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(54) **HANDHELD WIRELESS ENDOSCOPE IMAGE STREAMING APPARATUS**

(71) Applicant: **Phaox LLC**, Yardley, PA (US)

(72) Inventors: **Nishant Reddy**, Yardley, PA (US); **Amit Patel**, Providence, RI (US); **Michael Pfisterer**, Lafayette, CA (US); **Alejandro Vazquez**, Pawtucket, RI (US); **Trevor Pennypacker**, Menlo Park, CA (US)

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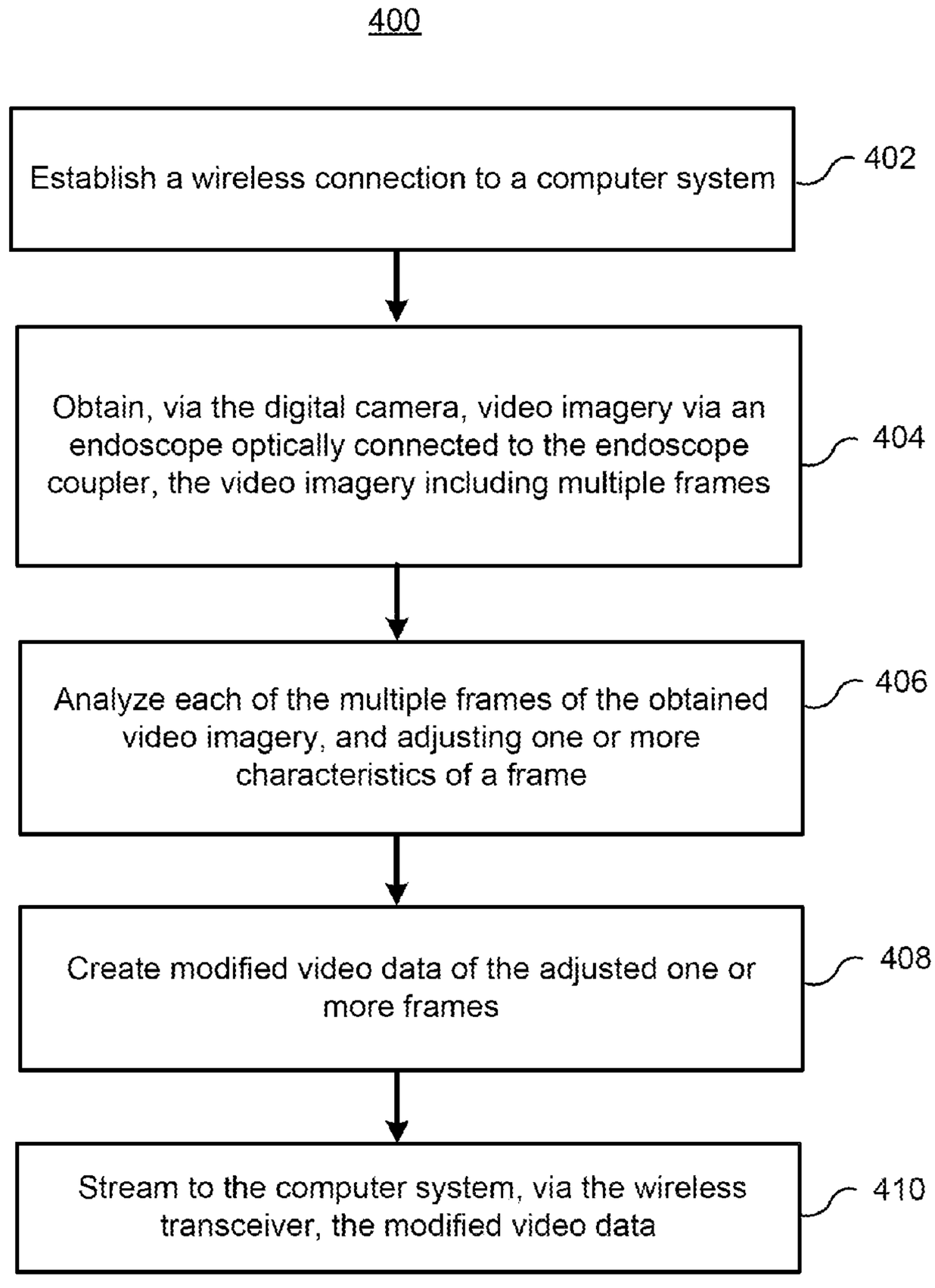
(57) **ABSTRACT**

Methods, systems, and apparatus, including computer programs encoded on computer storage media relate to a handheld wireless endoscope image streaming apparatus. The apparatus may establish a wireless connection to a computer system. The apparatus may obtain, via a digital camera, video imagery via an endoscope, the video imagery including multiple frames. The apparatus may stream to a computer system video data.



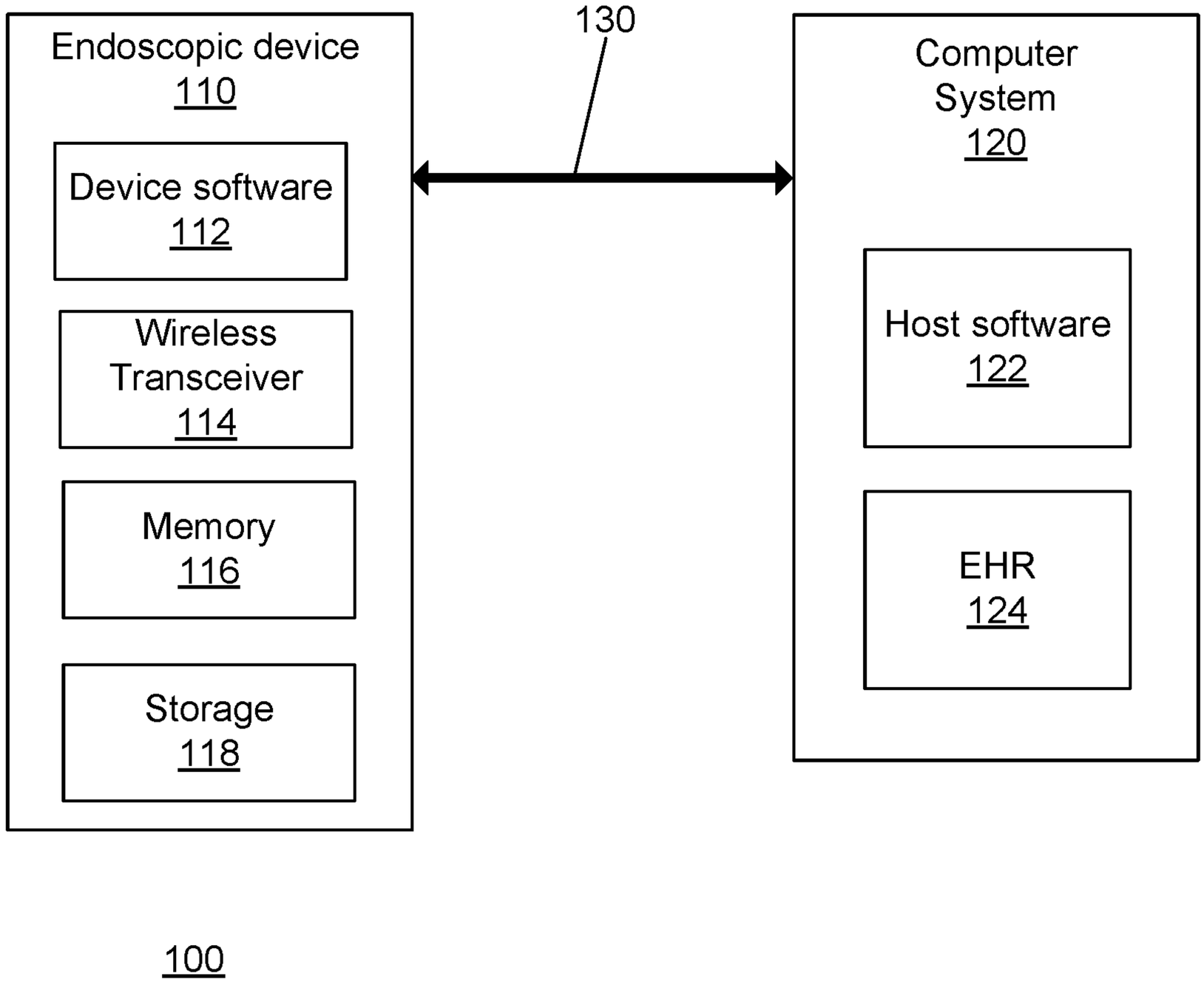

Endoscopic device
110
Device software
112
Wireless
Transceiver
114
Memory
116
Storage
118
130
Computer
System
120
Host software
122
EHR
124
100

