US 20250261859A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2025/0261859 A1**

Guo et al. (43) **Pub. Date: Aug. 21, 2025**

(54) **MEDICAL IMAGING DEVICE**

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(21) Appl. No.: **19/053,662**

(22) Filed: **Feb. 14, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/555,491, filed on Feb. 20, 2024.

Publication Classification

(51) **Int. Cl.**

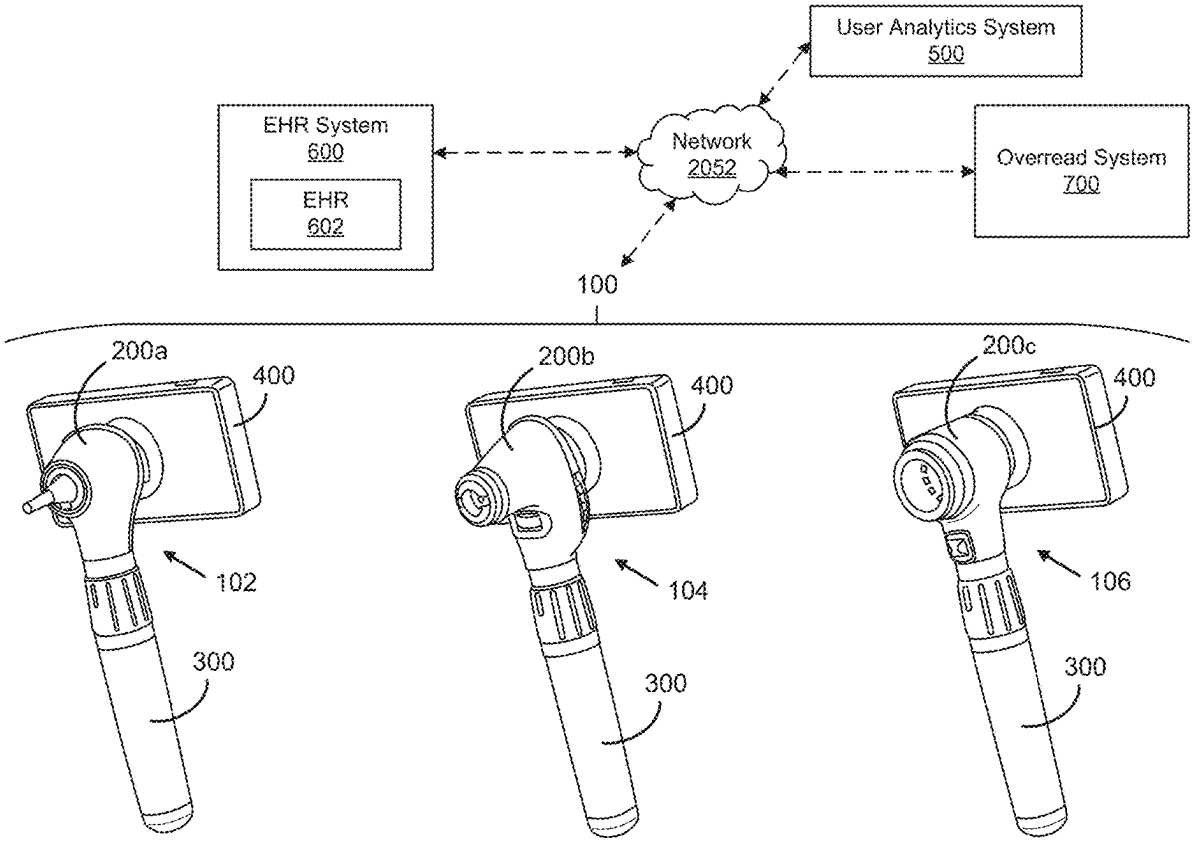
A61B 5/00	(2006.01)
A61B 1/00	(2006.01)
A61B 1/04	(2006.01)
A61B 1/227	(2006.01)
G16H 10/60	(2018.01)
G16H 40/63	(2018.01)

