may be positioned substantially perpendicular to or parallel with one or both of shoulders 134. Endoscopic camera system 102 can be gripped by the user in a manner such that shoulders 134 resist unwanted rotation of endoscopic camera 110 relative to the user's hand. Shoulders

134 can further facilitate user-desired rotation of endoscopic camera 110 about the axis relative to the user's hand. Shoulders 134 can continue along a portion of the length of endoscopic camera 110 and continue along or be incorporated into tail 130.

**[0045]** Shoulders 134 can divide endoscopic camera 110 into head 136 and body 138. Head 136 can be defined by a portion above shoulders 134 and/or body 138. In the illustrated example, head 136 extends above shoulders 134 and has a width decreasing from shoulders 134 to the top of head 136. The top of head 136 can include a curve configured to match a curve of a user's hand to facilitate placing the user's hand or a portion thereof on the top of head 136. The height of head 136 decreases along the length of endoscopic camera 110, such that head 136 forms a slope towards and/or into tail 130. Control panel 126 is disposed on the slope of head 136. Body 138 can be described as a portion below shoulders 134 and/or head 136. In the illustrated example, body 138 has a greater width than head 136 and the width of body 138 decreases towards ledge 142.

**[0046]** Face 150 can be a region located at the distal end of endoscopic camera 110. Face 150 can be located within grip region 132 and may be substantially flat enough to facilitate use of grip region 132. For example, the user may wrap one or more fingers around attachment collar 140 and have a portion of the hand against face 150. In certain grips, face 150 can also be a portion of endoscopic camera 110 where a portion of the weight of endoscopic camera 110 rests against the user's hand and prevents unwanted distal movement of endoscopic camera 110 through the hand (see, e.g., FIG. 9 and FIG. 10).

**[0047]** Attachment collar 140 is a location at or by which endoscopic camera 110 can be coupled to coupling 156. Attachment collar 140 can be a circular protrusion extending from endoscopic camera 110. Attachment collar 140 can take other forms, such as an opening in endoscopic camera 110 into which coupling 156 can be attached. In one embodiment, attachment collar 140 is a circular protrusion from face 150 in grip region 132. Attachment collar 140 can be positioned substantially centered along the width of endoscopic camera 110 and positioned with its center substantially aligned with shoulders 134. In this manner, grip region 132 may facilitate gripping of endoscopic camera 110 using shoulders 134 and attachment collar 140.

**[0048]** In addition to providing attachment functionality, attachment collar 140 can be located within grip region 132 and facilitate user's holding of endoscopic camera system 102. For example, attachment collar 140 can be located within grip region 132 and provide an area around which the user may grip to hold endoscopic camera system 102. In such a position,

the user may grip attachment collar 140, coupling 156, or combinations thereof. Attachment collar 140 and coupling 156 may include features to facilitate holding, such as knurling.

**[0049]** Ledge 142 is a protrusion from endoscopic camera 110 and can form a portion of grip region 132. Ledge 142 provides a region to facilitate holding endoscopic camera 110. For example, a user may grip endoscopic camera 110 with one or more fingers or another part of the hand against or along ledge 142. Endoscopic camera system 102 can be gripped by the user in a manner that ledge 142 resists unwanted distal or proximal motion of endoscopic camera 110 relative to the user's hand and to facilitate desired distal or proximal motion of endoscopic camera 110. In one embodiment, ledge 142 extends distally from face 150 and decreases in width as ledge 142 extends from face 150.

**[0050]** Ledge 142 can include one or more features, such as a first concavity 144, a second concavity 146, and a divot 148. First concavity 144 and second concavity 146 can run along ledge 142, be separated by a convex portion of ledge 142, and provide a location for the user to place fingers or a portion of the user's hand to improve grip on ledge 142 or to facilitate control of endoscopic camera system 102 as a whole. Divot 148 can be a concave space in ledge 142. Divot 148 can be a grip enhancing feature. For example, divot 148 can be a place at which the user may place a portion of the user's hand. Divot 148 can be adapted to provide a channel or other opening through which battery 114 may be manipulated. For example, ledge 142 can cooperate with battery latch 128 to hold battery 114 in place. Battery 114 can be located proximal to ledge 142, and divot 148 can provide a channel through which the user can manipulate battery 114 to insert or remove battery 114.

**[0051]** Grip region 132 can be configured to encourage or discourage a user to hold endoscopic camera system 102 in a particular way or location. For example, grip region 132 can be located to encourage a user to hold endoscopic camera system 102 a particular distance away from wireless transmitter 116, such as 5 centimeters or more. Grip region 132 can be located to encourage a user to grab endoscopic camera system 102 a particular distance away from a balance point of endoscopic camera system 102, a particular distance away from wireless transmitter 116, or a combination thereof. For example, endoscopic camera system 102 can be configured to have a balance point near grip region 132. The balance point can be located more than 5 centimeters away from wireless transmitter 116.

**[0052]** Grip region 132 can be configured to provide multiple, complimentary features to facilitate grip. For example, grip region 132 can be configured for a user to grip attachment collar 140 to control rotational movement of endoscopic camera system 102 relative to the user's hand. Grip region 132 can be further configured for a user to rest a portion of the

user's hand or fingers within first concavity 144 to control proximal and distal movement of endoscopic camera system 102.

**[0053]** FIGS. 6 and 7 are front and side views, respectively, of endoscopic camera 110, with labels illustrating dimensions of the various components and portions of endoscopic camera 110, according to one embodiment. The dimensions are meant to be exemplary in nature, applying to one embodiment, and any or all the dimensions may vary in alternative embodiments. Additionally, each exemplary dimension listed below may vary slightly, for example by approximately +/- 0.1 inch, without departing from the scope of the invention. Therefore, the dimensions listed below should be interpreted as examples only and should not be interpreted as limiting the scope of the invention as it is set forth in the claims.

**[0054]** FIG. 6 illustrates example dimensions D1, D2, D3, D4, and D5. Distance D1 is the width of the widest portion of endoscopic camera 110. In the illustrated embodiment, distance D1 is also the width of endoscopic camera 110 measured as shoulders 134 begin. In one embodiment, distance D1 is approximately 2.20 inches. In various alternative embodiments D1 may be between about 1.10 inches and about 3.30 inches, or more ideally between about 1.54 inches and about 2.86 inches, or even more ideally between about 1.98 inches and about 2.42 inches. Distance D2 is the width of one shoulder 134, or in other words a narrowing of the width of endoscopic camera 110 at each shoulder 134. In one embodiment, distance D2 is approximately 0.18 inches. In various alternative embodiments D2 may be between about 0.09 inches and about 0.27 inches, or more ideally between about 0.13 inches and about 0.23 inches, or even more ideally between about 0.16 inches and about 0.20 inches. Distance D3 is the height of endoscopic camera 110 measured from a bottom of ledge 142 to a top of head 136. In one embodiment, distance D3 is approximately 2.79 inches. In various alternative embodiments D3 may be between about 1.40 inches and about 4.19 inches, or more ideally between about 1.96 inches and about 3.63 inches, or even more ideally between about 2.5 inches and about 3.07 inches. Distance D4 is the width of the widest part of divot 148. In one embodiment, distance D4 is approximately 0.68 inches. In various alternative embodiments D4 may be between about 0.34 inches and about 1.02 inches, or more ideally between about 0.48 inches and about 0.88 inches, or even more ideally between about 0.61 inches and about 0.75 inches. Distance D5 is the width of the widest part of ledge 142. In one embodiment, distance D5 is approximately 1.68 inches. In various alternative embodiments D5 may be between about 0.84 inches and about 2.52 inches, or more ideally between about 1.18 inches and about 2.18 inches, or even more ideally between about 1.51 inches and about 1.85 inches.