FIG. 1

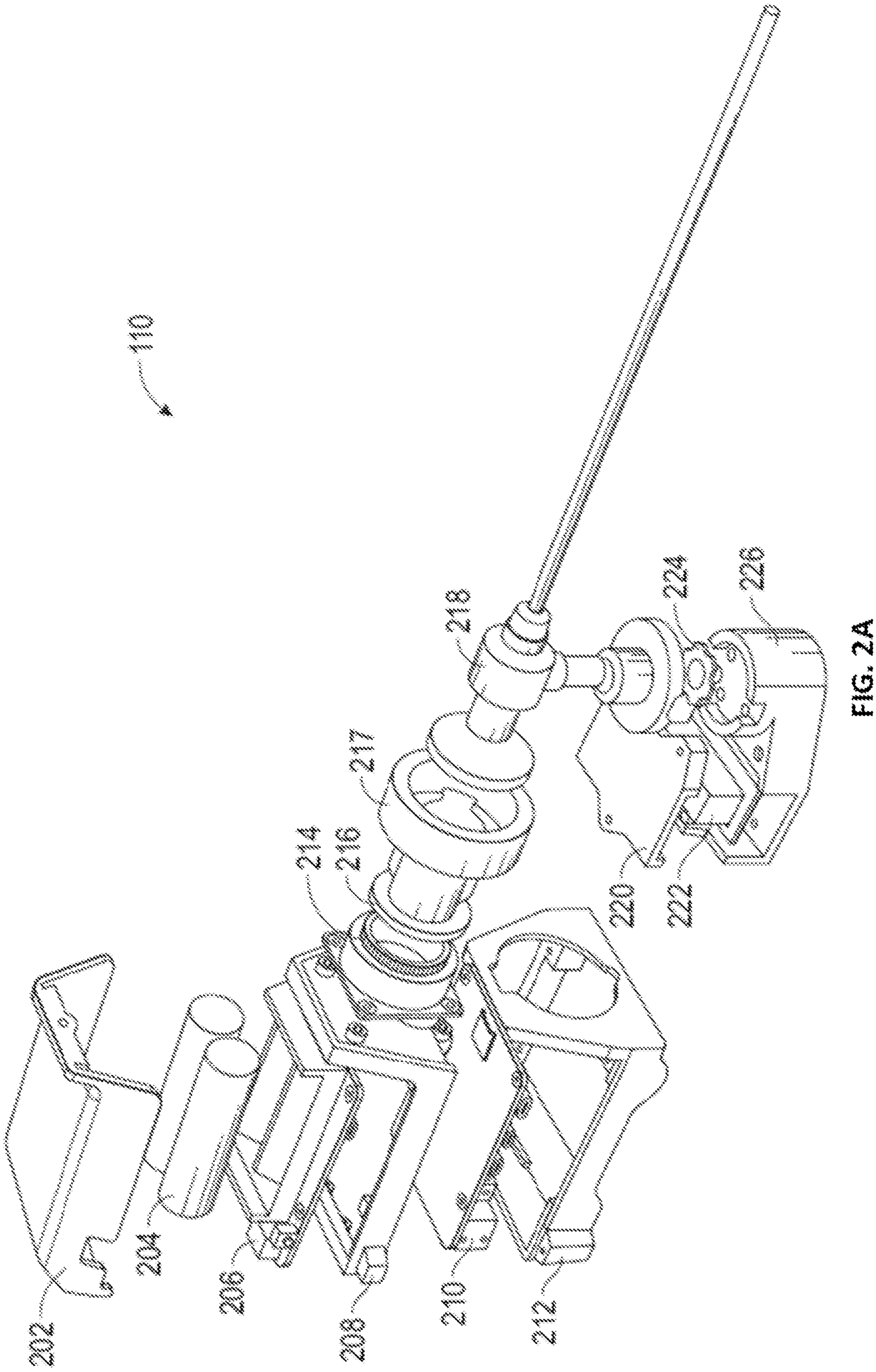


FIG. 2A

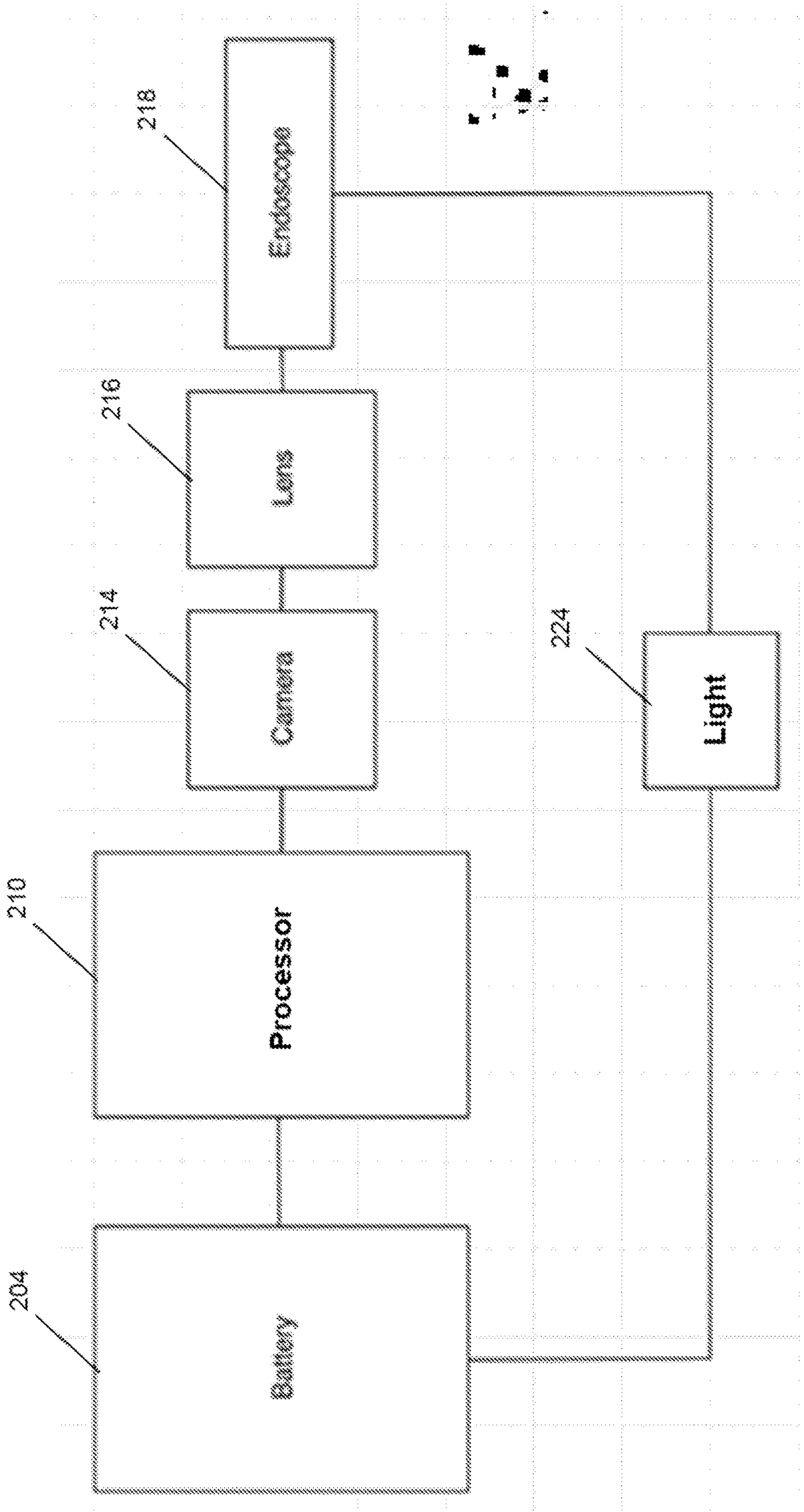

218
endoscope
216
Lens
214
Camera
224
Light
210
Processor
204
Battery

FIG. 2B

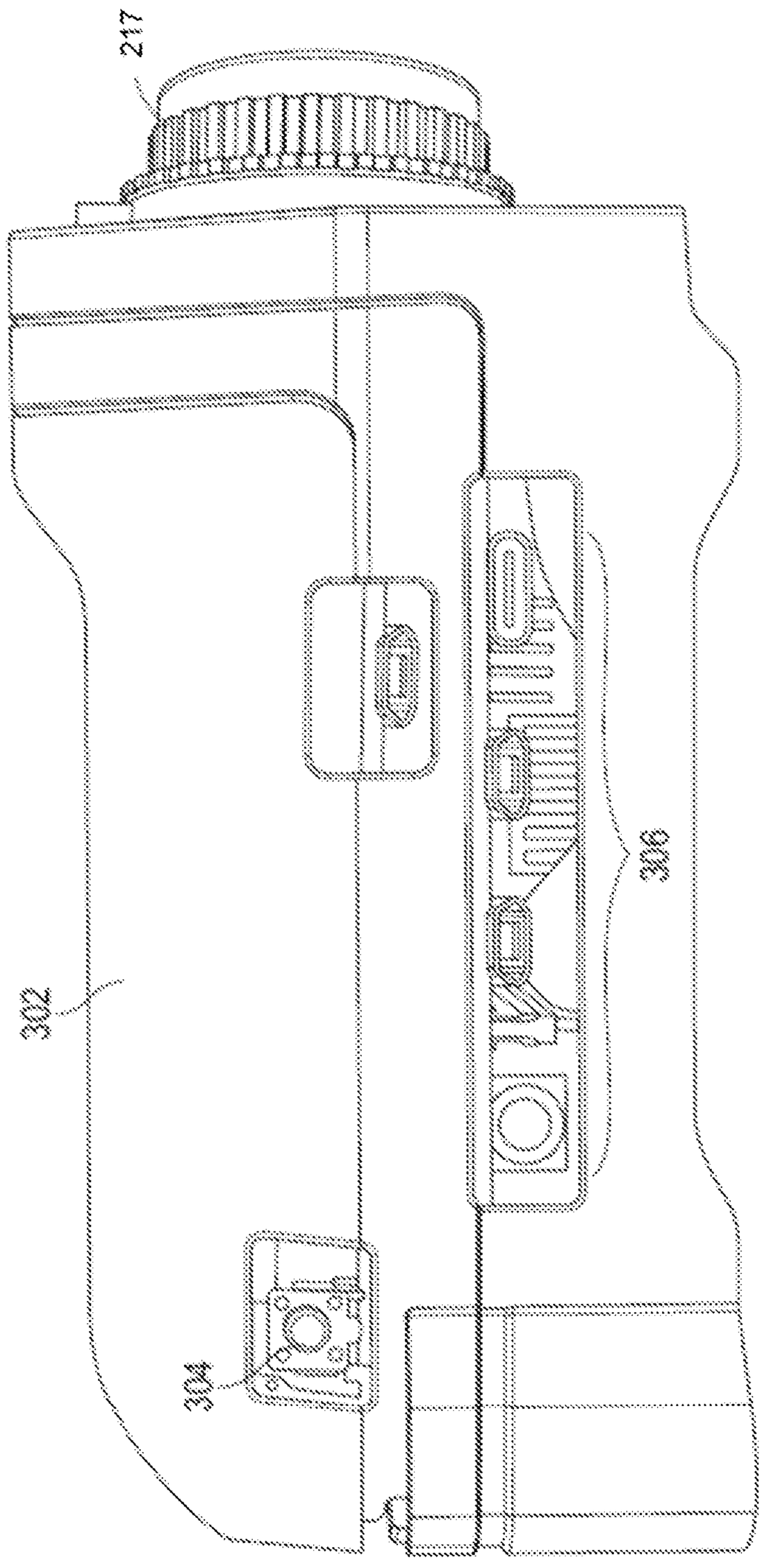


FIG. 3A

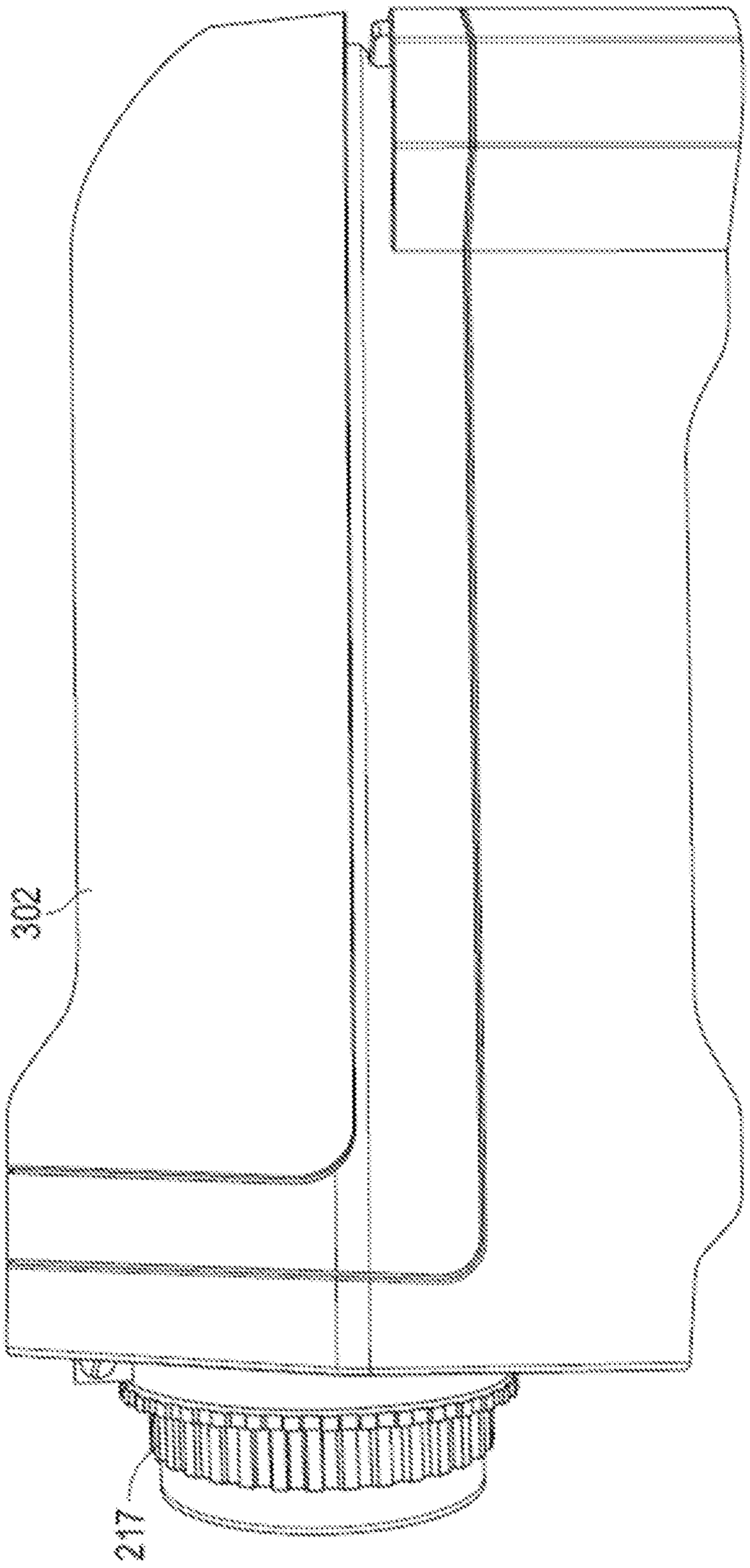


FIG. 3B

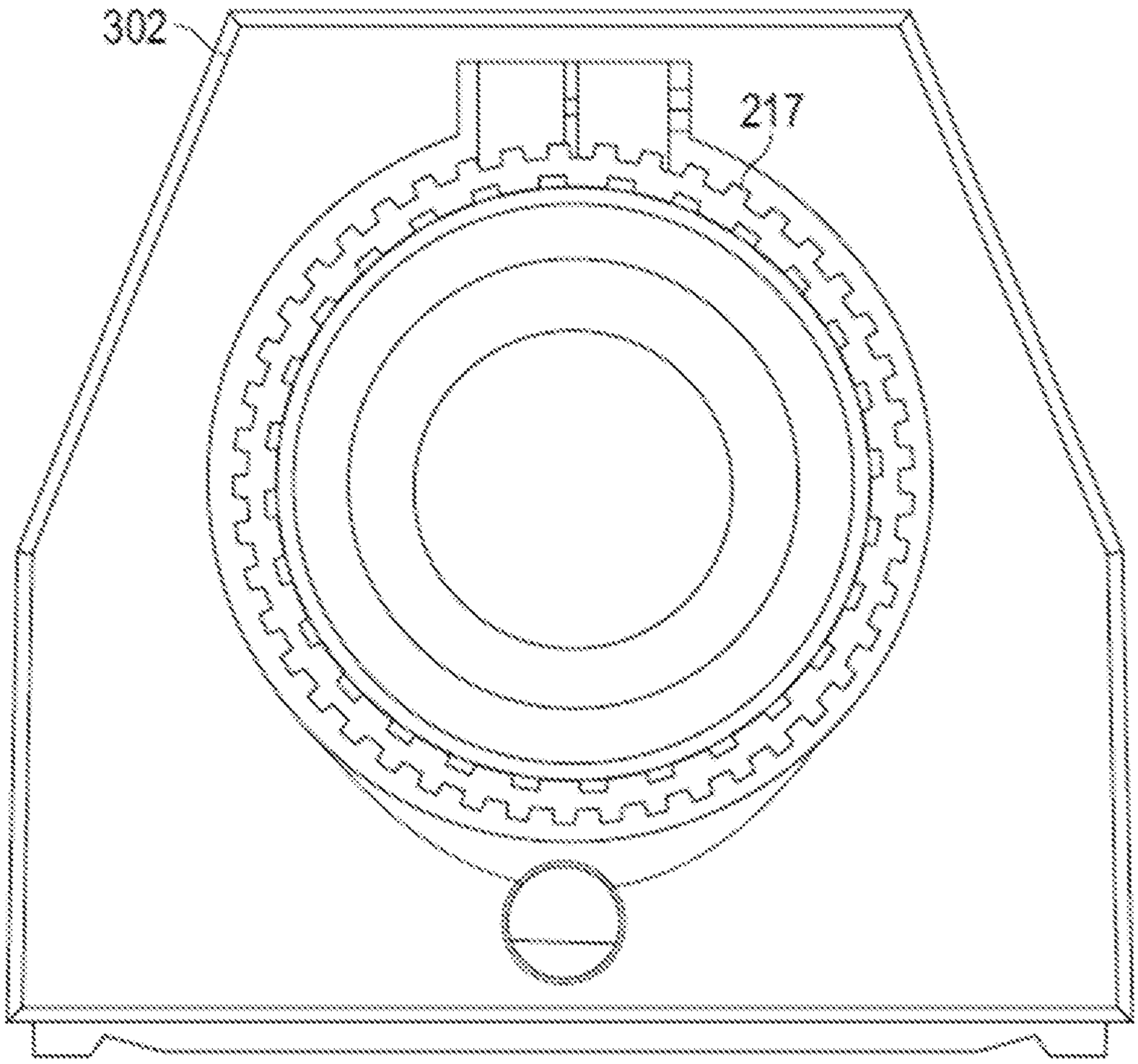


FIG. 3C

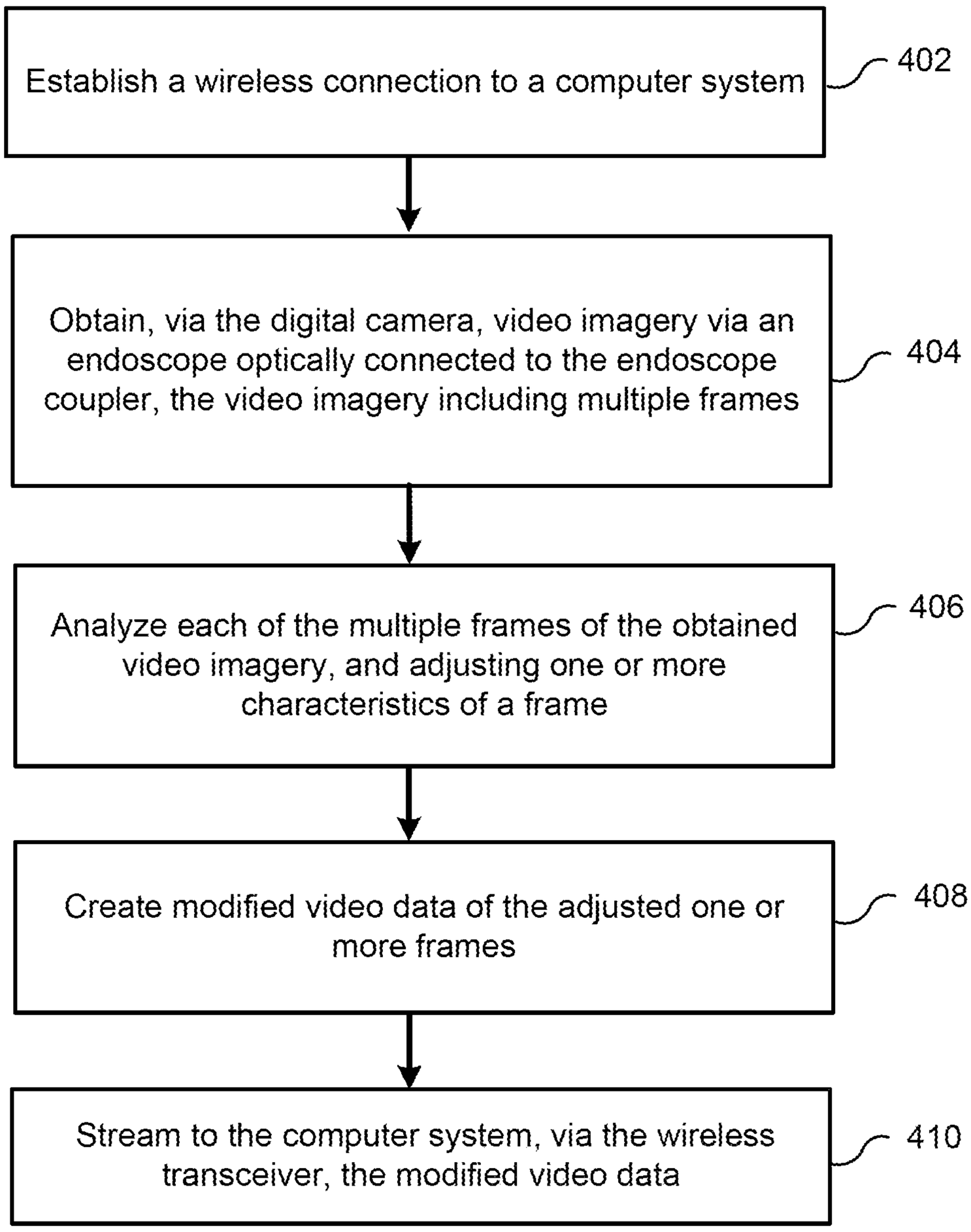

400
Establish a wireless connection to a computer system
402
Obtain, via the digital camera, video imagery via an endoscope optically connected to the endoscope coupler, the video imagery including multiple frames
404
Analyze each of the multiple frames of the obtained video imagery, and adjusting one or more characteristics of a frame
406
Create modified video data of the adjusted one or more frames
408
Stream to the computer system, via the wireless transceiver, the modified video data
410

FIG. 4

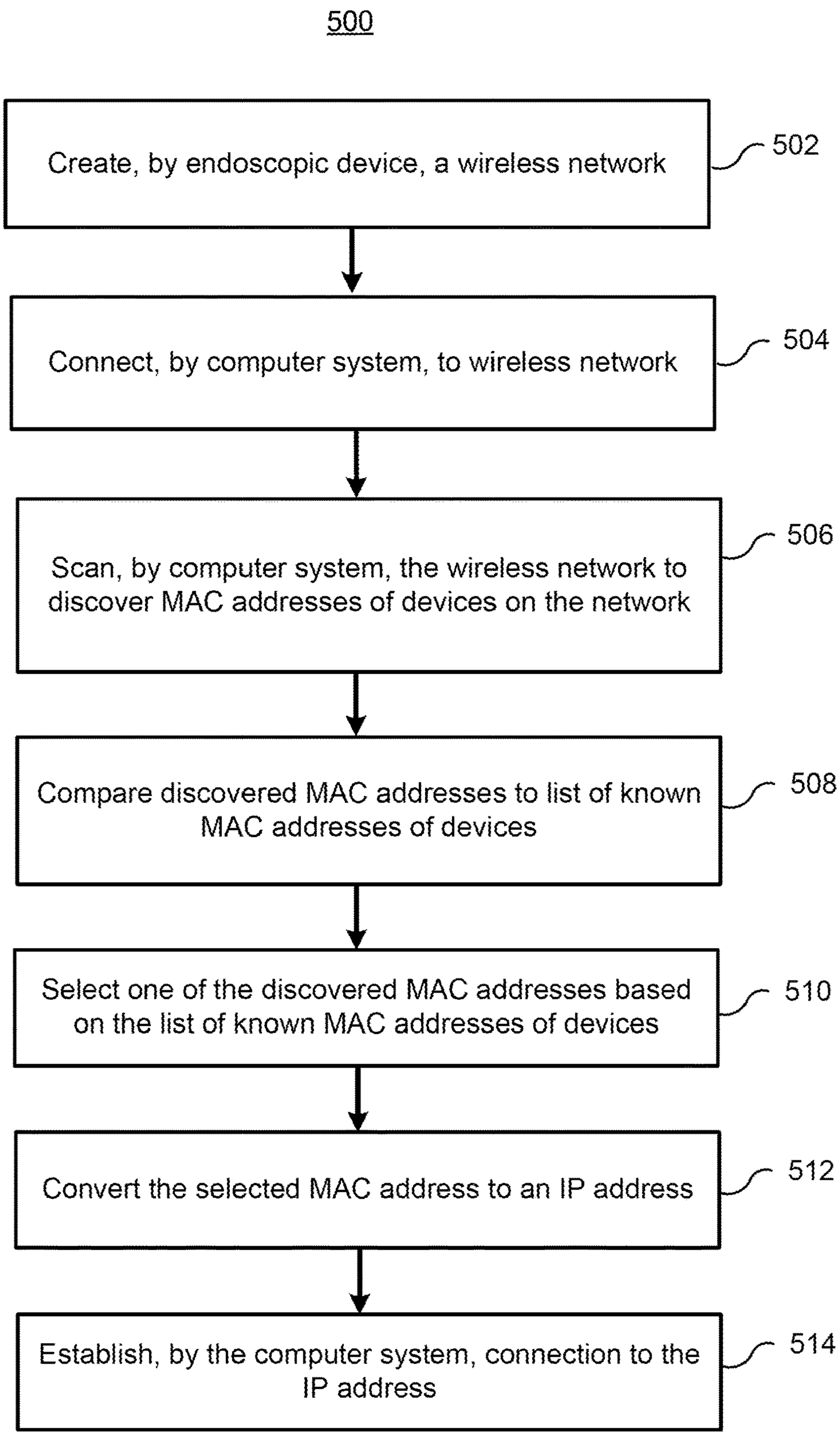

500
Create, by endoscopic device, a wireless network
502
Connect, by computer system, to wireless network
504
Scan, by computer system, the wireless network to discover MAC addresses of devices on the network