(52) **U.S. Cl.**

CPC ***A61B 5/0062*** (2013.01); ***A61B 1/0004*** (2022.02); ***A61B 1/00045*** (2013.01); ***A61B 1/04*** (2013.01); ***A61B 1/227*** (2013.01); ***A61B 5/441*** (2013.01); ***A61B 5/7435*** (2013.01); ***A61B 5/7475*** (2013.01); ***G16H 10/60*** (2018.01); ***G16H 40/63*** (2018.01)

(57) **ABSTRACT**

An imaging device for capturing images through an eyepiece of an optical viewing device. The imaging device includes a camera that aligns with the eyepiece for capturing the images viewed through the eyepiece, and a display for displaying the images captured by the camera. The imaging device determines a type of the optical viewing device. The imaging device presents a workflow on the display based on the type of the optical viewing device. The imaging device captures metrics related to user interactions with the workflow presented on the display and the images captured by the camera during the workflow.



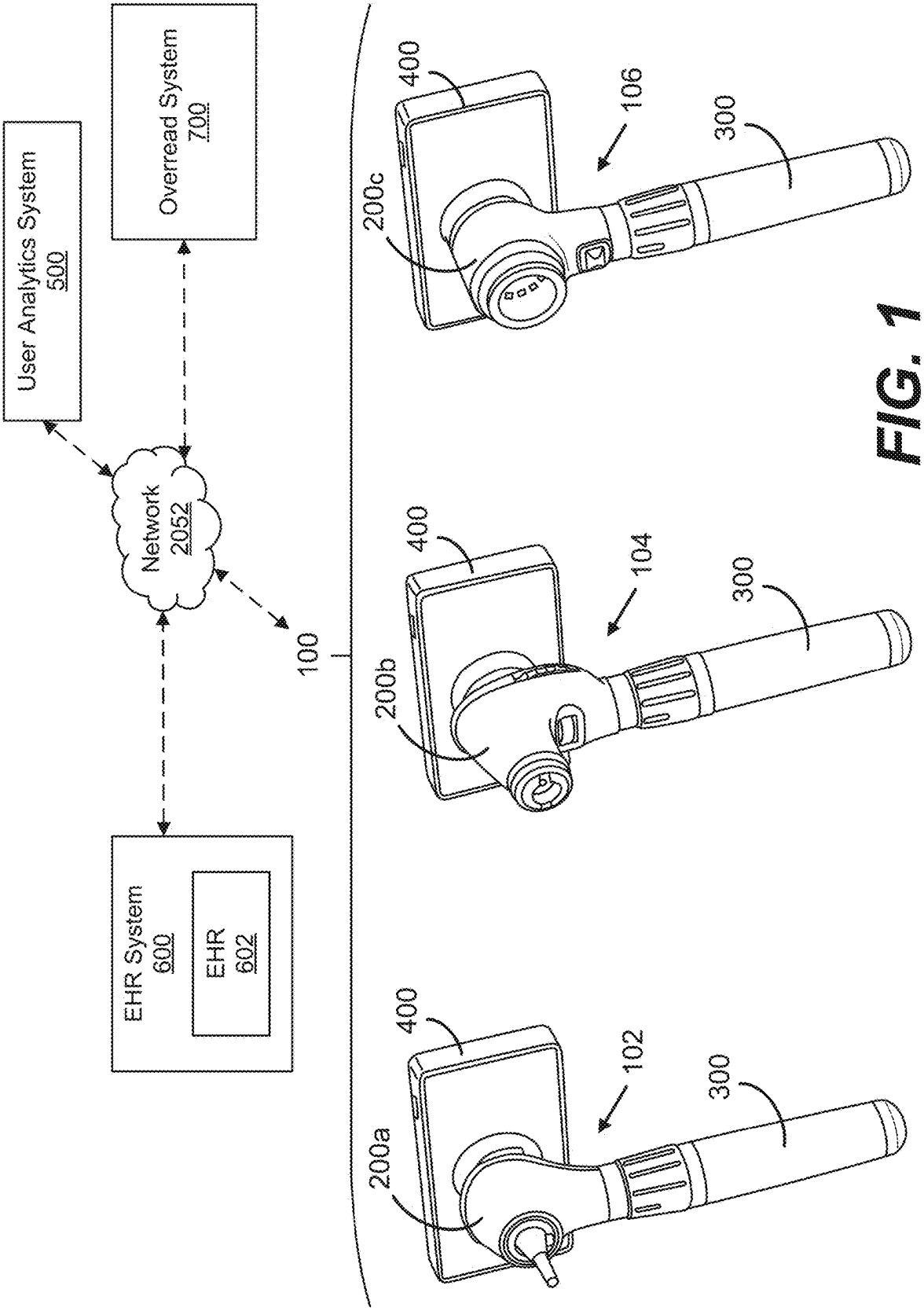

User Analytics System
500
Overread System
700
Network
2052
100
EHR System
600
EHR
602
200a
200b
200c
102
104
106
300
400