[0055] FIG. 7 illustrates example dimensions D6, D7, D8, D9, D10, D11, D12, D13, and D14 and region R1. Distance D6 is the distance from a top portion of attachment collar 140 to the top of endoscopic camera 110 (e.g., top of head 136). In one embodiment, distance D6 is approximately 0.40 inches. In various alternative embodiments D6 may be between about 0.20 inches and about 0.60 inches, or more ideally between about 0.28 inches and about 0.52 inches, or even more ideally between about 0.36 inches and about 0.44 inches. Distance D7 is the distance from a top of shoulders 134 to the top of endoscopic camera 110 (e.g., top of head 136). In one embodiment, distance D7 is approximately 0.90 inches. In various alternative embodiments D7 may be between about 0.45 inches and about 1.35 inches, or more ideally between about 0.63 inches and about 1.17 inches, or even more ideally between about 0.81 inches and about 0.99 inches. Distance D8 is the distance that attachment collar 140 extends from face 150 of grip region 132. In one embodiment, distance D8 is approximately 0.38 inches. In various alternative embodiments D8 may be between about 0.19 inches and about 0.57 inches, or more ideally between about 0.27 inches and about 0.49 inches, or even more ideally between about 0.34 inches and about 0.42 inches. Distance D9 is the height of tail 130. In one embodiment, distance D9 is approximately 0.66 inches. In various alternative embodiments D9 may be between about 0.33 inches and about 0.99 inches, or more ideally between about 0.46 inches and about 0.86 inches, or even more ideally between about 0.59 inches and about 0.73 inches. Distance D10 is the distance from the bottom of attachment collar 140 to a middle of ledge 142. In one embodiment, distance D10 is approximately 0.81 inches. In various alternative embodiments D10 may be between about 0.41 inches and about 1.22 inches, or more ideally between about 0.57 inches and about 1.05 inches, or even more ideally between about 0.73 inches and about 0.89 inches. Distance D11 is the distance from the distal end of ledge 142 to the proximal end of battery latch 128. In one embodiment, distance D11 is approximately 3.17 inches. In various alternative embodiments D11 may be between about 1.59 inches and about 4.76 inches, or more ideally between about 2.22 inches and about 4.12 inches, or even more ideally between about 2.85 inches and about 3.49 inches. Distance D12 is the distance the proximal end of battery latch 128 to the proximal end of tail 130. This can also be described as the width of tail 130. In one embodiment, distance D12 is approximately 1.44 inches. In various alternative embodiments D12 may be between about 0.72 inches and about 2.16 inches, or more ideally between about 1.01 inches and about 1.87 inches, or even more ideally between about 1.30 inches and about 1.58 inches. Distance D13 is the distance from face 150 to the proximal end of tail 130. In one embodiment, distance D13 is approximately 4.43 inches. In

various alternative embodiments D13 may be between about 2.22 inches and about 6.65 inches, or more ideally between about 3.10 inches and about 5.76 inches, or even more ideally between about 3.99 inches and about 4.87 inches. Distance D14 is the distance from the distal end of attachment collar 140 to the proximal end of tail 130. In one embodiment, distance D14 is approximately 4.80 inches. In various alternative embodiments D14 may be between about 2.40 inches and about 7.20 inches, or more ideally between about 3.36 inches and about 6.24 inches, or even more ideally between about 4.32 inches and about 5.28 inches. In one embodiment, region R1 is the region in which the balance point of endoscopic camera system 102 is located. The region R1 is approximately centered at face 150.

**[0056]** FIG. 8 illustrates a method for gripping endoscopic camera system 102, according to one embodiment. In this embodiment, the user's thumb is placed against ledge 142 with a portion of the thumb in second concavity 146. The user's index finger is placed on top of head 136, and the index finger may rest on a curve of head 136 configured to receive a portion of a user's hand. The remaining fingers are placed against coupling 156.

**[0057]** FIG. 9 illustrates an alternative embodiment of a method for gripping endoscopic camera system 102. In this embodiment, the user's thumb is placed against, and at least partially within, first concavity 144 in ledge 142. The user's thumb is also placed against face 150. The user's index finger is wrapped partially around attachment collar 140 with a portion of the finger resting against face 150 and with the end of the finger resting against coupling 156. The user's index finger and thumb may at least partially support the weight of endoscopic camera system 102 where face 150 meets the user's index finger and thumb and where first concavity 144 meets the user's thumb. The user's remaining fingers are also placed against coupling 156. These fingers may provide additional control of and support for endoscopic camera system 102.

**[0058]** FIG. 10 illustrates another alternative embodiment of a method for gripping an endoscopic camera system 102. In this example, the user's thumb is placed against, and at least partially within, first concavity 144 in ledge 142. The user's thumb is also placed against face 150. The user's thumb may at least partially support the weight of endoscopic camera system 102 where the thumb contacts first concavity 144 and face 150. The user's index finger is wrapped partially around attachment collar 140 and coupling 156, with the end of the finger resting against coupling 156. The user's remaining fingers are draped along coupling 156 and endoscope 104 with some of the ends of the fingers resting against light 106.

**[0059]** FIG. 11 illustrates one embodiment of a method 200 for visualizing a scene of interest with an endoscope by modulating illumination output to correct for overexposure or underexposure. In certain methods for visualizing a scene of interest, video capture parameters, such as exposure time or sensor gain, may be the primary parameters modified to adjust exposure of an image while maintaining constant illumination of the scene. In other methods, illumination output of a light may be the primary parameter modified to affect exposure of video, while video capture parameters affecting exposure remain substantially constant. Advantageously, modifying the illumination can be used to improve battery life of the system and decrease heat output. This can be done by, for example, keeping video capture parameters affecting exposure at a relatively high setting (e.g., settings tending to cause overexposure), which allows for illumination output to be relatively reduced. Reduced illumination output can beneficially reduce battery draw and heat output for the illumination source. With exposure parameters at a relatively high setting, less illumination is needed to properly expose the scene than would be required if the video capture parameters were reduced.

**[0060]** According to the embodiment depicted in FIG. 11, the method 200 may start by advancing the distal end of an endoscopic camera system to a scene of interest 202. Next, the endoscopic camera system may be used to illuminate the scene of interest 204. A video signal can then be captured by the system 206, and a processor of the system may be used to determine exposure of the video signal 208. If the processor determines that the video signal is overexposed or underexposed, it can then send a signal to change the illumination output from the light source 210. The method may then continue by removing the endoscopic camera system 212 or by continuing capturing video using the changed illumination output 206.

**[0061]** Prior to block 202, the process 200 can include various preparatory steps, including but not limited to selecting components of endoscopic camera system 102 (e.g., endoscope 104, light 106, and endoscopic camera 110), assembling endoscopic camera system 102 (e.g., optically connecting endoscope 104 to endoscopic camera 110 via coupling 156), establishing communication between wireless transmitter 116 and receiver 162, calibrating endoscopic camera system 102 and monitor 164, sterilizing endoscopic camera system 102, preparing the subject for the procedure, or other preparatory steps.

**[0062]** Block 202 recites “advancing distal end to scene of interest.” In an endoscopic procedure, the user can advance distal end 154 of endoscopic camera system 102 toward a scene of interest. For example, process 200 can be used for visualizing a scene of interest



during a procedure in a subject's sinus cavity, and the distal end of endoscopic camera system 102 can be advanced through subject's nostril or an access hole in subject's gingival tissue towards subject's sinus cavity.

**[0063]** Block 204 recites “illuminating scene of interest.” With distal end 154 located near the scene of interest, light 106 can be used to provide illumination at the scene of interest. For example, light 106 can shine into a proximal end of endoscope 104, and endoscope 104 transmits the light down the length of the scope and out distal end 154 to illuminate the scene of interest. This illumination can be used to facilitate the capture of video information using endoscopic camera system 102.

**[0064]** The illumination can be provided according to various parameters. Light 106 can provide illumination at a particular illumination output that can be varied (e.g., measured in lumens) manually by the user, automatically by the endoscopic camera 110 (e.g., by providing a signal through cable 108), or combinations thereof. In some examples, output of light 106 is controlled by pulse width modulation of a signal. For example, the duty cycle can be varied to increase or decrease the output of light 106.

**[0065]** Block 206 recites “capturing video.” Visual information at distal end 154 can travel down endoscope 104 and received at camera 112 in endoscopic camera 110. Camera 112 can convert the visual information into electrical signals. These signals can be transmitted to receiver 162 for display at monitor 164. The signals may undergo processing at camera 112, endoscopic camera 110, or elsewhere. The processing can include white balancing, filtering, noise reduction, level adjustments, color adjustments, compression, and other processing.