506
Compare discovered MAC addresses to list of known MAC addresses of devices
508
Select one of the discovered MAC addresses based on the list of known MAC addresses of devices
510
Convert the selected MAC address to an IP address
512
Establish, by the computer system, connection to the IP address
514

FIG. 5

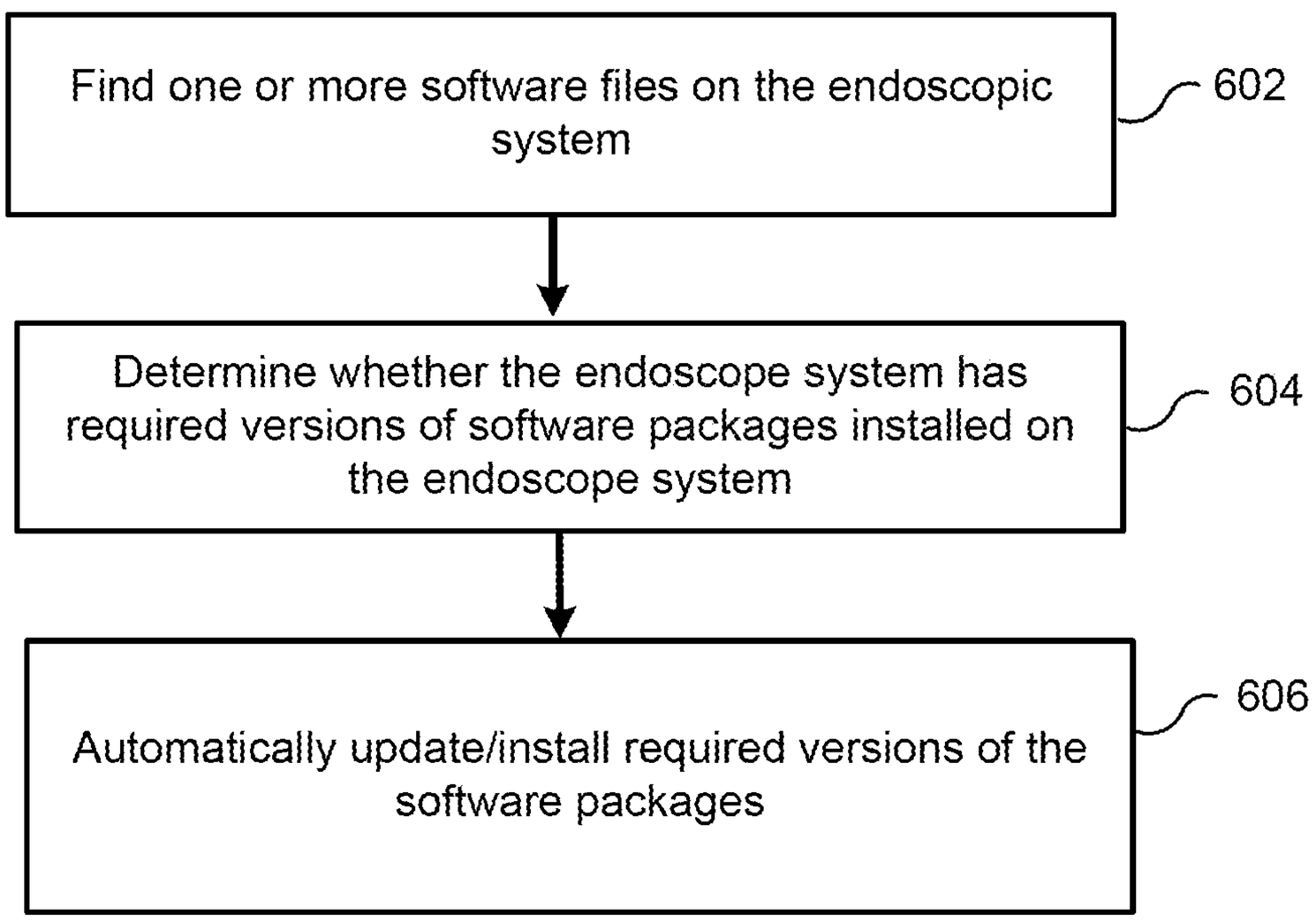

600
Find one or more software files on the endoscopic system
602
Determine whether the endoscope system has required versions of software packages installed on the endoscope system
604
Automatically update/install required versions of the software packages
606

FIG. 6

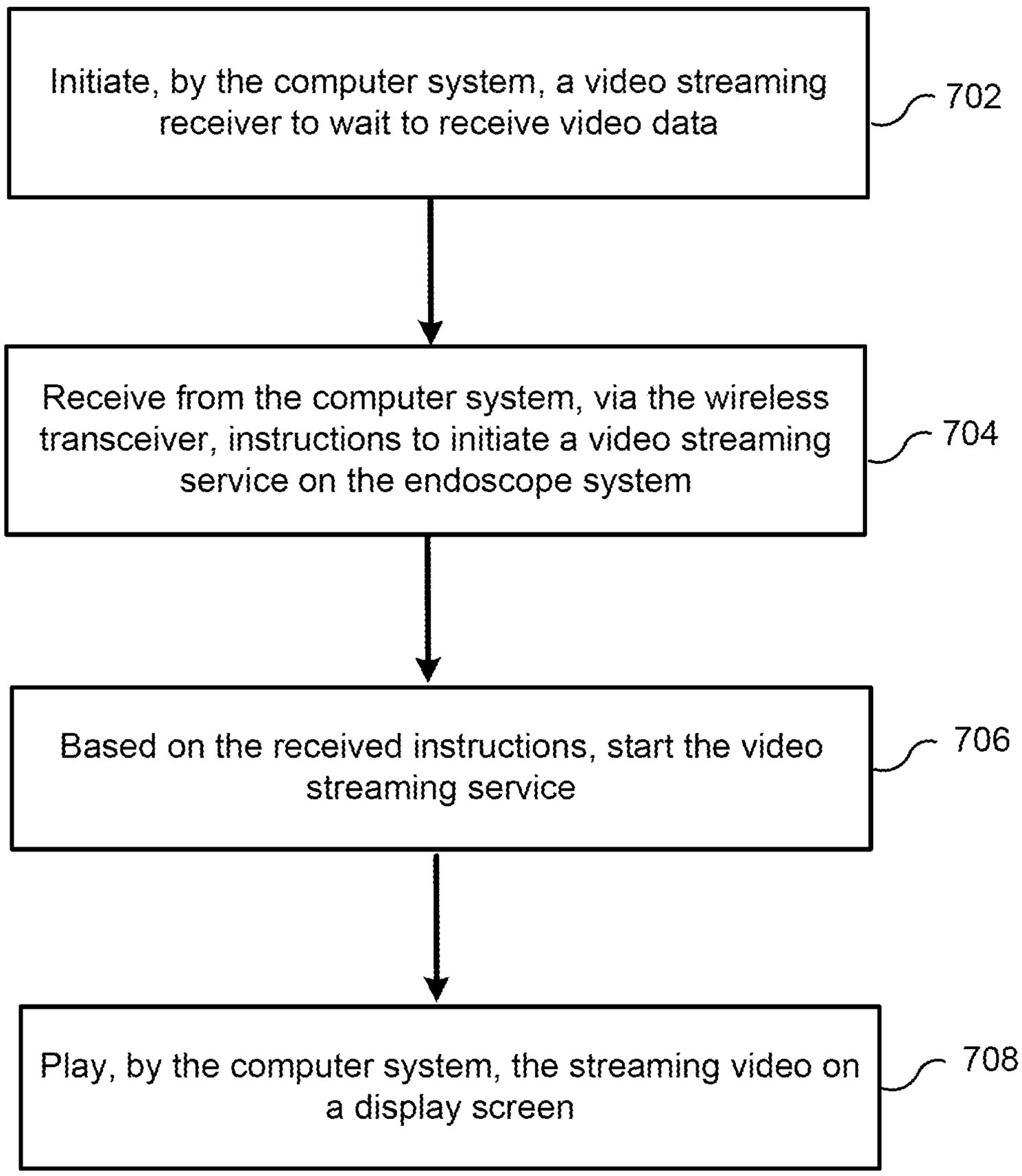

700
Initiate, by the computer system, a video streaming receiver to wait to receive video data
702
Receive from the computer system, via the wireless transceiver, instructions to initiate a video streaming service on the endoscope system
704
Based on the received instructions, start the video streaming service
706
Play, by the computer system, the streaming video on a display screen
708