FIG. 1

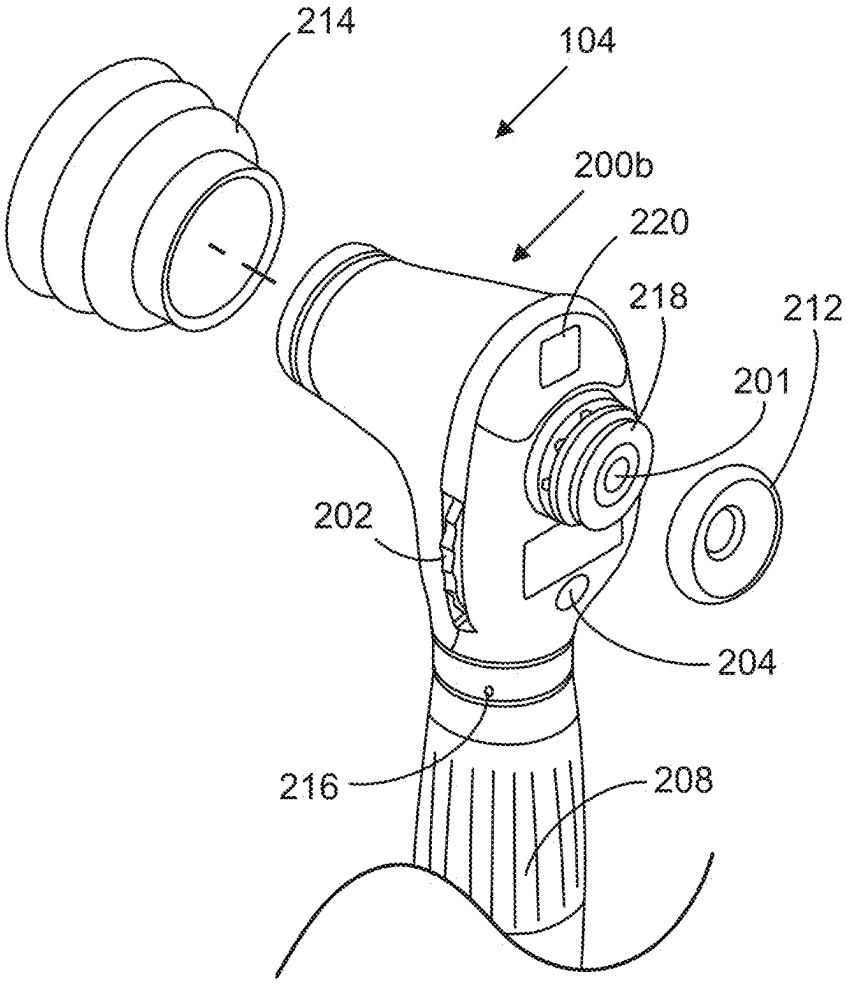


FIG. 2