**[0066]** Camera 112 may operate according to particular parameters, for example camera 112 can operate according to video capture characteristics that affect exposure of the resulting video. These characteristics can include, but need not be limited to shutter speed, exposure time, and imaging sensor sensitivity to light. These characteristics can be preset to maximize exposure of the resulting video, such as by decreasing shutter speed, increasing exposure time, and increasing imaging sensor sensitivity. Other parameters can include resolution, compression, frame rate, white balance, and other parameters.

**[0067]** Block 208 recites “determining exposure.” The signal from camera 112 can be analyzed to determine the exposure of one or more frames of the video image. This analysis can be performed within camera 112, on processing unit 118 or elsewhere. In one embodiment, this analysis can be performed by measuring a distribution of the brightness value of pixels that make up one or more video frames. Responsive to a first threshold

number of pixels being within a threshold region, the image may be determined to be improperly exposed. In another example, this analysis can be performed by averaging the pixel value in one or more frames and determining whether the resulting value is past an overexposure or underexposure threshold. In yet another example, the brightness may be determined based on received input from the user (e.g., the user pushes an “increase brightness” button, which may indicate that the video is underexposed). The result of block 208 may be a determination whether one or more frames of a video signal are underexposed, properly exposed, or overexposed. Another result may be a measurement of how overexposed or underexposed the one or more frames are.

**[0068]** Block 210 recites “changing illumination output.” Responsive to the video signal being underexposed or overexposed, the illumination output can be modified. For example, if the video signal is underexposed, the illumination output can be increased to bring the signal to proper exposure. If the video signal is overexposed, the illumination output can be decreased to bring the signal to proper exposure. Changing illumination output can be performed instead of or in addition to changing camera settings. For example, the exposure may be corrected by maintaining the same video capture characteristics that produced the overexposed or underexposed frame and changing the illumination output of light 106. The amount by which illumination output is changed can depend on various parameters, including whether illumination output is the only variable being changed, an amount of exposure or underexposure, whether previous frames were also overexposed or underexposed, and/or other parameters.

**[0069]** Changing illumination output may be limited, to avoid potentially undesirable rapid changing of illumination. In one embodiment, illumination output is changed responsive to a threshold number of frames being improperly exposed. For instance, the illumination output is increased after 12 frames being underexposed. In another example, changes to illumination output may be capped at a certain number of frames (e.g., illumination output cannot be changed more than once every 24 frames).

**[0070]** The process of capturing video, determining exposure, and changing illumination output in blocks 206, 208, and 210 may repeat until, for example, the user intervenes (e.g., by turning off video capture at the completion of the procedure).

**[0071]** Block 212 recites “removing endoscope.” The process 200 can conclude with endoscopic camera system 102 being removed from the scene of interest and the subject, such as at the completion of the procedure.

[0072] With regard to the processes, systems, methods, and other disclosures herein, although the steps of such processes, etc. have been described as occurring according to a certain ordered sequence, such processes could be practiced with the described steps performed in an order other than the order described herein. Additionally, in various embodiments, certain steps could be performed simultaneously, other steps could be added, and/or certain steps described herein could be omitted. In other words, the descriptions of processes herein are provided for the purpose of illustrating certain examples, and should in no way be construed so as to limit the claims.

[0073] Accordingly, the above description is intended to be illustrative and not restrictive. Many examples and applications other than the examples provided would be apparent upon reading the above description. The scope should be determined, not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. It is anticipated and intended that future developments will occur in the technologies discussed herein, and that the disclosed systems and methods will be incorporated into such future examples. In sum, the application is capable of modification and variation.

[0074] In some examples, system elements may be implemented as computer-readable instructions (e.g., software) on one or more computing devices (e.g., servers, personal computers, etc.), stored on computer readable media associated therewith (e.g., disks, memories, etc.). A computer program product may have such instructions stored on computer readable media for carrying out the functions described herein.

[0075] All terms used in the claims are intended to be given their broadest reasonable constructions and their ordinary meanings as understood by those knowledgeable in the technologies described herein unless an explicit indication to the contrary is made herein. In particular, use of the singular articles such as “a,” “the,” “said,” etc. should be read to recite one or more of the indicated elements unless a claim recites an explicit limitation to the contrary.

[0076] In the foregoing Detailed Description, various features are grouped together in various examples for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter. While embodiments of the

present invention have been shown and described, various modifications may be made without departing from the scope of the present invention. The invention, therefore, should not be limited, except to the following claims, and their equivalents.

What is claimed is:

1. A method for visualizing a scene of interest, the method comprising:  
advancing a distal end of an endoscope to the scene of interest;  
illuminating the scene of interest using an illumination source coupled to the endoscope;  
capturing a video signal of the scene of interest using a camera coupled to the endoscope, the camera having one or more video capture characteristics affecting exposure of the video signal of the scene of interest;  
determining, with a processor, that the scene of interest is overexposed or underexposed in the captured video signal; and  
changing a light output of the illumination source, by sending a signal from the camera to the light source, while maintaining the same one or more video capture characteristics affecting exposure of the video signal, to correct for overexposure or underexposure of the video signal.
2. The method of claim 1, wherein the one or more video capture characteristics affecting exposure of the video signal are selected from the group consisting of shutter speed, exposure time, and imaging sensor sensitivity to light.
3. The method of claim 1, wherein the one or more video capture characteristics affecting exposure of the video signal are set to maximize exposure.
4. The method of claim 1, further comprising wirelessly transmitting the video signal to a receiver coupled to a monitor.
5. The method of claim 4, wherein the video signal is uncompressed.
6. The method of claim 1, wherein the camera and the light source are cordless, so that the endoscope is not attached to a separate light box via a cord.
7. A method of gripping an endoscope coupled with a camera, the method comprising:  
gripping the camera by placing a hand on a grip member at a first end of the camera, wherein a transmitter of the camera is located near a second end of the camera, opposite the first end,

wherein a distance between the grip member and the transmitter is at least 5 centimeters, and

wherein a balance point of the camera and the endoscope, when they are coupled together, is located at the grip member.

8. The method of claim 7, wherein the grip member comprises a shoulder, and wherein gripping the endoscopic camera comprises placing a part of the hand against or along the shoulder, thereby facilitating rotation of endoscopic camera.

9. The method of claim 7, wherein the grip member comprises a ledge extending from the grip member, and wherein gripping the endoscopic camera comprises placing a part of the hand against or along the ledge extending from the endoscopic camera, thereby facilitating desired distal or proximal motion of endoscopic camera.

10. The method of claim 7, wherein the grip member comprises an attachment collar, and wherein gripping the endoscopic camera comprises gripping the attachment collar, thereby facilitating user control of the endoscopic camera.

11. The method of claim 7, wherein the grip member comprises an attachment collar, a shoulder, and a ledge extending from the grip member, and wherein gripping the endoscopic camera comprises gripping the attachment collar, placing a part of the hand against the shoulder, and placing a part of the hand against the ledge, thereby facilitating control of the endoscopic camera.

12. A wireless endoscopic camera, comprising:  
a grip region at a first end of the endoscopic camera, the grip region comprising a face and an attachment collar extending from the face in a first direction perpendicular to the grip region, wherein the attachment collar is adapted to couple the endoscopic camera to an endoscope;

a ledge extending from the grip region in the first direction, below the attachment collar, wherein the ledge is configured to resist movement of the endoscopic camera in a user's hand, and wherein the ledge comprises a first concavity and a second concavity separated by a first convexity, wherein the first and second concavities are adapted to accommodate the user's fingers; and

a wireless transmitter located near a second end of the camera opposite the first end.

13. The endoscopic camera of claim 12, wherein a distance between the grip region and the wireless transmitter is at least 5 centimeters.

14. The endoscopic camera of claim 12, wherein a balance point of the camera, when attached to the endoscope, is located at the grip member.

15. The endoscopic camera of claim 12, wherein the grip region comprises two shoulders.

16. The endoscopic camera of claim 15, wherein the two shoulders are configured to resist unwanted rotation of the endoscopic camera in the user's hand.