FIG. 7

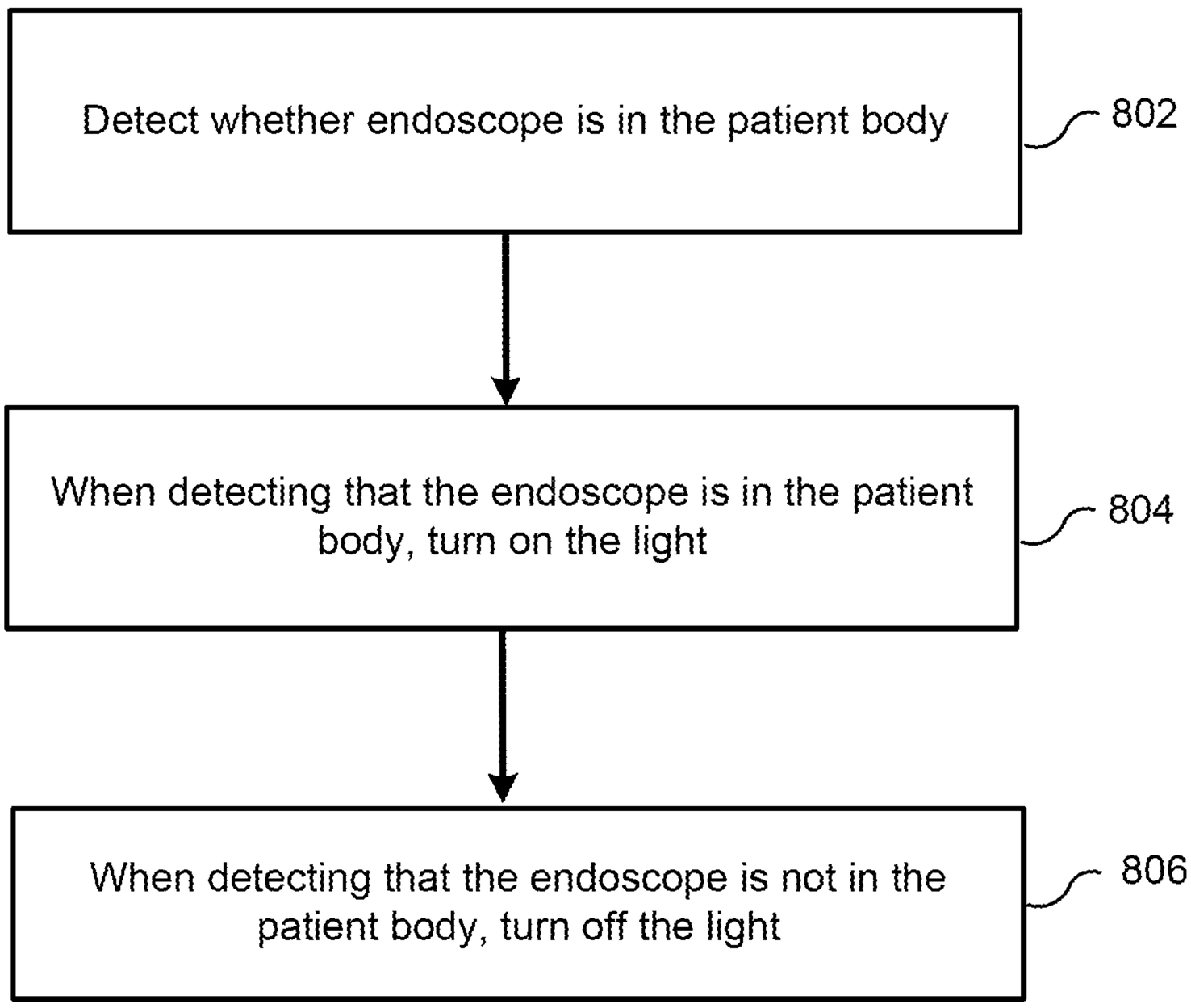

800
Detect whether endoscope is in the patient body
802
When detecting that the endoscope is in the patient body, turn on the light
804
When detecting that the endoscope is not in the patient body, turn off the light
806

FIG. 8

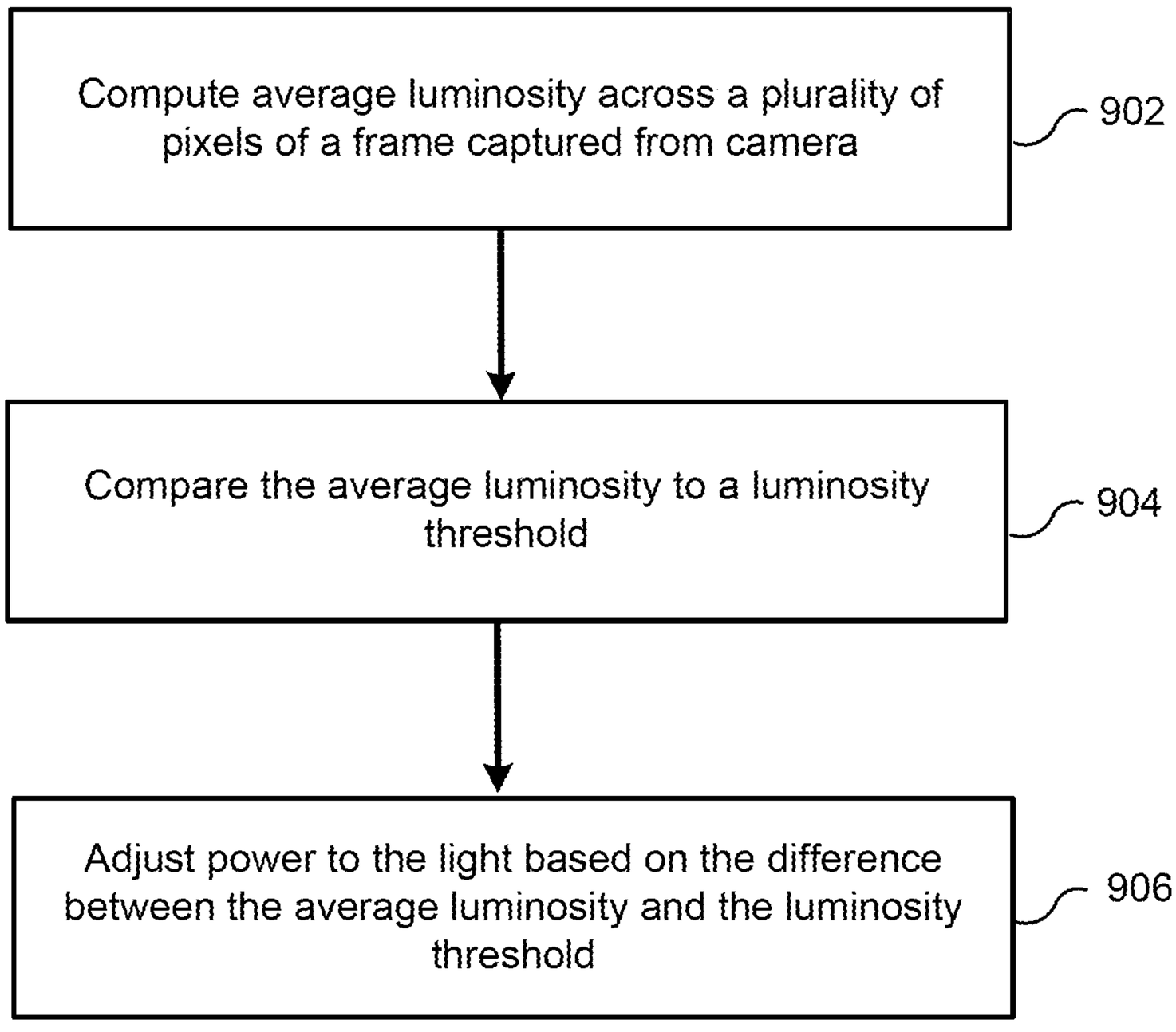

900
Compute average luminosity across a plurality of pixels of a frame captured from camera
902
Compare the average luminosity to a luminosity threshold
904
Adjust power to the light based on the difference between the average luminosity and the luminosity threshold
906

FIG. 9

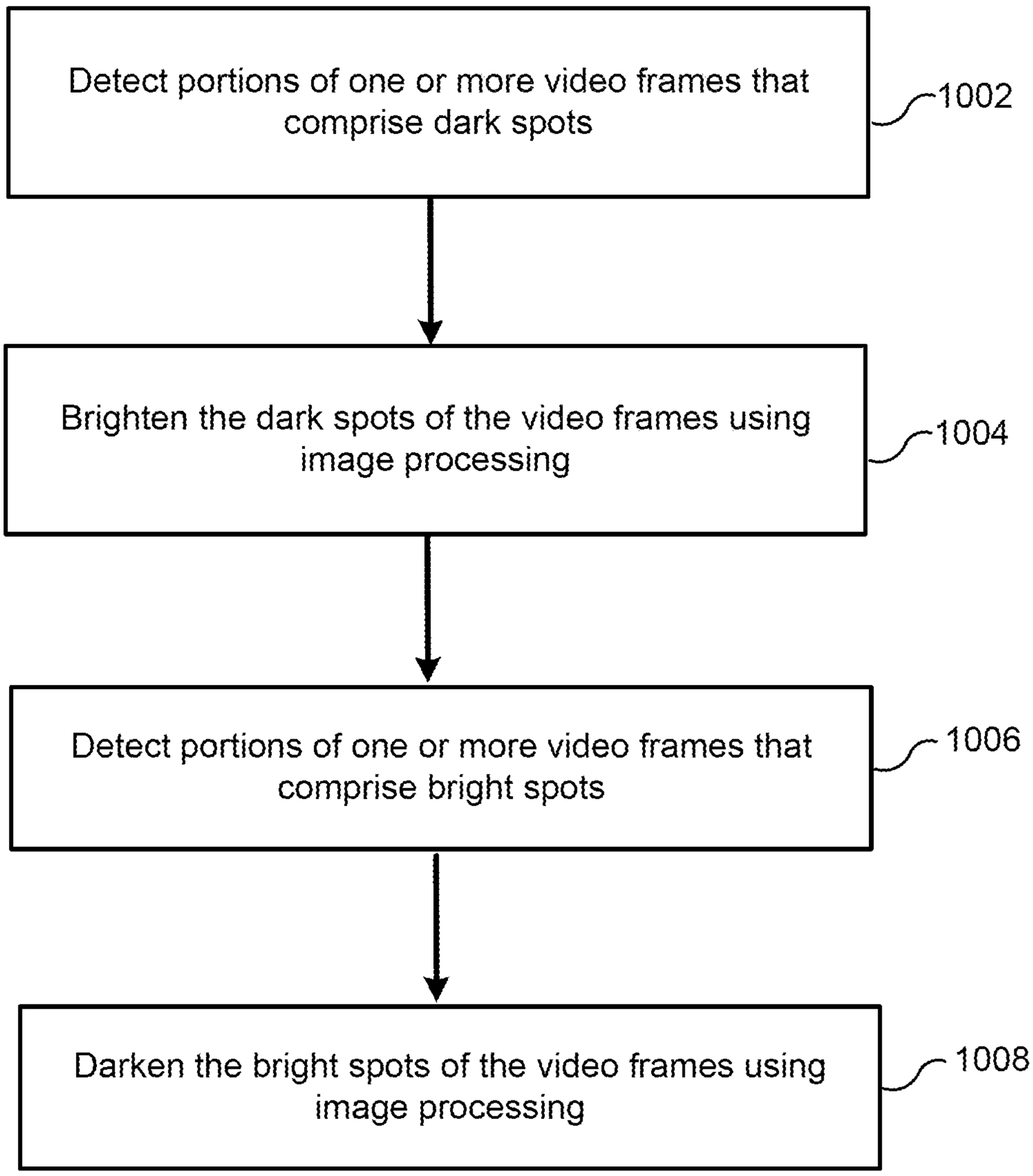

1000
Detect portions of one or more video frames that comprise dark spots
1002
Brighten the dark spots of the video frames using image processing
1004
Detect portions of one or more video frames that comprise bright spots
1006
Darken the bright spots of the video frames using image processing
1008

FIG. 10

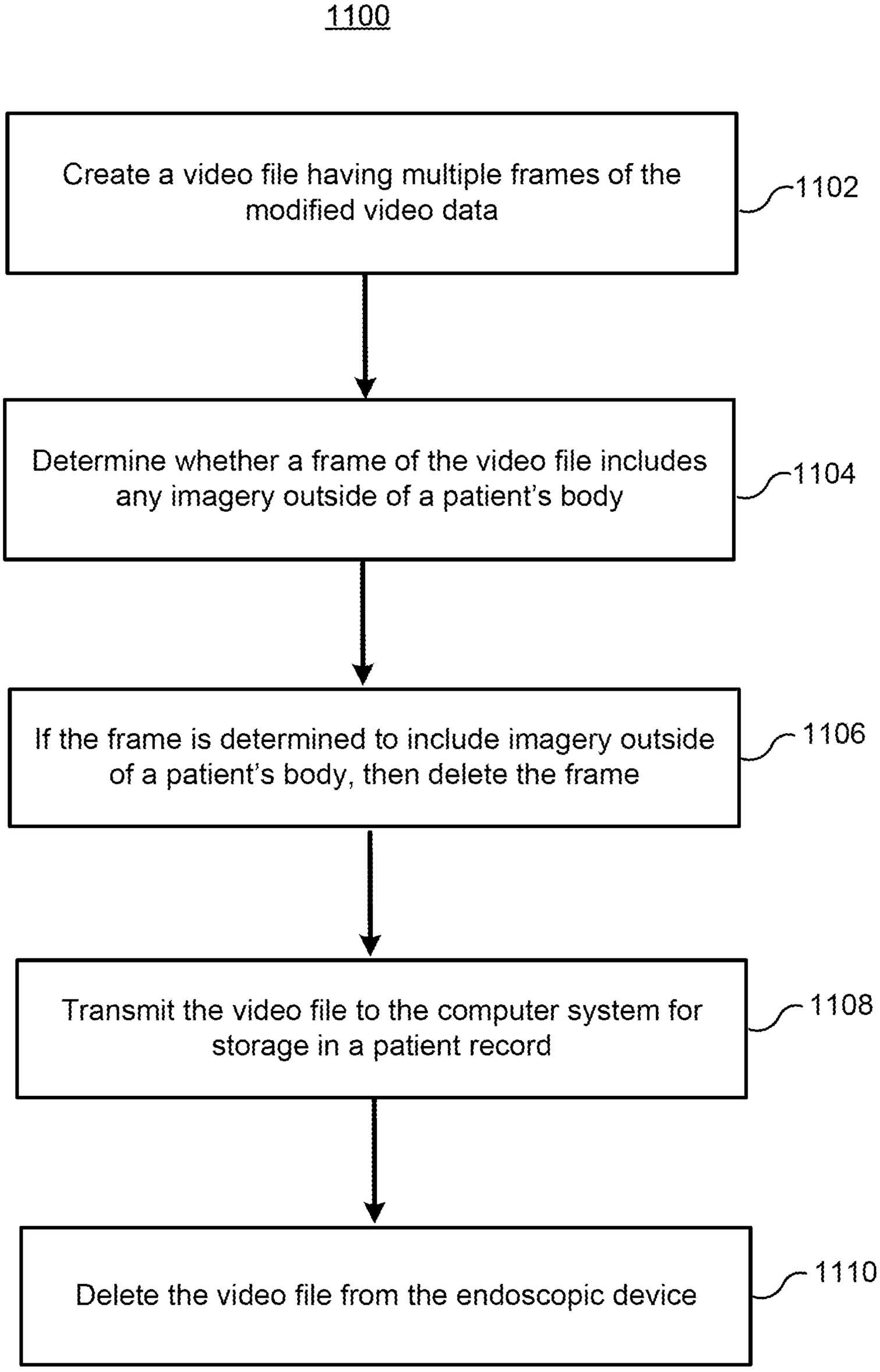

1100
Create a video file having multiple frames of the modified video data
1102
Determine whether a frame of the video file includes any imagery outside of a patient's body
1104
If the frame is determined to include imagery outside of a patient's body, then delete the frame
1106
Transmit the video file to the computer system for storage in a patient record
1108
Delete the video file from the endoscopic device
1110