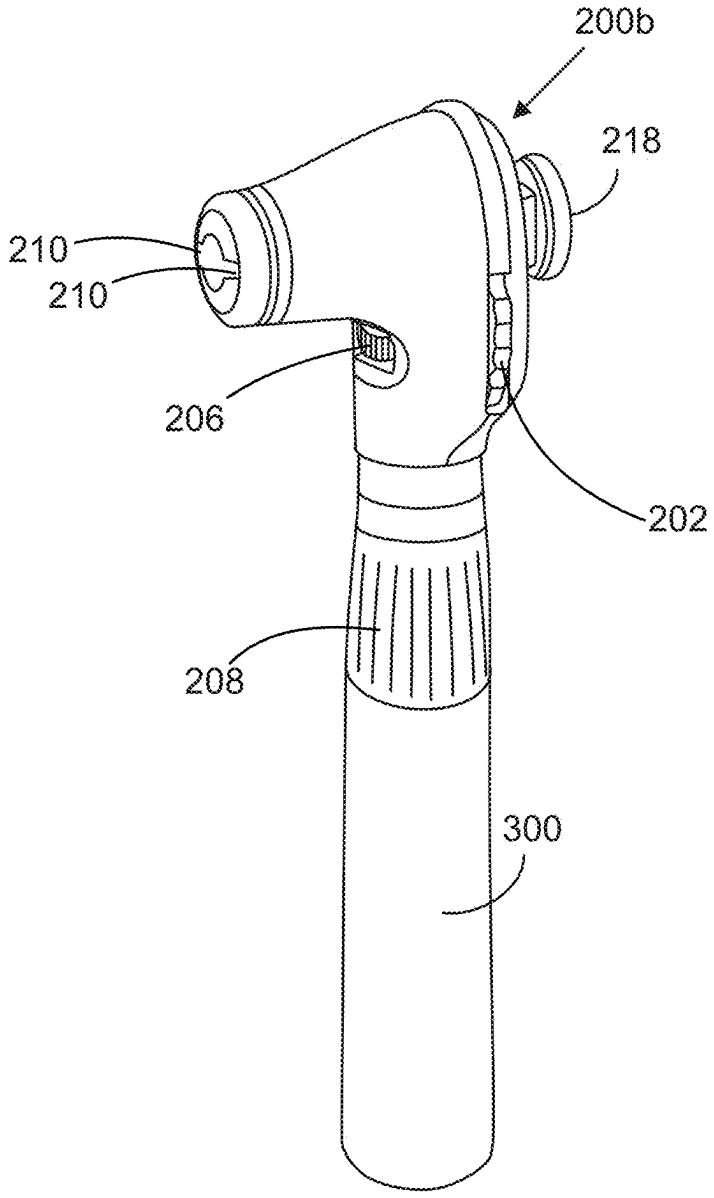


FIG. 3