17. A wireless endoscopic camera system, comprising:  
an endoscopic camera, comprising:

a grip region at a first end of the endoscopic camera, the grip region comprising a face and an attachment collar extending from the face in a first direction perpendicular to the grip region, wherein the attachment collar is adapted to couple the endoscopic camera to an endoscope;

a ledge extending from the grip region in the first direction, below the attachment collar, wherein the ledge is configured to resist movement of the endoscopic camera in a user's hand, and wherein the ledge comprises a first concavity and a second concavity separated by a first convexity, wherein the first and second concavities are adapted to accommodate the user's fingers; and

a wireless transmitter located near a second end of the camera opposite the first end; and

a light source directly couplable to an endoscope and not requiring connection to a separate light box device.

18. The endoscopic camera system of claim 17, wherein a distance between the grip surface and the wireless transmitter is at least 5 centimeters.

19. The endoscopic camera system of claim 17, wherein a balance point of the camera, when attached to the endoscope, is located at the grip member.

20. The endoscopic camera system of claim 17, further comprising a cable for connecting the light source to the endoscopic camera.

21. The endoscopic camera system of claim 17, wherein the light source comprises a cylindrical canister with a port for attaching to the endoscope.



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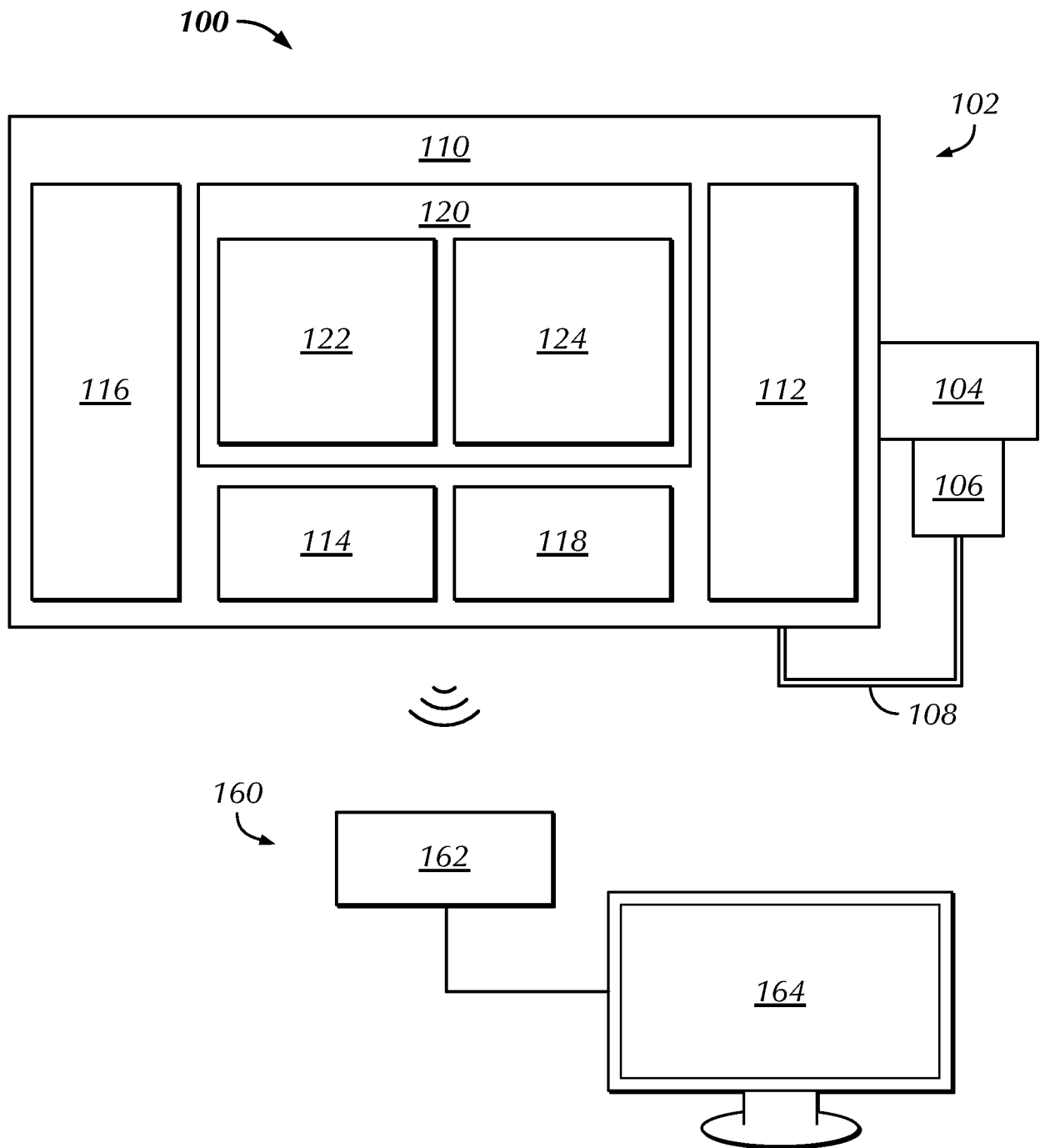