FIG. 11

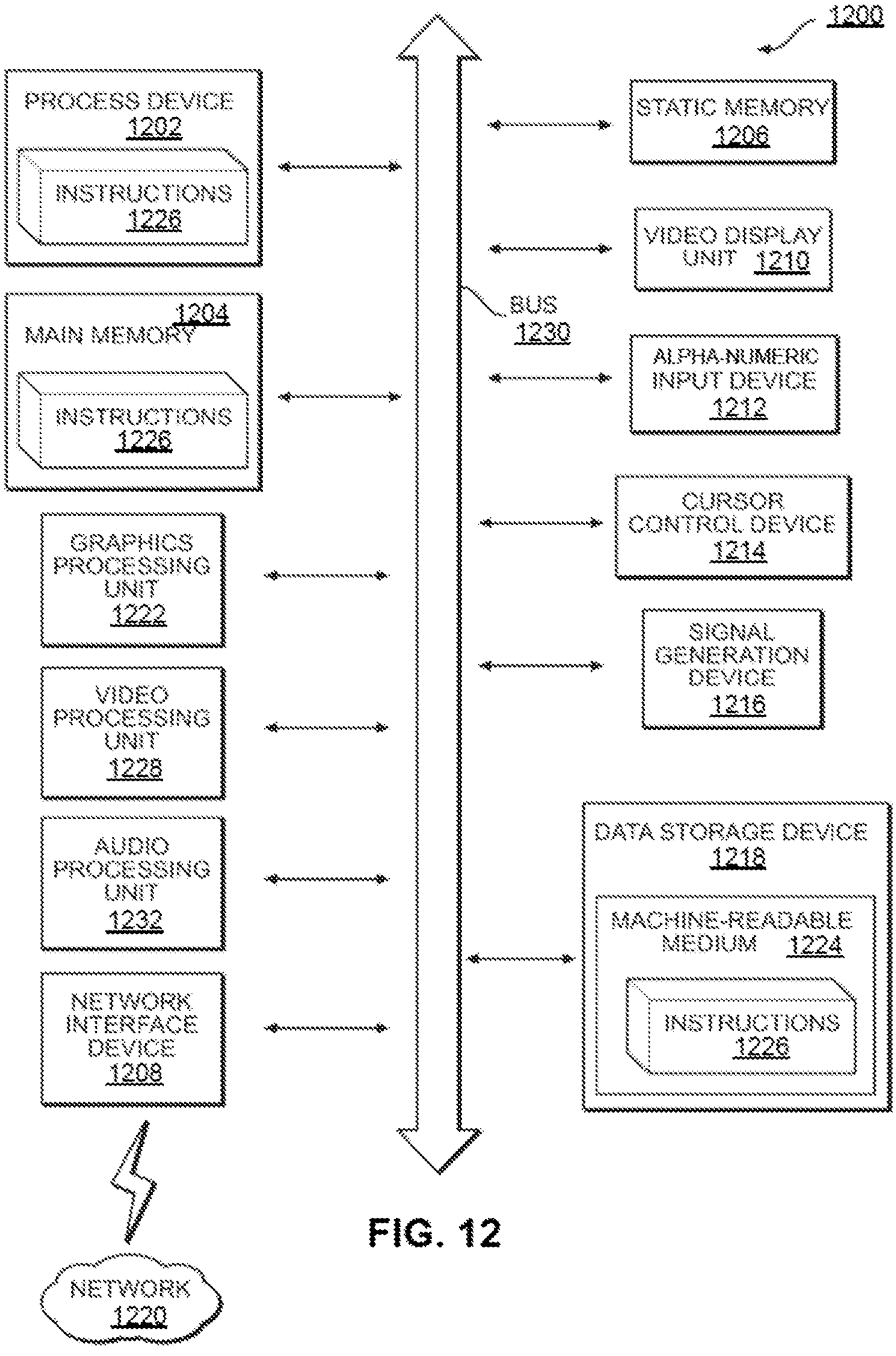

1200
PROCESS DEVICE
1202
INSTRUCTIONS
1226
MAIN MEMORY
1204
INSTRUCTIONS
1226
GRAPHICS PROCESSING UNIT
1222
VIDEO PROCESSING UNIT
1228
AUDIO PROCESSING UNIT
1232
NETWORK INTERFACE DEVICE
1208
NETWORK
1220
STATIC MEMORY
1206
VIDEO DISPLAY UNIT
1210
BUS
1230
ALPHA-NUMERIC INPUT DEVICE
1212
CURSOR CONTROL DEVICE
1214
SIGNAL GENERATION DEVICE
1216
DATA STORAGE DEVICE
1218
MACHINE-READABLE MEDIUM
1224
INSTRUCTIONS
1226

FIG. 12

HANDHELD WIRELESS ENDOSCOPE IMAGE STREAMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional application and claims the benefit of provisional U.S. Patent Application No. 63/225,440, filed Jul. 23, 2021, which is hereby incorporated by reference in its entirety.

FIELD

[0002] This application related generally to endoscope devices, and more particularly, to systems and methods for a handheld wireless endoscope image streaming apparatus.

BACKGROUND

[0003] Traditional endoscopic systems are prohibitively bulky and difficult to use. In typical wired endoscopic devices, the endoscopic device is connected to a computer system by one or more cables that may transmit imagery, light, and power. However, the cables are bulky, hard to sanitize, and weigh the instrument down. Moreover, they render the device difficult to maneuver and to transport. In existing wireless endoscopic systems, the endoscopic device requires a dedicated receiver box for communicating with the endoscopic device. These systems are expensive, take up more physical space, and are difficult to transport. It would be desirable for an endoscopic device to stream imagery wirelessly to a computer system without requiring an external receiver box to avoid the disadvantages of traditional systems.

SUMMARY

[0004] In general, one innovative aspect of the subject described in this specification can be embodied in systems, computer readable media, and methods for a handheld wireless endoscopic image streaming apparatus. One system comprises a portable wireless endoscope system comprising a hand-held body comprising a housing, the housing containing a battery-operated onboard processor, a wireless transceiver, a digital camera and a storage system contained within the housing, and the housing having an endoscope coupler with a lens and an attachment connector. The system establishes a wireless connection to a computer system. The system obtains, via the digital camera, video imagery via an endoscope optically connected to the endoscope coupler, the video imagery including multiple frames. The system analyzes each of the multiple frames of the obtained video imagery and adjusts one or more characteristics of a frame. The system creates modified video data of the adjusted one or more frames. The system streams to the computer system, via the wireless transceiver, the modified video data.

[0005] In another aspect of the system, the system receives from the computer system, via the wireless transceiver, instructions to initiate a video streaming service on the endoscope system. Based on the received instructions, the system starts the video streaming service.

[0006] In another aspect of the system, the system receives a start command from the computer system to begin obtaining video imagery. Based on the received command, the system starts image acquisition by the camera of endoscope system. The system receives a stop command from the computer system to stop obtaining video imagery. Based on the received stop command, the system stops image acquisition by the camera.

[0007] In another aspect of the system, the system creates a video file having multiple frames of the modified video data. The system determines whether a frame of the video file includes any imagery outside of a patient's body. If the frame is determined to include imagery outside of a patient's body, then the system deletes the frame.

[0008] In another aspect of the system, the system controls a light source to illuminate an endoscope optically coupled to the wireless endoscope system.

[0009] In another aspect of the system, the system determines an average luminosity across multiple pixels of a frame. The system adjusts power being passed to the light source to increase or decrease the luminosity of the light source to a predetermined luminosity value or range.

[0010] In another aspect of the system, the system establishes a connection with the computer system, where the computer system has determined the IP address of the endoscope system.

[0011] In another aspect of the system, the system initiates a video streaming receiver service on the computer system.

[0012] In another aspect of the system, the system determines whether the endoscope system has required versions of software packages installed on the endoscope system. The system automatically updates or installs required versions of the software packages.

[0013] In another aspect of the system, the one or more characteristics of the frame include heat transfer and artificial illumination.

[0014] Further areas of applicability of the present disclosure will become apparent from the detailed description, the claims and the drawings. The detailed description and specific examples are intended for illustration only and are not intended to limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present disclosure will become better understood from the detailed description and the drawings, wherein:

[0016] FIG. **1** illustrates an exemplary environment where embodiments of a handheld wireless endoscopic image streaming apparatus may operate.

[0017] FIG. **2**A illustrates an exploded view of an embodiment of an endoscopic device.

[0018] FIG. **2**B illustrates an exemplary block diagram of an embodiment of an endoscopic device.

[0019] FIG. **3**A illustrates a left side view of an embodiment of an endoscopic device.

[0020] FIG. **3**B illustrates a right side view of an embodiment of an endoscopic device.

[0021] FIG. **3**C illustrates a front view of an embodiment of an endoscopic device.

[0022] FIG. **4** illustrates an exemplary method **400** for wirelessly transmitting frames to a computer system.

[0023] FIG. **5** illustrates an exemplary method for establishing a wireless connection between an endoscopic device and a computer system.

[0024] FIG. **6** illustrates an exemplary method for updating and installing software on an endoscopic device.

[0025] FIG. **7** illustrates an exemplary method for streaming video from an endoscopic device to a computer system.

[0026] FIG. **8** illustrates an exemplary method for controlling a light based on whether an endoscope is in a cavity of a patient's body.

[0027] FIG. **9** illustrates an exemplary method for controlling power to a light.

[0028] FIG. **10** illustrates an exemplary method for adjusting one or more frames of video to create modified video data.

[0029] FIG. **11** illustrates an exemplary method for selectively deleting frames of a video file.

[0030] FIG. **12** illustrates an exemplary computer system for performing any one or more of the methodologies discussed herein.

DETAILED DESCRIPTION

[0031] In this specification, reference is made in detail to specific embodiments of the invention. Some of the embodiments or their aspects are illustrated in the drawings.

[0032] For clarity in explanation, the invention has been described with reference to specific embodiments, however it should be understood that the invention is not limited to the described embodiments. On the contrary, the invention covers alternatives, modifications, and equivalents as may be included within its scope as defined by any patent claims. The following embodiments of the invention are set forth without any loss of generality to, and without imposing limitations on, the claimed invention. In the following description, specific details are set forth in order to provide a thorough understanding of the present invention. The present invention may be practiced without some or all of these specific details. In addition, well known features may not have been described in detail to avoid unnecessarily obscuring the invention.

[0033] In addition, it should be understood that steps of the exemplary methods set forth in this exemplary patent can be performed in different orders than the order presented in this specification. Furthermore, some steps of the exemplary methods may be performed in parallel rather than being performed sequentially. Also, the steps of the exemplary methods may be performed in a network environment in which some steps are performed by different computers in the networked environment.

[0034] Some embodiments are implemented by a computer system. A computer system may include a processor, a memory, and a non-transitory computer-readable medium. The memory and non-transitory medium may store instructions for performing methods and steps described herein.

[0035] FIG. **1** illustrates an exemplary environment **100** where embodiments of a handheld wireless endoscopic image streaming apparatus may operate. Endoscopic device **110** may comprise a handheld wireless apparatus for streaming endoscopic images. Endoscopic device **110** may capture, for example, endoscopic video and photos. Endoscopic device **110** may include device software **112** stored and operating on the device. Computer system **120** may comprise a computer system such as desktop, laptop, tablet, server, mobile device, embedded device, augmented reality/virtual reality device, and other computer systems. The endoscopic device **110** and computer system **120** may be wirelessly connected via connection **130**. Connection **130** may comprise a network, such as a local wireless network, intranet, local area network, the Internet, or other network. Computer system **120** may include host software **122** that interfaces and communicates over connection **130** with device software **112** and may include electronic health records (EHR) system **124**. The EHR **124** may comprise a digital version of patient medical charts that are maintained by a medical provider for a plurality of patients. In some embodiments, the EHR **124** may be stored on an external server and accessed by the computer system **120** through a network.

[0036] In exemplary environment **100**, endoscopic device **110** wirelessly streams endoscopic imagery directly to computer system **120** without needing an intermediate device such as a receiver box or cable box to communicate with computer system **120**, which favorably impacts the cost of the system, reduces space needs, and improves portability. In one embodiment, the endoscopic device **110** may be portable between different computer systems in different clinical areas, allowing the endoscopic device **110** to be transported with little or no external equipment.

[0037] FIG. **2**A illustrates an exploded view of an embodiment of the endoscopic device **110**. Endoscopic device **110** may comprise a case, including a top case portion **202**, middle case portion **208**, and bottom case portion **212**. The case may be made of any material such as plastic, metal, composites, and other materials. In some embodiments, the case may comprise a 3D printed plastic enclosure. The case may be ergonomic and easy to hold. In some embodiments, the endoscopic device **110** may be configured to fit in one hand. Endoscopic device **110** may include or more batteries **204** for powering the device. Batteries **204** may rest in the battery board **206** for holding the batteries and electrically connecting the batteries **204** to the other components of the device. In some embodiments, the batteries **204** may be rechargeable, such as via a power cable or wireless charging system of endoscopic device **110** or in a separate charging system. Processor **210** may store and execute instructions to perform operations described herein. Processor **210** may be connected to memory and a storage system comprising permanent storage for storing instructions and data. Processor may be connected to a wireless transceiver for transmitting and receiving data over wireless connection **130**. In some embodiments, the processor **210**, memory, storage system, and wireless transceiver may be embedded on one or more circuit boards.