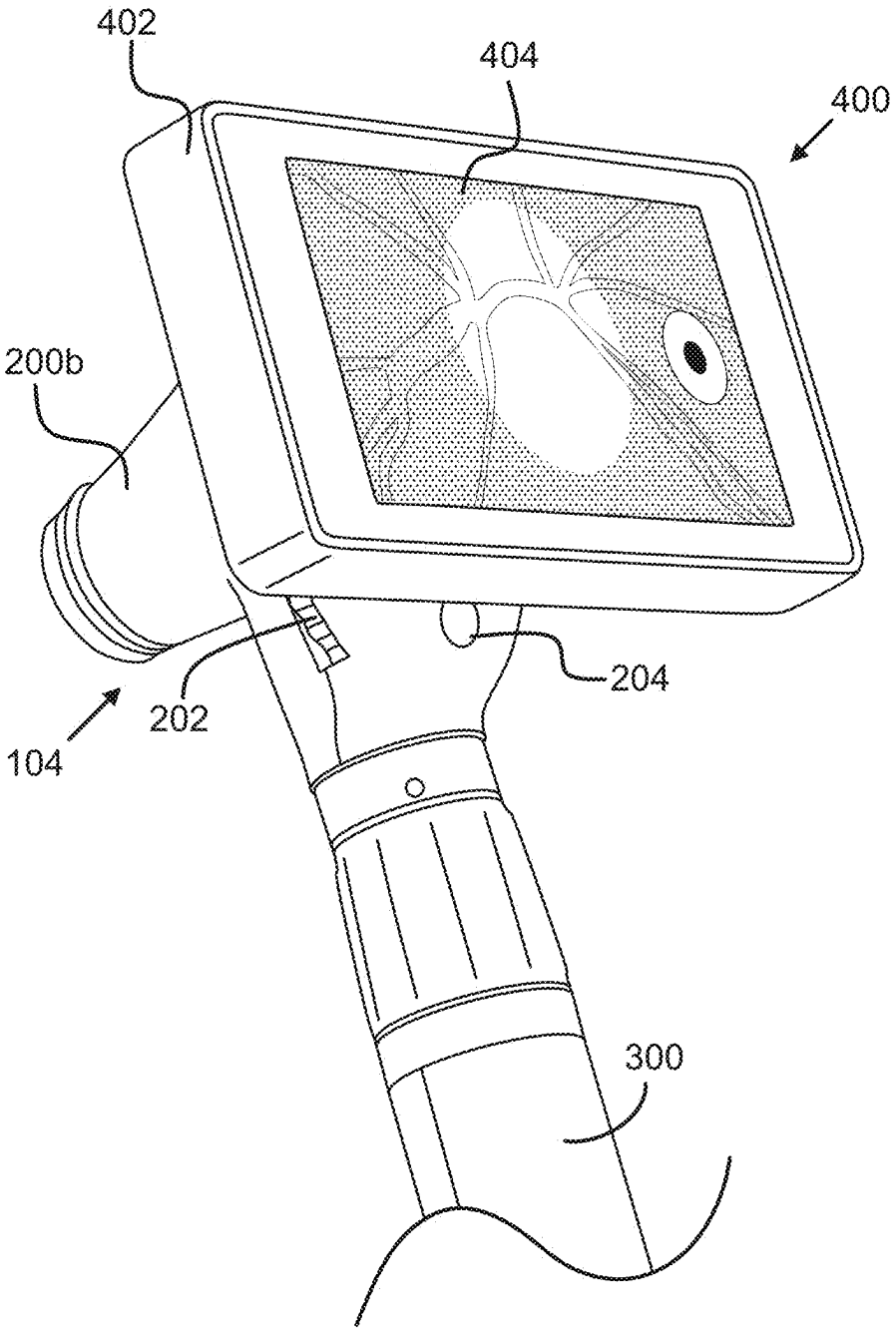
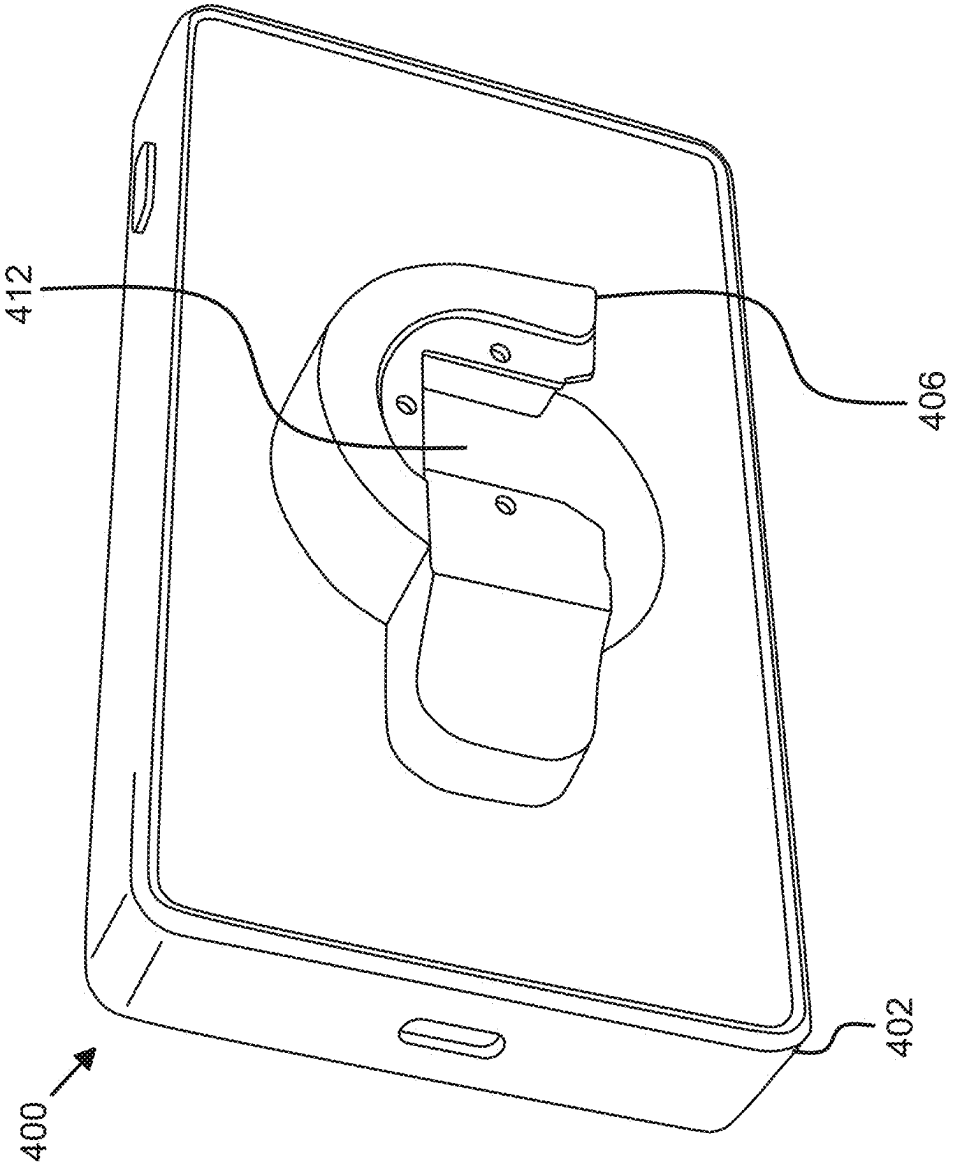