FIG. 1

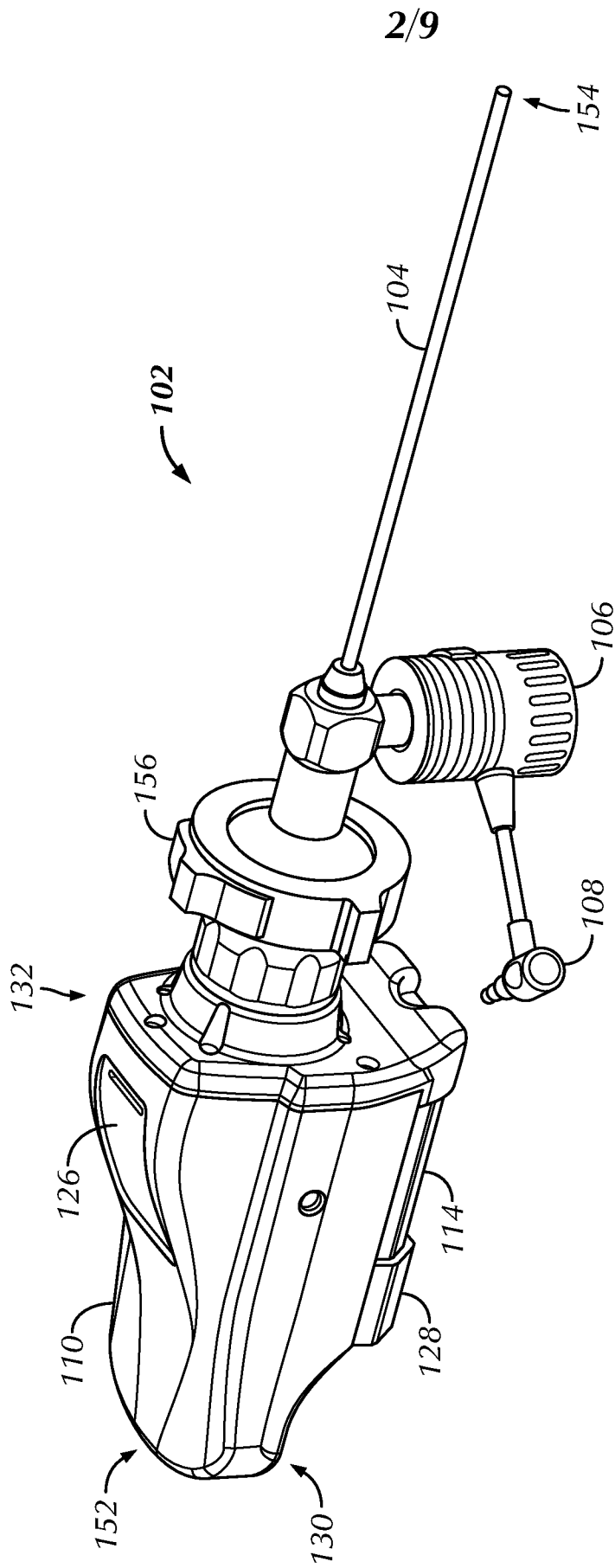


FIG. 2

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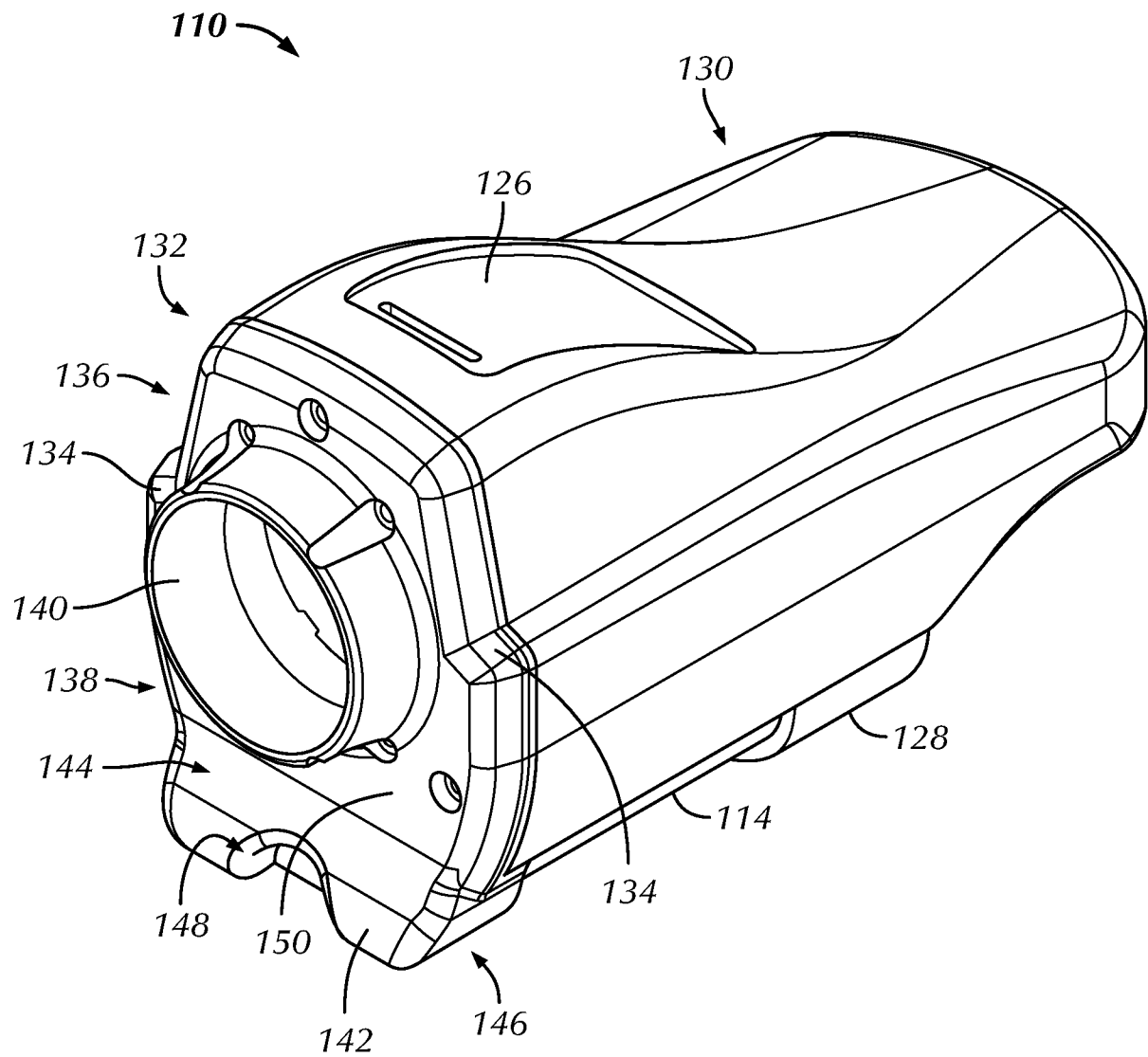