[0038] Digital camera **214** may be controlled by processor **210** and be configured for capturing video and still images. Endoscope coupler may comprise a lens **216** and attachment connector **217**. Lens **216** may be used in conjunction with digital camera **214** to focus light on the digital sensor of the digital camera **214**. Attachment connector **217** may comprise a mechanical attachment for coupling an endoscope **218**. Endoscope **218** may comprise a flexible tube for inserting into the cavity of the body of a patient to capture medical images. The endoscope **218** may attach and detach from attachment connector **217**. Attachment connector **217** may be configured to couple with a variety of different types and models of endoscopes.

[0039] Light case may comprise a top light case portion **220** and bottom light case portion **226** for housing light **224**. Light **224** may comprise a light source, such as a light-emitting diode (LED), for radiating light into the endoscope **218** to enable the digital camera **214** to capture imagery. Boost converter **222** may be housed in the light case and may adjust voltage and current from the device to be suitable to power the light **224**. In one embodiment, the light **224**,

light case, and boost converter **222** are attachable and detachable to the side of the endoscope **218**.

[0040] FIG. **2**B illustrates an exemplary block diagram of an embodiment of the endoscopic device **110**. Battery **204** may be electrically connected to processor **210** to provide a power source. Processor **210** may be connected to camera **214** and control its operation with electrical signals. Camera **214** may be optically coupled to lens **216**, which is optically connected to endoscope **218** through which imagery passes and is captured.

[0041] In an embodiment, light **224** is powered by battery **204**. Power from the battery **204** may run through an operational amplifier voltage follower circuit, which may use a digital to analog converter of the processor **210** as a reference voltage. Then power may run through boost converter **222** to increase the voltage and reduce current of the electrical circuit to a suitable range for light **224**. In some embodiments, the light **224** may require a higher voltage than used by the processor **210** or that is provided by the battery **204** without boost converter **222**. The output voltage of the boost converter **222** may be adjustable to enable configuration of the device for different types of light **224**. The light **224** may be optically connected to the endoscope **218** to radiate light into the endoscope from its proximal end to the distal end in the cavity of a patient's body.

[0042] FIG. **3**A illustrates a left side view of an embodiment of the endoscopic device **110**. Case **302** may comprise a housing for the components of the device. Endoscopic device **110** may include a power button **304** and one or more ports **306** for optionally connecting to a power cable and for wired transmission and receipt of data from a computer system **120**. During normal endoscopic operation, the endoscopic device **110** may communicate wirelessly with computer system **120** without being plugged in. Ports **306** may be configured for use during special operations, connecting external adapters and components, debugging, recharging, and so on. Attachment connector **217** is shown with endoscope **218** detached.

[0043] FIG. **3**B illustrates a right side view of an embodiment of the endoscopic device **110**.

[0044] FIG. **3**C illustrates a front view of an embodiment of the endoscopic device **110**.

[0045] FIG. **4** illustrates an exemplary method **400** for analyzing and adjusting one or more frames of video imagery by the endoscopic device **110** and wirelessly transmitting the frames to computer system **120**. In step **402**, endoscopic device **110** establishes a wireless connection to a computer system **120**. The wireless connection may be established through a pairing process between the endoscopic device **110** and computer system **120** and may be configured to connect over a wireless protocol such as Wi-Fi (e.g., Wifi 802.11n/ac/ax), Bluetooth, or other protocols.

[0046] In step **404**, the endoscopic device **110** obtains, via the digital camera **214**, video imagery via an endoscope **218** optically connected to the endoscope coupler, the video imagery including multiple frames. Imagery from the distal end of the endoscope **218** in the patient's body may be optically transmitted through the endoscope **218** to the digital sensors of digital camera **214**, such as by fiber optic cable. Endoscope **218** may be optically connected to light **224**. Light may be optically transmitted from light **224** from the proximal end of the endoscope **218** through the length of the endoscope **218** to its distal end to illuminate the patient's body to allow capturing imagery.

[0047] In step **406**, the endoscopic device **110** analyzes each of the multiple frames of the obtained video imagery and adjusts one or more characteristics of a frame. Processor **210** may perform image processing to adjust various characteristics of video frames such as image brightness, resolution, frame rate, contrast, color correction, visual enhancement, and so on. In some embodiments, processor **210** may perform additional processing such as artificial intelligence techniques for object detection for detecting medically significant portions of a frame, such as tumors or abnormalities. In some embodiments, one or more characteristics of a frame may further include heat transfer, artificial illumination, and other characteristics.

[0048] In step **408**, the endoscopic device **110** creates modified video data of the adjusted one or more frames. The modified video data may incorporate the image processing and adjustments made by the processor **210** in step **406**.

[0049] In step **410**, the endoscopic device **110** streams to the computer system **120**, via the wireless transceiver, the modified video data. The modified video data may be streamed in real-time to enable a clinician to view the modified video data on the computer system **120** in real-time while manipulating the endoscope **218** in the patient's body.

[0050] FIG. **5** illustrates an exemplary method **500** for establishing a wireless connection between the endoscopic device **110** and computer system **120**. Method **500** may comprise an exemplary method of pairing the endoscopic device **110** and computer system **120** to enable streaming imagery from the endoscopic device **110** to the computer system **120** and may comprise an embodiment of step **402**.

[0051] In step **502**, the endoscopic device **110** creates a wireless network, such as a Wi-Fi, Bluetooth, or other wireless network. The wireless network may be established by the wireless transceiver in accordance with instructions from the processor **210**. In an embodiment, the endoscopic device **110** creates the wireless network automatically when it is turned on via power button **304**. In some embodiments, the wireless network has an identifier, which is optionally pre-configured, to identify it as belonging to endoscopic device **110**.

[0052] In step **504**, the computer system **120** connects to the wireless network. The computer system **120** may include a wireless transceiver that monitors for wireless networks. The computer system **120** may scan for wireless networks and may connect to a wireless network comprising an identifier that is known to be associated with endoscopic device **110**. In some embodiments, one or more known identifiers for the wireless network may be configured in host software **122**.

[0053] In step **506**, the computer system **120** scans the wireless network to discover Media Access Control (MAC) addresses of devices on the network. A MAC address may comprise a hardware address of a computer device, which in some embodiments may be hardcoded. Computer system **120** may scan the wireless network by pinging devices on the network or passively monitoring data packets on the network. Computer system **120** may discover the MAC address of each active device on the wireless network.

[0054] In step **508**, the computer system **120** may compare discovered MAC addresses on the wireless network to a list of known MAC addresses of devices. The list of known MAC addresses of devices may comprise a list of MAC addresses of endoscopic devices, or a larger set of candidate devices that may be endoscopic devices. For example, in an

embodiment, the list of known MAC addresses includes the addresses of processors or network adapters comprising components of endoscopic device **110**, but which may also comprise components of other digital devices as well. The computer system **120** may determine whether discovered devices on the network comprise an endoscopic device based on comparing the discovered MAC addresses to the list of known MAC addresses of devices. In some embodiments, the list of known MAC addresses of devices may be generated during the manufacturing process for endoscopic devices **110** or processors **210**.

[0055] In step **510**, the computer system **120** may select one of the discovered MAC addresses based on the list of known MAC addresses of devices. When a match between a discovered MAC address and a MAC address on the list is found, then the computer system **120** may select the discovered MAC address. The computer system **120** may flag that the discovered MAC address is for an endoscopic device or may be a candidate for being an endoscopic device. When a discovered MAC address does not match an address on the list, then the computer system **120** may discard the MAC address as not relevant.

[0056] In step **512**, the computer system **120** may convert the selected MAC address to an Internet Protocol (IP) address. An IP address may comprise a network address of a device that allows transmitting data to and receiving data from the device over a network. In some embodiments, the computer system **120** may look up the MAC address in an address table that contains pairs of associated MAC and IP addresses. Using the address table, the computer system **120** may convert a MAC address into an associated IP address on the wireless network. The computer system **120** may store the address table or may retrieve the address table from an external device.

[0057] In step **514**, the computer system **120** may establish a connection to the IP address. The IP address being the network address of the endoscopic device **110**, a connection between the endoscopic device **110** and computer system **120** is established. In some embodiments, the endoscopic device **110** and computer system **120** may perform a handshake to confirm that the IP address belongs to the endoscopic device **110** and that the endoscopic device **110** and computer system **120** are authenticated. In some embodiments, the connection is established using a protocol with sufficient bandwidth and low latency to enable receipt of video imagery. Optionally, the connection may be encrypted. In some embodiments, the connection comprises a Secure Shell Protocol (SSH) connection that enables the computer system **120** to execute commands on the endoscopic device **110** via remote access.

[0058] Additional variations of method **500** may be used in some embodiments. Alternatively, in steps **502** and **504**, the computer system **120** may create a wireless network and endoscopic device **110** may connect to the wireless network. In a variation, in steps **502** and **504**, the endoscopic device **110** and computer system **120** may both connect to an existing wireless network in the clinical location. Moreover, in an alternative approach to steps **506-512**, a process may be performed wherein the endoscopic device **110** broadcasts a message on the wireless network including an identifier identifying itself as endoscopic device **110** and its MAC address and IP address. Computer system **120** may receive the message and authenticate the identifier, such as using public key cryptography or symmetric key cryptography, to confirm that the sender of the message is the endoscopic device **110**. Computer system **120** may establish a connection to the IP address.

[0059] Vice versa, in an alternative approach to steps **506-512**, a process may be performed wherein the computer device **120** broadcasts a message on the wireless network including an identifier indicating a request to connect to an endoscopic device and its MAC address and IP address. Endoscopic device **110** may receive the message and authenticate the identifier, such as using public key cryptography or symmetric key cryptography, to confirm that the sender of the message is computer system **120**. Endoscopic device **110** may transmit a message to the computer system **120** including an identifier identifying itself as endoscopic device **110** and its MAC address and IP address. Computer system **120** may establish a connection to the IP address.

[0060] FIG. **6** illustrates an exemplary method **600** for updating and installing software on the endoscopic device **110**. In an embodiment, after endoscopic device **110** and computer system **120** establish a wireless connection in step **402**, the computer system **120** analyzes the device software **112** on the endoscopic device **110** to determine whether the device software **112** is out of date and, if so, updates and installs new software. The check for software updates may be initiated automatically after the pairing process to enable the endoscopic device **110** to immediately update its software when necessary, prior to sending imagery to the computer system **120**.

[0061] In step **602**, the computer system **120** finds one or more software files on the endoscopic device **110**. The computer system **120** may access the file system on the storage system of the endoscopic device **110** via wireless connection **130** to search for and find software files of the endoscopic device **110**. The software files may execute methods and processes herein such as methods **400**, **500**, **600**, **700**, **800**, **900**, **1000**, **1100**. In some embodiments, the computer system **120** may find the software files by opening and retrieving a file directory location where the software files are known to be located. The file directory location may be a pre-configured location, or the file directory location may be manually input to the computer system **120** during or before the update process. Alternatively, the computer system **120** may find the software files by searching the file system of the endoscopic device **110** for file names of the software files, where the file names may be pre-configured or manually input.

[0062] In step **604**, the computer system **120** determines whether the endoscopic device **110** has required versions of software packages installed on the endoscopic device **110**. The software packages may, for example, comprise software files. The computer system **120** may check the version of the software packages and compare with a list of latest version numbers of the software packages in host software **122**. The host software **122** may update its list of latest version numbers of the software packages through a network, such as the Internet. In some embodiments, the software packages on the endoscopic device **110** may comprise version tags or fields storing their version number. In some embodiments, the computer system **120** may detect whether any expected software files on the endoscopic device **110** are missing by comparing the software files found on the endoscopic device **110** to the contents of a software repository. If the version numbers of the software packages on the endoscopic device **110** matches the latest software package version numbers

identified in the host software **122** of computer system **120**, then the software packages are not updated.

[0063] In step **606**, the computer system **120** automatically updates/installs required versions of the software packages. If any of the software packages on the endoscopic device **110** comprise a version number that is less than the latest version number, or if any software packages are missing, then the computer system **120** updates the software package by transmitting the latest version of the software package from the computer system **120** to the endoscopic device **110** and installing it on the endoscopic device **110**. The prior version of the software package on the endoscopic device may be replaced in the process. In some embodiments, the computer system **120** transfers the new version of the software package to the endoscopic device **110** using Secure File Transfer Protocol (SFTP) or other protocols. Optionally, the file transfer is performed via an encrypted connection.

[0064] FIG. **7** illustrates an exemplary method **700** for streaming video from the endoscopic device **110** to the computer system **120**. In an embodiment, after the software package versions on the endoscopic device **110** are checked and updated, the process of streaming video may be initiated automatically.

[0065] In step **702**, the computer system **120** may initiate a video streaming receiver service in the host software **122** to receive streaming video data from the endoscopic device **110**. The video streaming receiver service waits to receive transmitted video data. The computer system **120** may transmit one or more instructions to the endoscopic device over the wireless connection **130** to begin streaming video.

[0066] In step **704**, the endoscopic device **110** receives from the computer system **120**, via the wireless transceiver, instructions to initiate a video streaming service on the endoscopic device **110**.

[0067] In step **706**, based on the received instructions, the endoscopic device **110** starts the video streaming service. A plurality of frames of video data are captured from the digital camera **214**, optionally modified by the processor **210**, and streamed from the endoscopic device **110** to the computer system **120**.

[0068] In step **708**, the computer system **120** receives the streamed plurality of frames of video data at the video streaming receiver service and plays the streaming video on a display screen in real-time.

[0069] In some embodiments, start and stop commands may be issued from the computer system **120** to initiate and cease video streaming by the endoscopic device **110**. In an embodiment, a user may press a button on the computer system **120** to start video streaming, and the computer system **120** may transmit over the wireless connection **130** a start command to the endoscopic device **110**. User input to start video streaming may also comprise voice commands, gestures, touch inputs, or other controls, which may be detected and received by the computer system **120**.

[0070] The endoscopic device **110** may receive the start command from the computer system **120** to begin obtaining video imagery. Based on the received command, the endoscopic device **110** may start image acquisition by the camera **214** of the endoscopic device **110**. Imagery may be streamed via the method **700** or other methods herein.