FIG. 4

FIG. 5



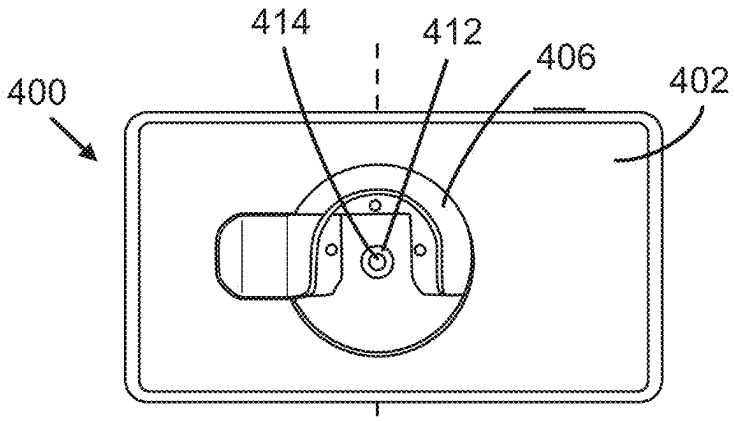


FIG. 6A

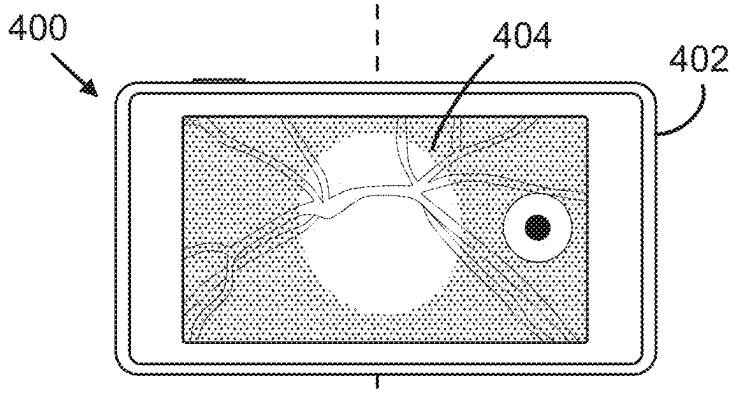


FIG. 6B

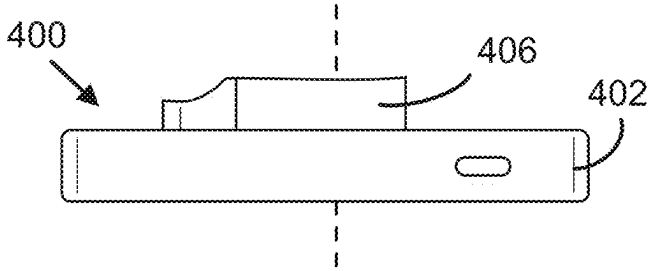


FIG. 6C

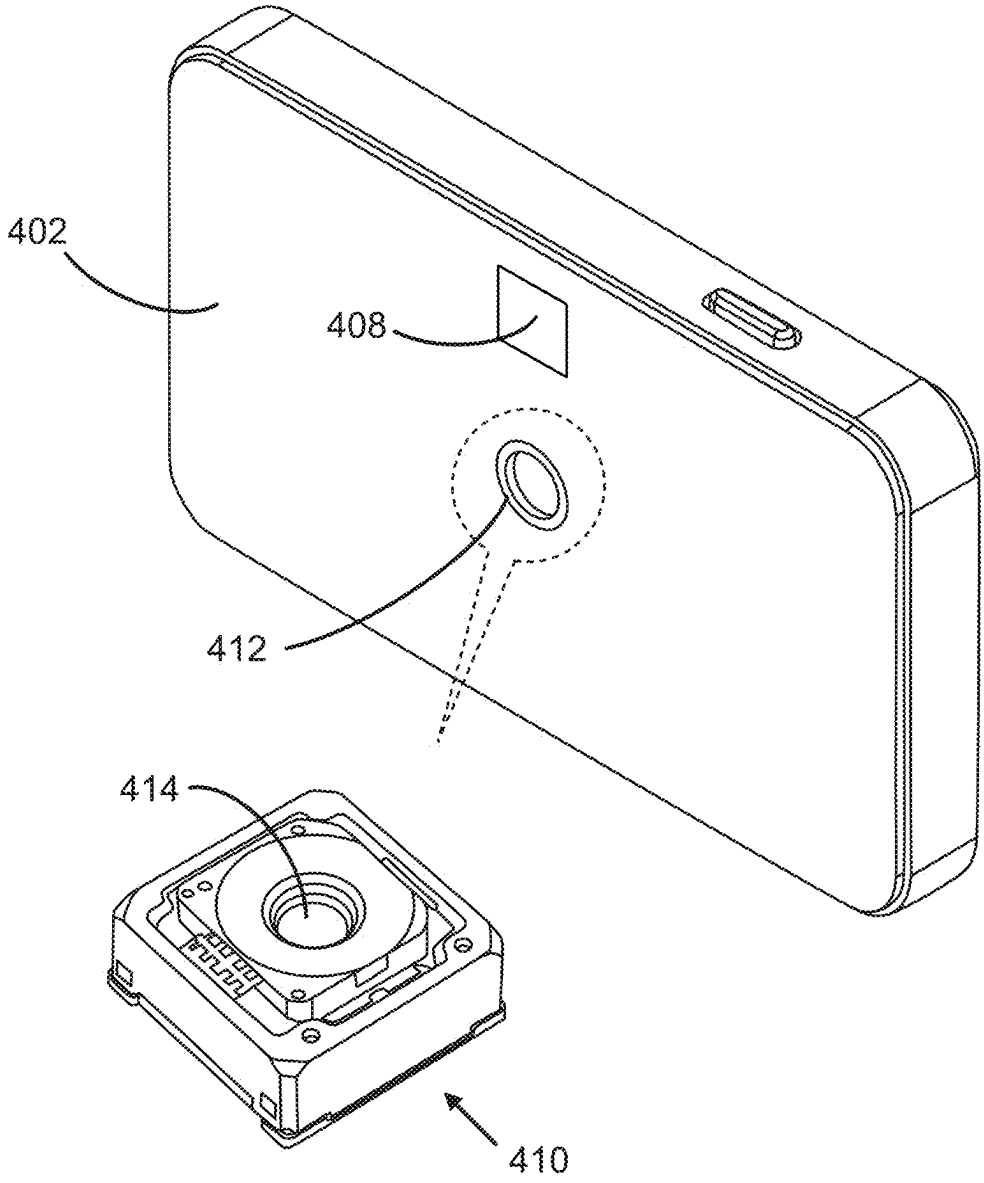