FIG. 3

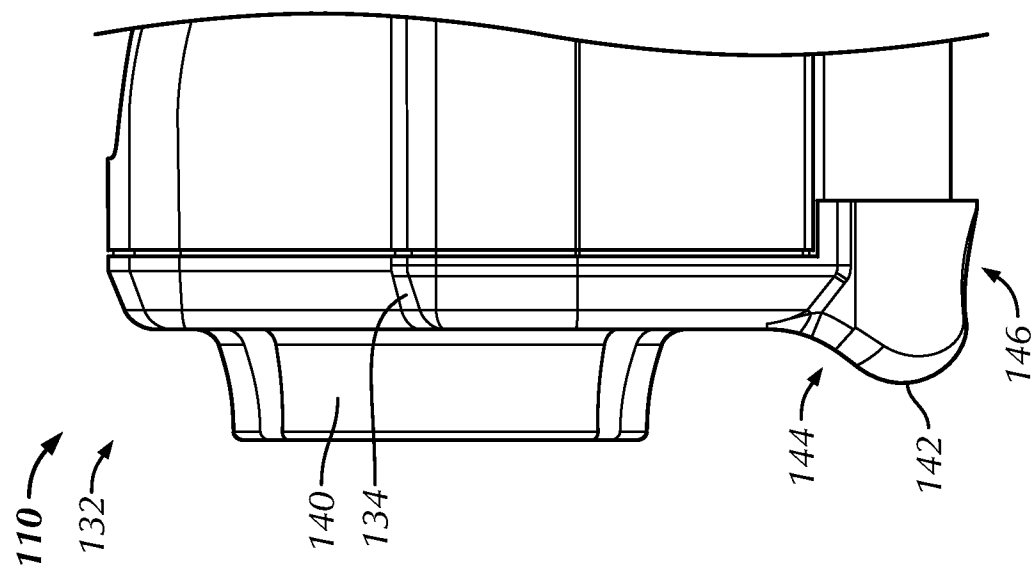


FIG. 5

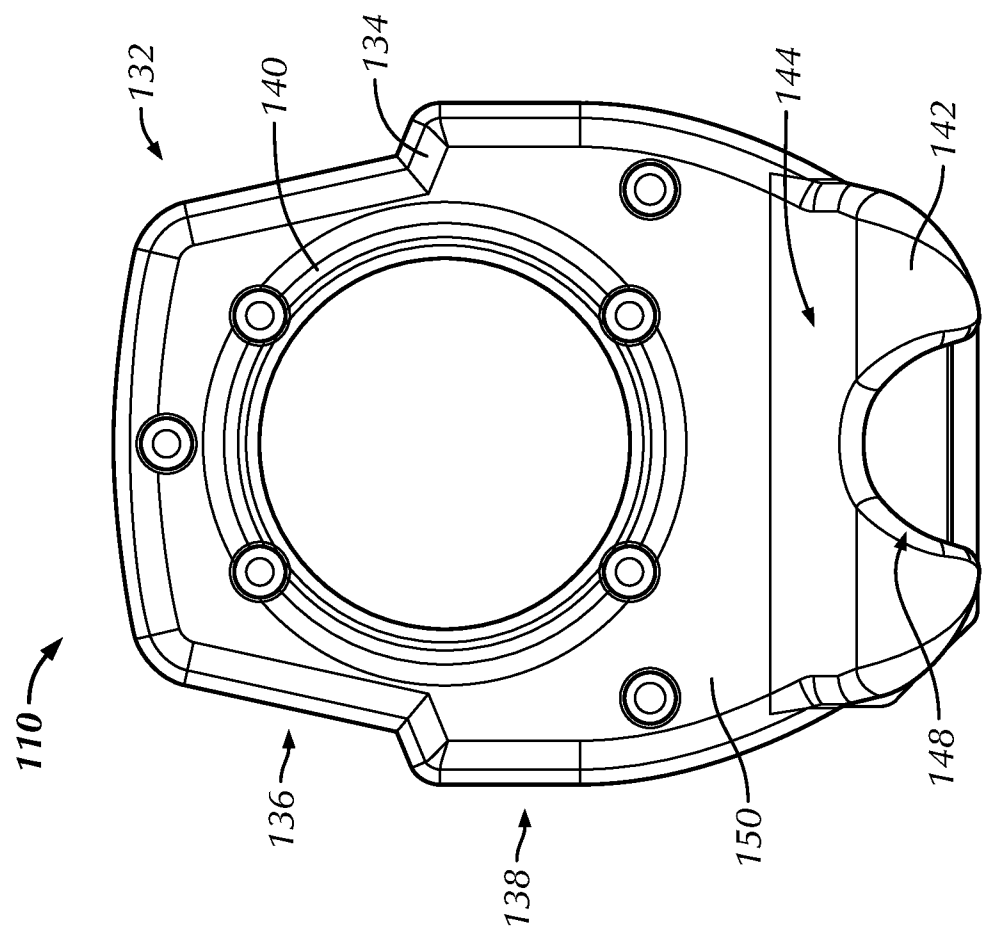


FIG. 4

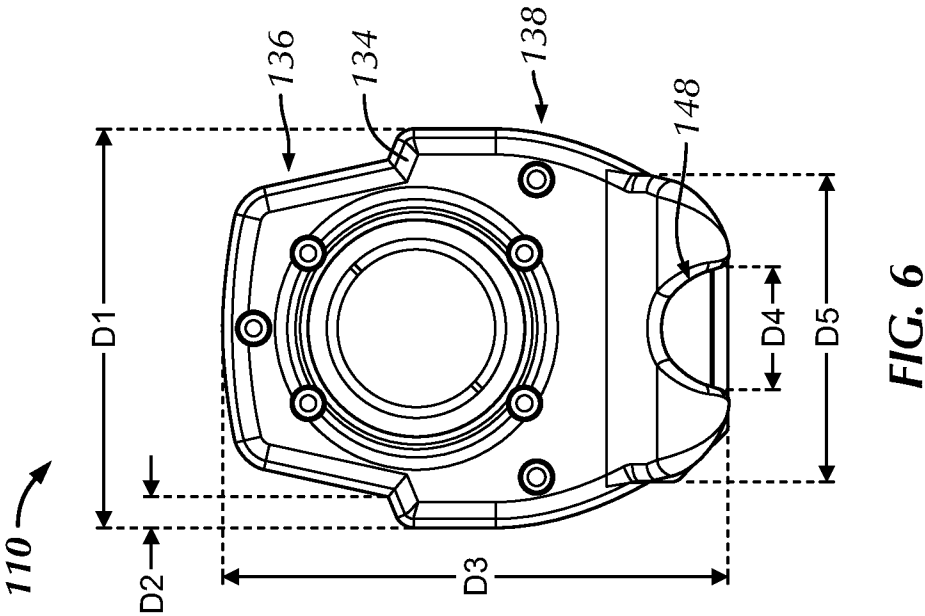


FIG. 6

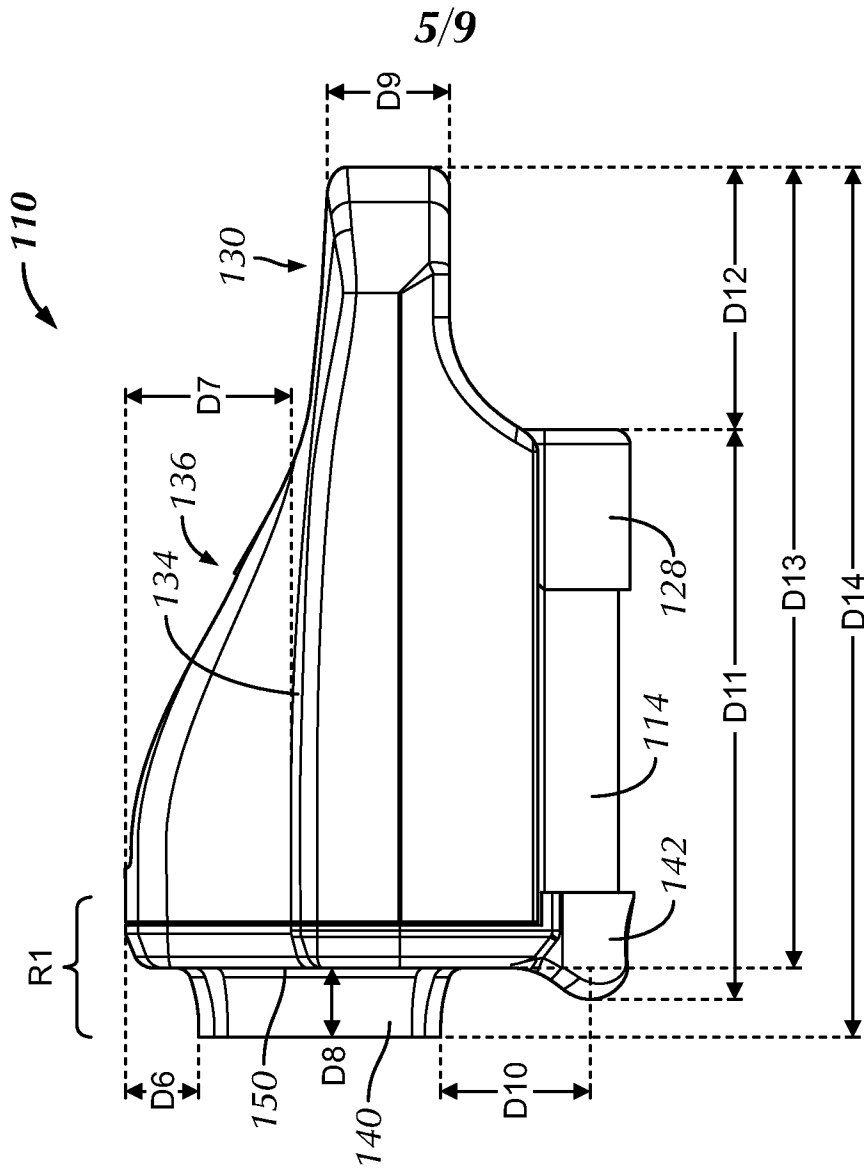


FIG. 7

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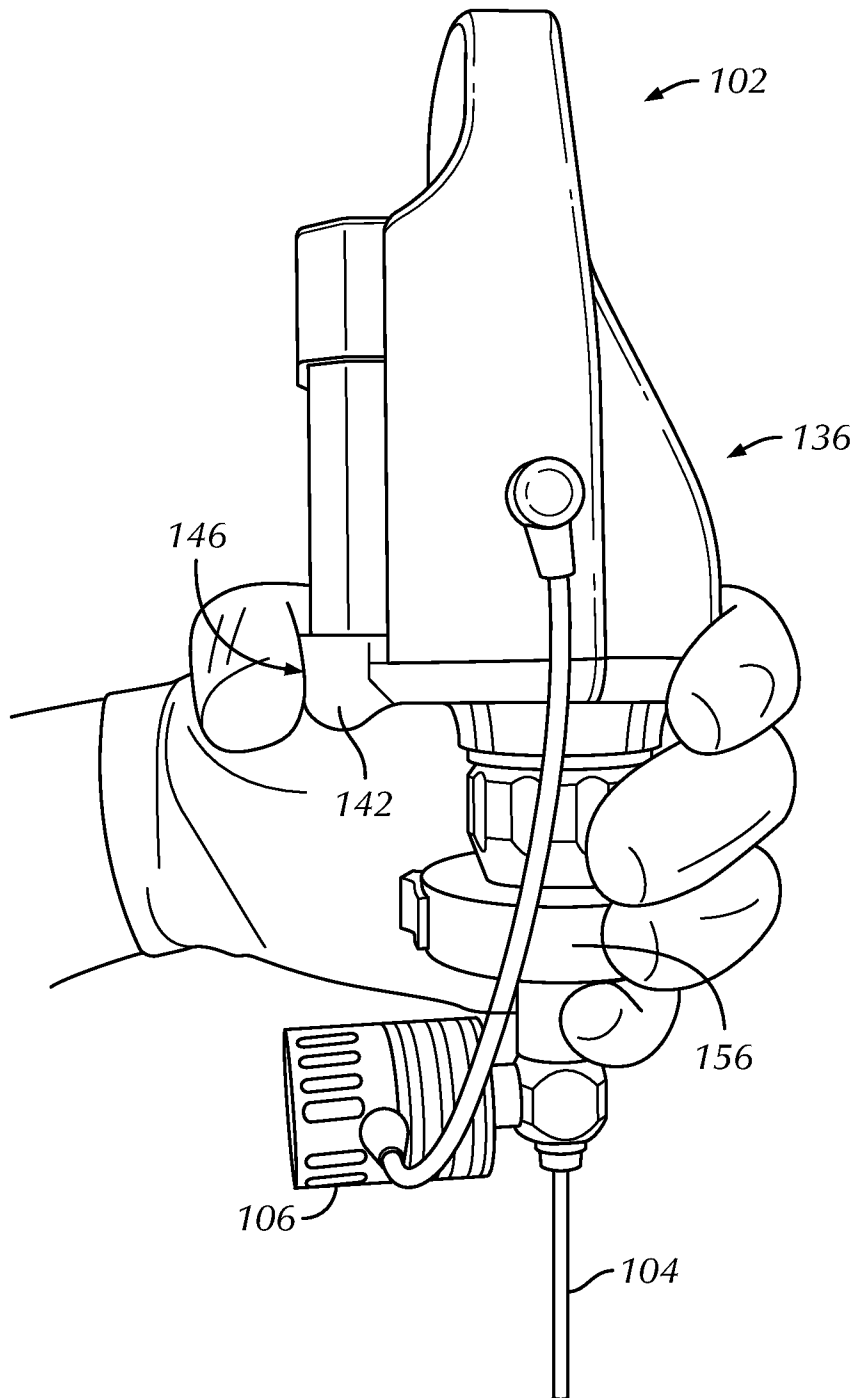