[0071] When the endoscopic procedure is complete, a user may press a button on the computer system **120** to stop streaming or issue a voice command, gesture, touch inputs, or other controls to stop streaming. The computer system **120** may transmit over the wireless connection **130** a stop command to the endoscopic device **110**.

[0072] The endoscopic device **110** may receive the stop command from the computer system **120** to stop obtaining video imagery. Based on the received stop command, the endoscopic device **110** may stop image acquisition by the camera **214**. The endoscopic device **110** may stop the video streaming service, and computer system **120** may stop the video streaming receiver service. The endoscopic device **110** may finalize creation and storage of a video file of the video data via method **1100** or other methods herein.

[0073] FIG. **8** illustrates an exemplary method **800** for controlling the light **224** based on whether the endoscope **218** is in the patient's body. In an embodiment, method **800** may be performed during the process of image capture and streaming by the endoscopic device **110**, such as during steps **404**, **406**, **408**, **706**, and other steps herein.

[0074] In step **802**, the endoscopic device **110** detects whether the endoscope **218** is in the patient's body cavity. In some embodiments, processor **210** analyzes one or more frames of video image data captured by camera **214** and performs image processing to determine whether the distal end of the endoscope **218** is in the patient's body cavity based on the frames.

[0075] In some embodiments, processor **210** analyzes the luminosity of the pixels of a frame to determine whether the pixels are dark or bright. When the pixels are dark, the endoscope **218** may be in a dark cavity such as the patient's body cavity. Processor **210** may compute the average luminosity of one or more pixels of a frame. When the average luminosity is below a pre-configured threshold brightness, then the processor **210** may determine that the endoscope **218** is in the patient's body cavity. In some embodiments, the processor **210** may monitor the change in luminosity of the pixels of video data between frames. When the processor **210** detects that the average luminosity of pixels of video data has become darker in later frames as compared to prior frames and the change in pixel luminosity exceeds a pre-configured threshold, then the processor may determine that the endoscope **218** is in the patient's body cavity.

[0076] In some embodiments, processor **210** analyzes the color of one or more pixels of a frame to determine whether the endoscope **218** is in the patient's body. The processor **210** may detect that the color distribution of one or more pixels of a frame matches the expected color distribution of an image taken in a patient's body and determine that the endoscope **218** is in the patient's body cavity. The processor **210** may analyze a color histogram of one or more pixels of a frame to determine the color distribution. In an embodiment, the processor **210** may detect that one or more portions of the frame comprise pixels that match one or more expected pixel colors of an image taken in a patient's body and determine that the endoscope **218** is in the patient's body cavity. In an embodiment, the processor **210** may detect that one or more portions of the frame comprise pixels that match one or more expected pixel colors of an image taken outside of a patient's body cavity and determine that the endoscope **218** is outside of the patient's body cavity. In an embodiment, the processor **210** may compute an average pixel color of one or more pixels of a frame and detect that the average pixel color matches one or more expected pixel colors of an image taken in a patient's body cavity and determine that the endoscope **218** is in the patient's body cavity.

[0077] In some embodiments, processor **210** uses a computer vision module to determine whether the endoscope **218** is in the patient's body cavity. The computer vision module may comprise an artificial intelligence (AI) program such as a neural network. In an embodiment, the computer vision module is trained on a plurality of labeled training images that are tagged as being inside the patient's body cavity or outside the patient's body cavity. The computer vision module may comprise one or more internal numerical parameters that are adjusted based on the training process to enable the computer vision module to classify unseen images as being inside the patient's body cavity or outside the patient's body cavity. The processor **210** may input a frame to the computer vision module and receive a classification output from the computer vision module that the frame is inside the patient's body cavity or outside the patient's body cavity. The processor **210** may determine the location of the endoscope **218** based on the classification output from the computer vision module.

[0078] In step **804**, when the endoscopic device **110** detects that the endoscope **218** is in the patient's body, endoscopic device **110** turns on the light **224**.

[0079] In step **806**, when the endoscopic device **110** detects that the endoscope **218** is not in the patient's body, the device turns off the light **224**. By turning off the light **224** when the endoscope **218** is not in the patient's body, the device may conserve battery power and also simplify operation of the device.

[0080] In some embodiments, the endoscope device **100** may automatically begin recording video when the device determines that the scope has been inserted into the body cavity. The endoscopic device **110** may automatically stop recording video when the device determines that the scope has been removed from the body cavity. Moreover, the endoscopic device **110** may evaluate recorded video and determine if any of the portions of the video depict imagery taken outside of the patient's body. In such instances, the endoscopic device **110** may delete those portions of record video.

[0081] In some embodiments, the endoscopic device **110** may record endoscopy video, de-identify patient sensitive data and upload the video to a separate computing device or server. For example, the system may use a trained machine learning network (such as a convolutional neural network) to identify and label pathology of images for significant findings (such as pathology, abnormal anatomy, etc.). The obtained videos may be catalogued and indexed with labels or other output of the trained machine learning network. A database of the videos may be searched and video imagery retrieved based on the key words as found in the database. Participating clinicians that use the endoscopic device **110** may access the video. This allows clinicians at different location to collaboratively review the endoscopy videos to assist in the care and treatment of patients.

[0082] FIG. **9** illustrates an exemplary method **900** for controlling power to the light **224**. In an embodiment, method **900** may be performed during the process of video capture and streaming by the endoscopic device **110**, such as during steps **404**, **406**, **408**, **706**, and other steps herein. Endoscopic device **110** may determine an average luminosity across multiple pixels of a frame and adjust power being passed to the light source to increase or decrease the luminosity of the light source to a predetermined luminosity value or range.

[0083] In step **902**, processor **210** computes an average luminosity across a plurality of pixels of a frame captured from camera **214**. The average luminosity may be computed over all or a subset of pixels of a frame.

[0084] In step **904**, processor **210** compares the average luminosity to a luminosity threshold. The luminosity threshold may comprise a pre-configured threshold. In some embodiments, processor **210** may compare the average luminosity to a plurality of luminosity thresholds, such as an upper luminosity threshold and a lower luminosity threshold. In some embodiments, the luminosity threshold or thresholds may be configurable by a user.

[0085] In step **906**, processor **210** adjusts power to the light based on the difference between the average luminosity and the luminosity threshold. In one embodiment, the processor **210** determines that the average luminosity is below the luminosity threshold (or below a lower luminosity threshold) and increases power to the light from battery **204** to increase the luminosity of the light. In one embodiment, the processor **210** determines that the average luminosity is above the luminosity threshold (or above an upper luminosity threshold) and decreases power to the light from battery **204** to decrease the luminosity of the light.

[0086] In some embodiments, the processor **210** may compute the amount of difference between the average luminosity and the luminosity threshold and compute an amount to adjust power to the light **224** based on the amount of difference. When the amount of difference is greater, the processor **210** may increase or decrease the power by a greater amount. When the amount of difference is lesser, the processor **210** may increase or decrease the power by a lesser amount. The processor **210** may calculate an amount to adjust power to the light **224** to increase or decrease the luminosity of the light to a predetermined luminosity value or range. In an embodiment, the predetermined luminosity value or range may be configurable by a user. The predetermined luminosity value or range may be dependent on a type of endoscopic procedure being performed with endoscopic device **110**.

[0087] FIG. **10** illustrates an exemplary method **1000** for adjusting one or more frames of video to create modified video data. In an embodiment, method **1000** may be performed during the process of video capture and streaming by the endoscopic device **110**, such as during steps **404**, **406**, **408**, **706**, and other steps herein. Processor **210** may selectively adjust the luminosity of different portions of a frame to brighten dark spots and darken bright spots.

[0088] In step **1002**, the endoscopic device **110** detects portions of one or more video frames that comprise dark spots. Processor **210** may detect one or more portions of a frame that have a lower than desired luminosity. In an embodiment, processor **210** may compute an average luminosity of one or more pixels comprising a portion of a frame and compare it to a luminosity threshold. Processor **210** may check that the light **224** is on and at a desired level of power or luminosity to determine that the light **224** does not require additional power. When it is determined that the light is on, the processor **210** may determine that the average luminosity of the pixels is below the luminosity threshold and that image processing should be applied. On the other hand, if the light **224** is off or at level of power or luminosity lower than a predetermined value or range, then the endoscopic device **110** may first turn on the light and adjust the power to the light using method **900** before repeating step **1002** and

continuing in method **1000**. In some embodiments, the luminosity threshold may comprise a preconfigured threshold and optionally the luminosity threshold may be configurable by a user.

[0089] In step **1004**, the processor **210** may brighten the dark spots of the one or more video frames using image processing. The processor **210** may increase the luminosity of one or more pixels comprising the portion of the frame that is dark, such as by adjusting one or more pixel intensity values, until the pixels exceed the luminosity threshold.

[0090] In some embodiments, the processor **210** may increase the luminosity non-linearly across the one or more pixels of the dark portion of the frame. The processor **210** may increase the luminosity the greatest for pixels that are the darkest (having the greatest difference below the luminosity threshold) in the center of the dark portion and may increase the luminosity the least for pixels that are less dark (having the least difference below the luminosity threshold) at the edge of the dark portion. The increase in luminosity may peak in the center of the dark portion and gradually, non-linearly decline towards the edges of the dark portion.

[0091] In step **1006**, the endoscopic device **110** detects portions of one or more video frames that comprise bright spots. Processor **210** may detect one or more portions of a frame that have a higher than desired luminosity. In an embodiment, processor **210** may compute an average luminosity of one or more pixels comprising a portion of a frame and compare it to a luminosity threshold. Processor **210** may check that the light **224** is on and at a desired level of power or luminosity to determine that the power and luminosity of the light **224** does not need to be decreased. The processor **210** may determine that the average luminosity is above a luminosity threshold and that image processing should be applied. On the other hand, if the light **224** has a level of power or luminosity greater than a predetermined value or range, then the endoscopic device **110** may first adjust the power to the light using method **900** before repeating step **1006** and continuing in method **1000**. In some embodiments, the luminosity threshold may comprise a preconfigured threshold and optionally the luminosity threshold may be configurable by a user.

[0092] In step **1008**, the processor **210** may darken the bright spots of the one or more video frames using image processing. The processor **210** may decrease the luminosity of one or more pixels comprising the portion of the frame that is bright, such as by adjusting the pixel values, until the pixels are below the luminosity threshold.

[0093] In some embodiments, the processor **210** may decrease the luminosity non-linearly across the one or more pixels of the bright portion of the frame. The processor **210** may decrease the luminosity the most for pixels that are the brightest (having the greatest difference above the luminosity threshold) in the center of the bright portion and may decrease the luminosity the least for pixels that are less bright (having the least difference above the luminosity threshold) at the edge of the bright portion. The decrease in luminosity may peak in the center of the bright portion and gradually, non-linearly decline towards the edges of the bright portion.

[0094] In some embodiments, the processor **210** may smooth changes in luminosity of a pixel between sequential frames of video to make changes in luminosity of the imagery appear more gradual. For example, when the processor **210** significantly adjusts the luminosity of a pixel in a first frame, it may optionally apply a limit to disallow completely removing the luminosity adjustment in the very next frame and instead spread the change in luminosity over several frames.

[0095] Method **1000** may be applied to a plurality of different portions of a frame to selectively brighten portions of the frame that are darker than a pre-configured threshold and to selectively darken portions of the frame that are brighter than a pre-configured threshold.

[0096] In some embodiments, a lower luminosity threshold may be used for dark spots in step **1002** and an upper luminosity threshold may be used for bright spots in step **1006**, so that the modified video data is configured to represent a range of luminosity values. In some embodiments, the modified video data may include a tag to indicate that the video data is modified with adjusted luminosity.

[0097] FIG. **11** illustrates an exemplary method **1100** for selectively deleting frames of a video file. In an embodiment, method **1100** may be performed after capture of video imagery is completed. For example, method **1100** may be performed after a stop command is received from the endoscopic device **110**, and the device stops the video streaming service. Endoscopic device **110** may selectively delete frames of a video file to delete any personally identifiable information of the patient, or irrelevant information, in the video file.

[0098] In step **1102**, the processor **210** creates a video file having multiple frames of the modified video data. In an embodiment, a stop command is received from the computer system **120**, and the camera **214** stops acquiring image data and the processor **210** saves the video data it has captured (and optionally modified) into the video file.

[0099] In step **1104**, the processor **210** determines whether a frame of the video file includes any imagery outside of a patient's body. In an embodiment, the processor **210** spawns a new process or thread to open the video file that was saved in step **1102** and analyze the frames of the video file. The processes described in step **802** and elsewhere herein for determining when a frame of video is inside or outside the patient's body may be used.

[0100] In some embodiments, the processor **210** may determine whether a frame includes any personally identifiable information through additional computer vision techniques. In an embodiment, the processor **210** may process the video frame with a face detector to detect any human faces in the frame. The face detector may comprise an artificial intelligence program, such as a neural network, and may scan the pixels of an image to determine if the pixels match characteristic features of a human face, such as eyes, nose, mouth, and other features. If a face is detected, then the frame may be determined to be outside the patient's body. In an embodiment, the processor **210** may apply text detection to the video frame to detect any text in the frame. The text detection may be performed by a text detector comprising an artificial intelligence program, such as a neural network. If text is detected, then the frame may be determined to be outside the patient's body.

[0101] In step **1106**, if the frame is determined to include imagery outside of a patient's body, then the processor **210** may delete the frame. After deleting one or more frames of the video file, the processor **210** may save the edited video data in a new file on the storage system.

[0102] In step **1108**, endoscopic device **110** may transmit the video file to the computer system **120** for storage in a

patient record. In one embodiment, the endoscopic device **110** may upload the edited video file to EHR **124** using a Representational State Transfer Application Programming Interface (REST API). The edited video file may be stored in the patient's medical history.

[0103] In step **1110**, endoscopic device **110** may delete the video file from the device. The processor **210** may delete the edited video file and modified video file from the storage system of the device. In an embodiment, the processor **210** actively writes garbage data over the edited video file and modified video file in the storage system to ensure they cannot be improperly retrieved. The processor **210** may optionally have an encrypted storage system such as an encrypted hard drive that stores the video files in an encrypted format. In one embodiment, the endoscopic device **110** waits for an acknowledgement message from the computer system **120** that the edited video file has been successfully saved in the patient record before deleting the video files from its storage system.

[0104] In some embodiments, the endoscopic device **110** may include sensors to determine the orientation or position of the endoscopic device in a 3-dimensional space. For example, the endoscopic device **110** may include a gyroscope and accelerometer to track the position and rotational movement of the endoscopic device. Maintaining proper orientation of the endoscopic device may be importation in certain use cases. For example, maintaining proper orientation would be important for a safe and accurate sinonasal endoscopy, especially in the context of a surgical procedure. In this example, an endoscopist or surgeon is responsible for maintaining proper orientation by assuring that the dorsal/superior aspect of the camera head unit is always parallel to the patient's midline and is point at the 12 o'clock position (or the patient's vertex). However, while in use, drifting or rotation of the endoscopic device **110** may occur, especially from hand-held use for an extended period of time. To account for this rotational drift, the endoscopic device **110** may perform an initialization procedure to set a position of the endoscopic device **110** in the 3-dimensional space. For example, the endoscopic device **110** may initialize it position to a "true north" orientation. At the beginning of an examination procedure, a camera of the endoscopic device **110** may be calibrated to a patient's anatomy. Although the anatomy of a patient does not vary, the patient's positions may vary from case to case (e.g., supine, recumbent, upright). The device may set its orientation position in response to an orientation command or an input such as physical button on the endoscopic device **110**. A user interface may be provided, such as through a monitor or a hand-held computing device, where the user interface presents a grid with a representation of the endoscopic device. The user interface may be updated in real-time with the 3-dimensional orientation of the device (e.g., displaying the devices position relative to a x-, y-, z- axis).

[0105] In some embodiments, the endoscopic device **110** may initialize a 3-dimensional (3D) position of the hand-held body (or other components of the endoscopic device **110**). The endoscopic device **110** may monitor the rotation of the hand-held body in at least an x-axis, y-axis and a z-axis. Where the rotation of the hand-held body rotates greater than a predetermined threshold angular value (i.e., an acceptable rotational value), the endoscopic device **110** may provide an alert to the operator of the device. For example, the endoscopic device **110** may monitor the degree of rotation of the endoscopic device **110** in any of the three degrees of rotation, and determine whether the endoscopic device rotates to a threshold predetermined value of acceptable rotation from the initialized position. The device may generate an alert (such as a haptic alert or audible alert) if the endoscopic device **110** has rotated to or past the threshold predetermined value. In some embodiments, a user interface may prompt the user of the endoscopic device **110** to rotate the device **110** in a direction to move the device's position back to or towards the initialized oriented position. In some embodiments, a vibration may be produced by the endoscopic device **110** to alert the device operator of the determined angular drift of the endoscopic device **110**.

[0106] In some embodiments, a user interface may be displayed that depicts overlayed visualization of imagery obtained during an endoscopy procedure. The user interface may display an automatically scaled measurement grid and may display labels identifying key structures of the body cavity (e.g., the nasal septum, inferior turbinate, middle turbinate, choana, etc.).

[0107] FIG. **12** illustrates an example machine of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. In alternative implementations, the machine may be connected (e.g., networked) to other machines in a LAN, an intranet, an extranet, and/or the Internet. The machine may operate in the capacity of a server or a client machine in client-server network environment, as a peer machine in a peer-to-peer (or distributed) network environment, or as a server or a client machine in a cloud computing infrastructure or environment

[0108] The machine may be a personal computer (PC), a tablet PC, a set-top box (STB), a Personal Digital Assistant (PDA), a cellular telephone, a web appliance, a server, a network router, a switch or bridge, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein.

[0109] The example computer system **1200** includes a processing device **1202**, a main memory **1204** (e.g., read-only memory (ROM), flash memory, dynamic random access memory (DRAM) such as synchronous DRAM (SDRAM) or Rambus DRAM (RDRAM), etc.), a static memory **1206** (e.g., flash memory, static random access memory (SRAM), etc.), and a data storage device **1218**, which communicate with each other via a bus **1230**.

[0110] Processing device **1202** represents one or more general-purpose processing devices such as a microprocessor, a central processing unit, or the like. More particularly, the processing device may be complex instruction set computing (CISC) microprocessor, reduced instruction set computing (RISC) microprocessor, very long instruction word (VLIW) microprocessor, or processor implementing other instruction sets, or processors implementing a combination of instruction sets. Processing device **1202** may also be one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. The processing device

1202 is configured to execute instructions **1226** for performing the operations and steps discussed herein.

[0111] The computer system **1200** may further include a network interface device **1208** to communicate over the network **1220**. The computer system **1200** also may include a video display unit **1210** (e.g., a liquid crystal display (LCD) or a cathode ray tube (CRT)), an alphanumeric input device **1212** (e.g., a keyboard), a cursor control device **1214** (e.g., a mouse) or an input touch device, a graphics processing unit **1222**, a signal generation device **1216** (e.g., a speaker), graphics processing unit **1222**, video processing unit **1228**, and audio processing unit **1232**.

[0112] The data storage device **1218** may include a machine-readable storage medium **1224** (also known as a computer-readable medium) on which is stored one or more sets of instructions or software **1226** embodying any one or more of the methodologies or functions described herein. The instructions **1226** may also reside, completely or at least partially, within the main memory **1204** and/or within the processing device **1202** during execution thereof by the computer system **1200**, the main memory **1204** and the processing device **1202** also constituting machine-readable storage media.

[0113] In one implementation, the instructions **1226** include instructions to implement functionality corresponding to the components of a device to perform the disclosure herein. While the machine-readable storage medium **1224** is shown in an example implementation to be a single medium, the term "machine-readable storage medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more sets of instructions. The term "machine-readable storage medium" shall also be taken to include any medium that is capable of storing or encoding a set of instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies of the present disclosure. The term "machine-readable storage medium" shall accordingly be taken to include, but not be limited to, solid-state memories, optical media and magnetic media.

[0114] Some portions of the preceding detailed descriptions have been presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the ways used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of operations leading to a desired result. The operations are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

[0115] In general, the terms "engine" and "module", as used herein, refer to logic embodied in hardware or firmware, or to a collection of software instructions, possibly having entry and exit points, written in a programming language, such as, for example, Java, Lua, C or C++. A software module may be compiled and linked into an executable program, installed in a dynamic link library, or may be written in an interpreted programming language such as, for example, BASIC, Perl, or Python. It will be appreciated that software modules may be callable from other modules or from themselves, and/or may be invoked in response to detected events or interrupts. Software modules configured for execution on computing devices may be provided on one or more computer readable media, such as compact discs, digital video discs, flash drives, or any other tangible media. Such software code may be stored, partially or fully, on a memory device of the executing computing device. Software instructions may be embedded in firmware, such as an EPROM. It will be further appreciated that hardware modules may be comprised of connected logic units, such as gates and flip-flops, and/or may be comprised of programmable units, such as programmable gate arrays or processors. The modules described herein are preferably implemented as software modules, but may be represented in hardware or firmware. Generally, the modules described herein refer to logical modules that may be combined with other modules or divided into sub-modules despite their physical organization or storage

[0116] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the above discussion, it is appreciated that throughout the description, discussions utilizing terms such as "identifying" or "determining" or "executing" or "performing" or "collecting" or "creating" or "sending" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage devices.

[0117] The present disclosure also relates to an apparatus for performing the operations herein. This apparatus may be specially constructed for the intended purposes, or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions, each coupled to a computer system bus.

[0118] Various general purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform the method. The structure for a variety of these systems will appear as set forth in the description above. In addition, the present disclosure is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the disclosure as described herein.

[0119] The present disclosure may be provided as a computer program product, or software, that may include a machine-readable medium having stored thereon instructions, which may be used to program a computer system (or other electronic devices) to perform a process according to the present disclosure. A machine-readable medium includes

any mechanism for storing information in a form readable by a machine (e.g., a computer). For example, a machine-readable (e.g., computer-readable) medium includes a machine (e.g., a computer) readable storage medium such as a read only memory ("ROM"), random access memory ("RAM"), magnetic disk storage media, optical storage media, flash memory devices, etc.

[0120] In the foregoing disclosure, implementations of the disclosure have been described with reference to specific example implementations thereof. It will be evident that various modifications may be made thereto without departing from the broader spirit and scope of implementations of the disclosure as set forth in the following claims. The disclosure and drawings are, accordingly, to be regarded in an illustrative sense rather than a restrictive sense.

1. A portable wireless endoscope system, comprising:

a hand-held body comprising a housing, the housing containing a battery-operated onboard processor, a wireless transceiver, a digital camera and a storage system contained within the housing, and the housing having an endoscope coupler with a lens and an attachment connector, wherein the onboard processor is configured to perform the operations comprising:

creating, by the wireless endoscope system, a wireless network for connection by a computer system, wherein the computer system scans for the wireless network for a predetermined media access control (MAC) address and obtains an Internet Protocol (IP) address associated with a MAC address of the portable wireless endoscope system;

establishing a wireless connection to the computer system, wherein the wireless connection comprises a secure connection with the computer system and the wireless endoscope system, enabling the computer system to execute commands on the wireless endoscope system;

after the computer system initiates a video streaming service, receiving from the computer system one or more instructions over the wireless connection to begin streaming video by the wireless endoscope system;

obtaining, via the digital camera, video imagery via an endoscope optically connected to the endoscope coupler, the video imagery including multiple frames;

analyzing each of the multiple frames of the obtained video imagery, and adjusting one or more characteristics of a frame;

creating modified video data of the adjusted one or more frames; and

streaming to the computer system, via the wireless transceiver, the modified video data;

wherein the wireless endoscope system is configured to receive a stop command from either the computer system or an input via the wireless endoscope system, the stop command stopping the streaming of the video stream from the wireless endoscope system to the computer system;

wherein the wireless endoscope system is configured to receive a start command from either the computer system or an input via the wireless endoscope system, the start command starting the streaming of the video stream from the wireless endoscope system to the computer system;

after stopping the video streaming service, creating by the wireless endoscope system a video file and transmitting the video file from the wireless endoscope system to the computer system, wherein the video file includes multiple frames from the video stream; and

after the video file has been transmitted to the computer system, deleting the video file from a storage system of the wireless endoscope system.

2. The system of claim **1**, wherein the onboard processor is further configured to perform the operations comprising:

receiving from the computer system, via the wireless transceiver, instructions to initiate a video streaming service on the endoscope system; and

based on the received instructions, starting the video streaming service.

3. The system of claim **1**, wherein the onboard processor is further configured to perform the operations comprising:

receiving a start command from the computer system to begin obtaining video imagery;

based on the received command starting image acquisition by the camera of endoscope system;

receiving a stop command from the computer system to stop obtaining video imagery; and

based on the received stop command stopping image acquisition by the camera.

4. The system of claim **1**, wherein the onboard processor is further configured to perform the operations comprising:

creating a video file having multiple frames of the modified video data;

determining whether a frame of the video file includes any imagery outside of a patient's body; and

if the frame is determined to include imagery outside of a patient's body, then deleting the frame.

5. The system of claim **1**, wherein the onboard processor is further configured to perform the operations comprising:

controlling a light source to illuminate an endoscope optically coupled to the wireless endoscope system.

6. The system of claim **5**, wherein the onboard processor is further configured to perform the operations comprising:

determining an average luminosity across multiple pixels of a frame; and

adjusting power being passed to the light source to increase or decrease the luminosity of the light source to a predetermined luminosity value or range.

7. The system of claim **2**, wherein the onboard processor is further configured to perform the operations comprising:

establishing a connection with the computer system, where the computer system has determined the IP address of the endoscope system.

8. The system of claim **1**, wherein the computer system is configured to perform the operations comprising:

initializing a 3-dimensional (3D) position of the hand-held body;

monitoring the rotation of the hand-held body in at least an x-axis, y-axis and a z-axis; and

providing an alert where the rotation of the hand-held body rotates greater than a predetermined threshold angular value.

9. The system of claim **1**, wherein the onboard processor is further configured to perform the operations comprising:

determining whether the endoscope system has required versions of software packages installed on the endoscope system; and

automatically updating or installing required versions of the software packages.

10. (canceled)

11. A computer-implemented method for streaming endoscopic video data comprising:

creating, by a wireless endoscope system, a wireless network for connection by a computer system, wherein the computer system scans for the wireless network for a predetermined media access control (MAC) address and obtains an Internet Protocol (IP) address associated with a MAC address of the portable wireless endoscope system;

establishing, by the wireless endoscope system, a secure wireless connection to the computer system, wherein the wireless connection comprises a secure connection with the computer system and the wireless endoscope system, enabling the computer system to execute commands on the wireless endoscope system;

after the computer system initiates a video streaming service, receiving from the computer system one or more instructions over the secure wireless connection to begin streaming video by the wireless endoscope system;

obtaining, via a digital camera, video imagery via an endoscope optically connected to an endoscope coupler, the video imagery including multiple frames;

analyzing each of the multiple frames of the obtained video imagery, and adjusting one or more characteristics of a frame;

creating modified video data of the adjusted one or more frames; and

streaming to the computer system, via a wireless transceiver, the modified video data;

wherein the wireless endoscope system is configured to receive a stop command from either the computer system or an input via the wireless endoscope system, the stop command stopping the streaming of the video stream from the wireless endoscope system to the computer system;

wherein the wireless endoscope system is configured to receive a start command from either the computer system or an input via the wireless endoscope system, the start command starting the streaming of the video stream from the wireless endoscope system to the computer system;

after stopping the video streaming service, creating by the wireless endoscope system a video file and transmitting the video file from the wireless endoscope system to the computer system, wherein the video file includes multiple frames from the video stream; and

after the video file has been transmitted to the computer system, deleting the video file from a storage system of the wireless endoscope system.

12. The method of claim **11**, further comprising:

receiving from the computer system, via the wireless transceiver, instructions to initiate a video streaming service on the endoscope system; and

based on the received instructions, starting the video streaming service.

13. The method claim **11**, further comprising:

receiving a start command from the computer system to begin obtaining video imagery;

based on the received command starting image acquisition by the camera of endoscope system;

receiving a stop command from the computer system to stop obtaining video imagery; and

based on the received stop command stopping image acquisition by the camera.

14. The method of claim **11**, further comprising:

creating a video file having multiple frames of the modified video data;

determining whether a frame of the video file includes any imagery outside of a patient's body; and

if the frame is determined to include imagery outside of a patient's body, then deleting the frame.

15. The method of claim **11**, further comprising:

controlling a light source to illuminate an endoscope optically coupled to the wireless endoscope system.

16. The method of claim **15**, further comprising:

determining an average luminosity across multiple pixels of a frame; and

adjusting power being passed to the light source to increase or decrease the luminosity of the light source to a predetermined luminosity value or range.

17. The method of claim **12**, further comprising:

establishing a connection with the computer system, where the computer system has determined the IP address of the endoscope system.

18. The method of claim **11**, further comprising:

initializing a 3-dimensional (3D) position of the hand-held body;

monitoring the rotation of the hand-held body in at least an x-axis, y-axis and a z-axis; and

providing an alert where the rotation of the hand-held body rotates greater than a predetermined threshold angular value.

19. The method of claim **11**, further comprising:

determining whether the endoscope system has required versions of software packages installed on the endoscope system; and

automatically updating or installing required versions of the software packages.

20. (canceled)

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