FIG. 8

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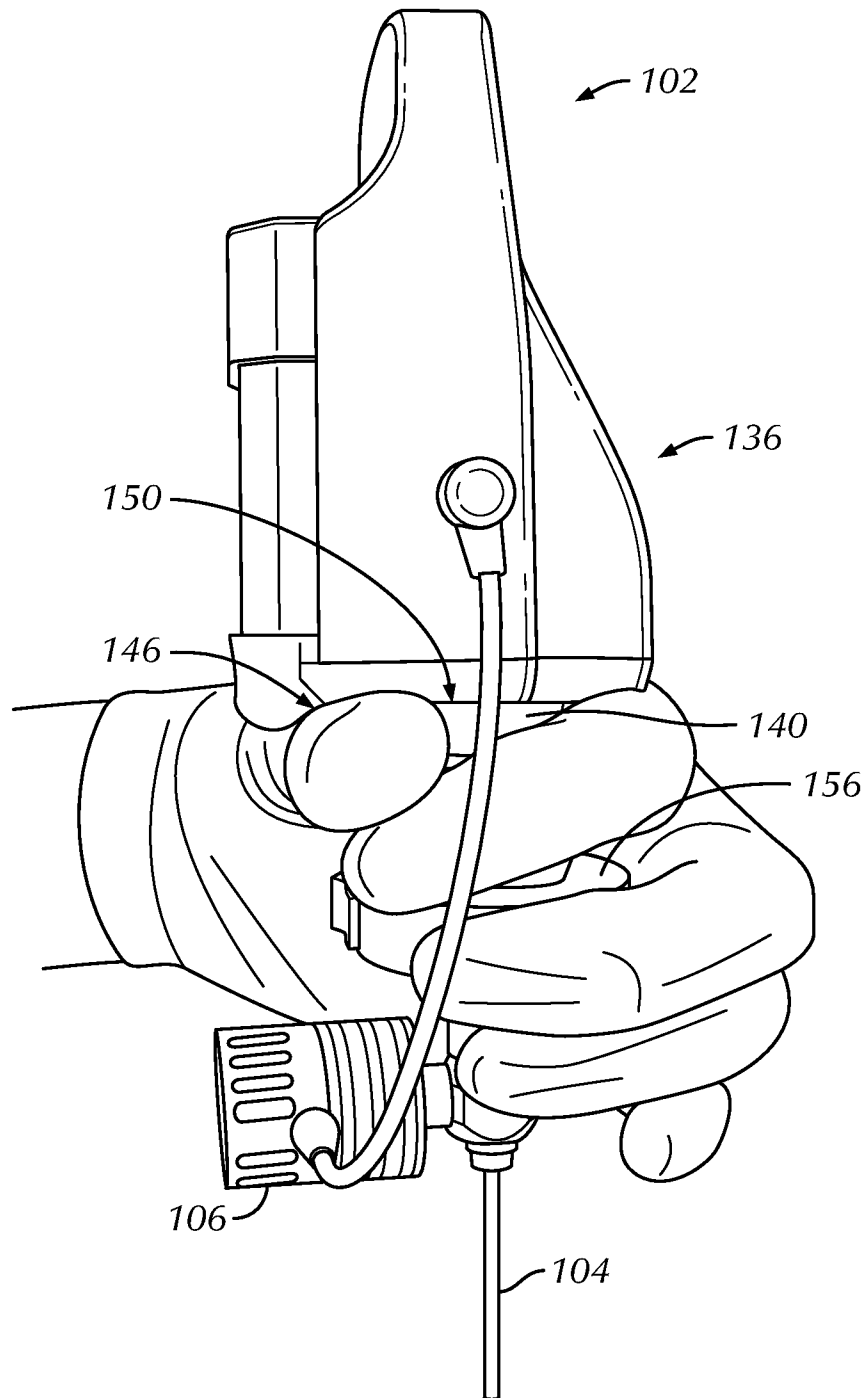


FIG. 9

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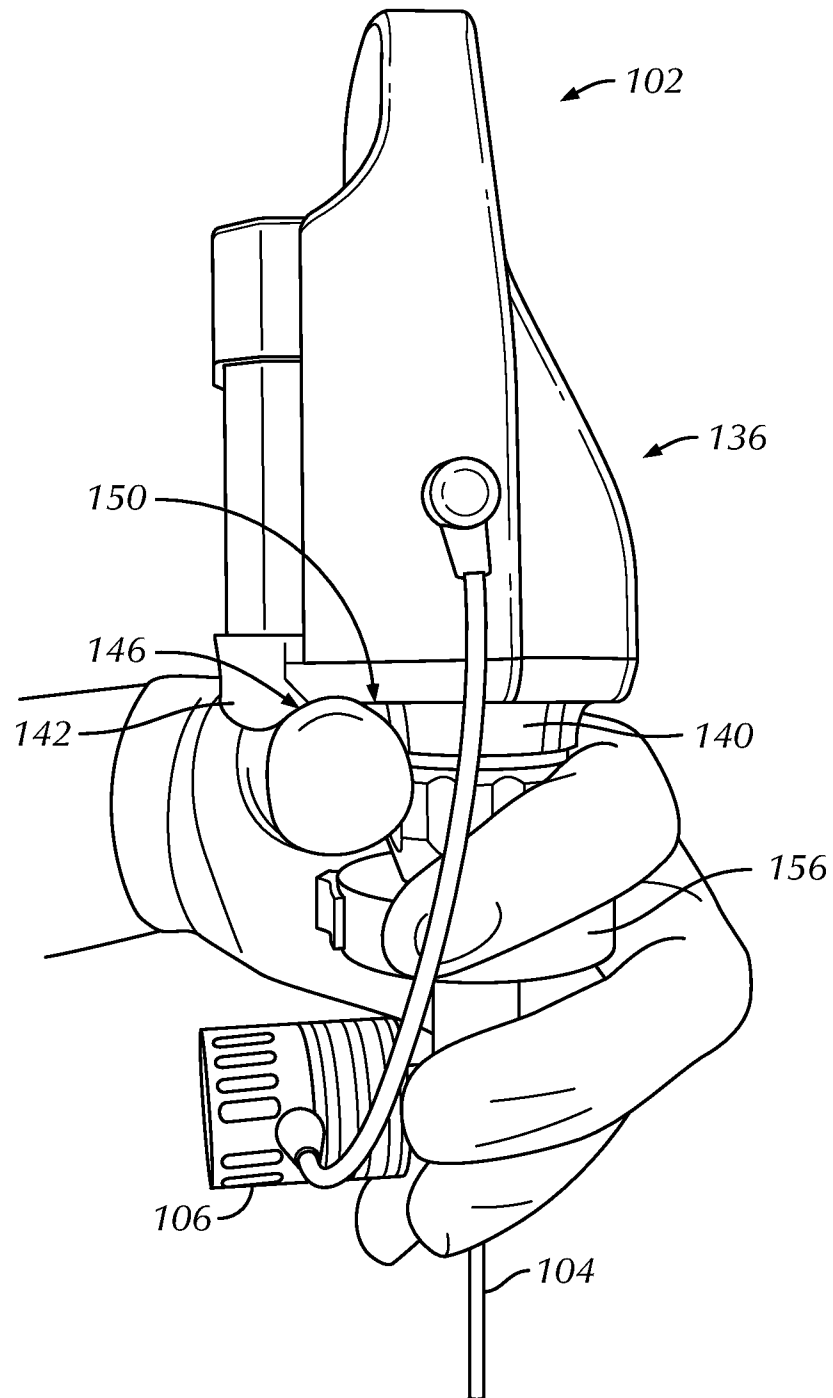


FIG. 10



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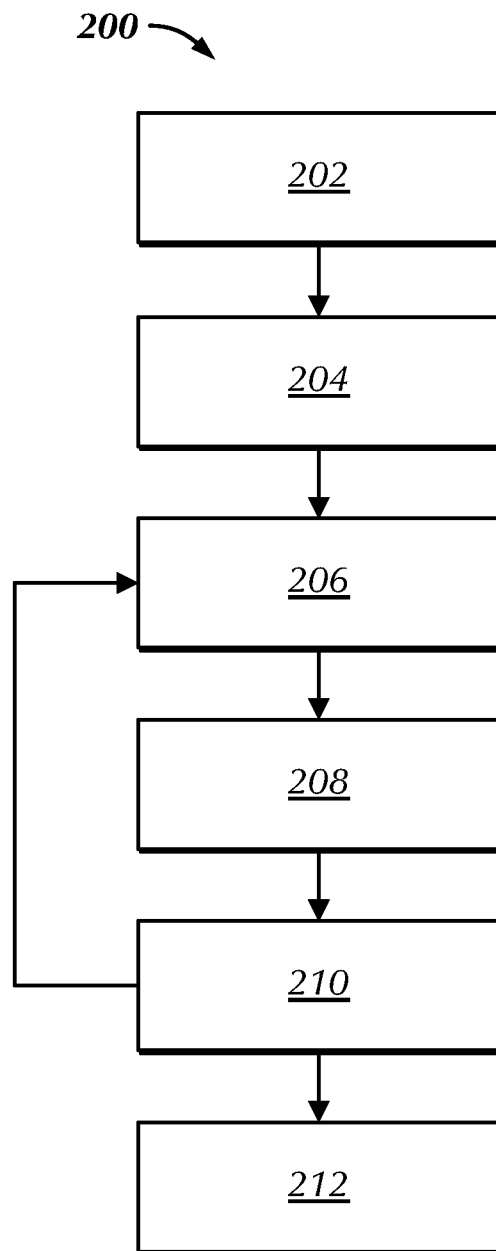


FIG. 11

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US17/17199

## A. CLASSIFICATION OF SUBJECT MATTER

IPC - A61B1/06, A61B1/045, H04N5/235, H04N5/225, H04N5/232 (2017.01)

CPC - A61B1/00009, A61B1/0661, A61B1/00006, A61B1/045, H04N5/2354, H04N5/2256, H04N5/23216, A61B1/00016, A61B1/0684

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0116470 A1 (OVOD, VI) April 30, 2015; paragraphs [0018], [0025], [0105], [0117], [0126]	1-3
Y		4-6
Y	US 2011/0193949 A1 (NAMBAKAM, V, et al.) August 11, 2011; paragraphs [0023], [0025], [0032], [0050]	4-5
Y	US 2013/0324794 A1 (COVER, R, et al.) December 5, 2013; figures 1, 7; paragraphs [0078], [0082]	6
A	US 2001/0015754 A1 (NAKASHIMA, M, et al.) August 23, 2001; entire document	1-6
A	US 2014/0052004 A1 (D'ALFONSO, D, et al.) February 20, 2014; entire document	1-6
A	US 2014/0139130 A1 (REDBEARD VENTURES LLC) May 22, 2014; entire document	1-6
A	WO 2014/028758 A1 (ANTHREX, INC.) February 20, 2014; entire document	1-6
A	US 2011/0208004 A1 (FEINGOLD, BH, et al.) August 25, 2011; entire document	1-6

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

18 May 2017 (18.05.2017)

Date of mailing of the international search report

02 JUN 2017

Name and mailing address of the ISA/

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents  
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

PCT Helpdesk: 571-272-4300  
PCT OSP: 571-272-7774

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US17/17199

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-6 are directed toward a method for visualizing a scene of interest, the method comprising capturing a video signal, determining, with a processor, that the scene of interest is overexposed or underexposed, sending a signal to correct for overexposure or underexposure.

Group II: Claims 7-11 are directed toward a method of gripping an endoscope coupled with a camera, the method comprising: gripping the camera, wherein a distance between the grip member and the transmitter is at least 5 centimeters.

\*\*\*-Continued Within the Next Supplemental Box-\*\*\*

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1-6

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

\*\*\*\*-Continued from Box No. III -\*\*\*\*

Group III: Claims 12-21 are directed toward a wireless endoscopic camera system, comprising a grip region comprising a face and an attachment collar, a ledge comprising a first concavity and a second concavity adapted to accommodate the user's fingers.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons.

The special technical features of Group I include advancing a distal end of an endoscope to the scene of interest; illuminating the scene of interest (which is not present in Groups II or III) using an illumination source coupled to the endoscope (which is not present in Group II); capturing a video signal of the scene of interest using a camera coupled to the endoscope, the camera having one or more video capture characteristics affecting exposure of the video signal of the scene of interest; determining, with a processor, that the scene of interest is overexposed or underexposed in the captured video signal; and changing a light output of the illumination source, by sending a signal from the camera to the light source, while maintaining the same one or more video capture characteristics affecting exposure of the video signal, to correct for overexposure or underexposure of the video signal (which is not present in Groups II or III).

The special technical features of Group II include gripping the camera by placing a hand on a grip member at a first end of the camera (which is not present in Groups I or III), wherein a transmitter of the camera is located near a second end of the camera, opposite the first end (which is not present in Group I), wherein a distance between the grip member and the transmitter is at least 5 centimeters, and wherein a balance point of the camera and the endoscope, when they are coupled together, is located at the grip member (which is not present in Groups I or III).

The special technical features of Group III include a grip region at a first end of the endoscopic camera (which is not present in Group I), the grip region comprising a face and an attachment collar extending from the face in a first direction perpendicular to the grip region, wherein the attachment collar is adapted to couple the endoscopic camera to an endoscope; a ledge extending from the grip region in the first direction, below the attachment collar, wherein the ledge is configured to resist movement of the endoscopic camera in a user's hand, and wherein the ledge comprises a first concavity and a second concavity separated by a first convexity, wherein the first and second concavities are adapted to accommodate the user's fingers (which is not present in Groups I or II); and a wireless transmitter located near a second end of the camera opposite the first end (which is not present in Group I); and a light source directly coupleable to an endoscope (which is not present in Group II) and not requiring connection to a separate light box device (which is not present in Groups I or II).

The common technical features of Groups I, II, and III include an illumination source coupled to an endoscope, a camera coupled to the endoscope, a grip region at a first end of the endoscopic camera, wherein a transmitter of the camera is located near a second end of the camera, opposite the first end.

These common technical features are disclosed by US 2001/0015754 A1 (NAKASHIMA): an illumination source (light source unit 22; figure 1) coupled to an endoscope (20), a camera (30) coupled to the endoscope (20; figure 1), a grip region (at tube 25) at a first end of the endoscopic camera (at the lower end; figure 1), wherein a transmitter (transmitter antenna 32) of the camera (30; figure 1) is located near a second end (upper end) of the camera, opposite the first end (opposite the first, lower end; figure 1).

Because the common technical features are disclosed by Nakashima, the inventions are not so linked as to form a single general inventive concept. Therefore, Groups I-III lack unity.