FIG. 7

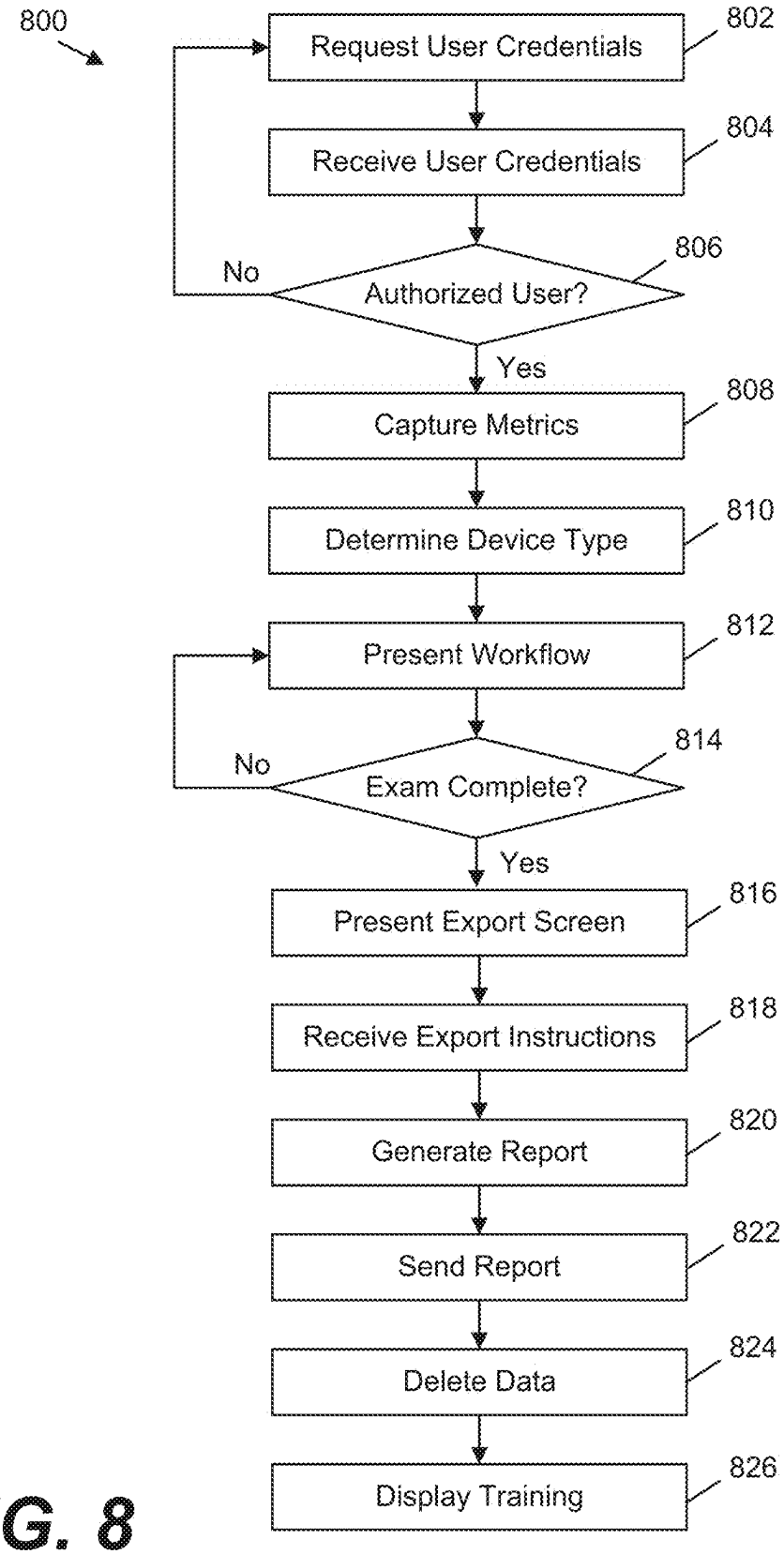

800
Request User Credentials
802
Receive User Credentials
804
Authorized User?
806
No
Yes
Capture Metrics
808
Determine Device Type
810
Present Workflow
812
Exam Complete?
814
No
Yes
Present Export Screen
816
Receive Export Instructions
818
Generate Report
820
Send Report
822
Delete Data
824
Display Training
826

FIG. 8

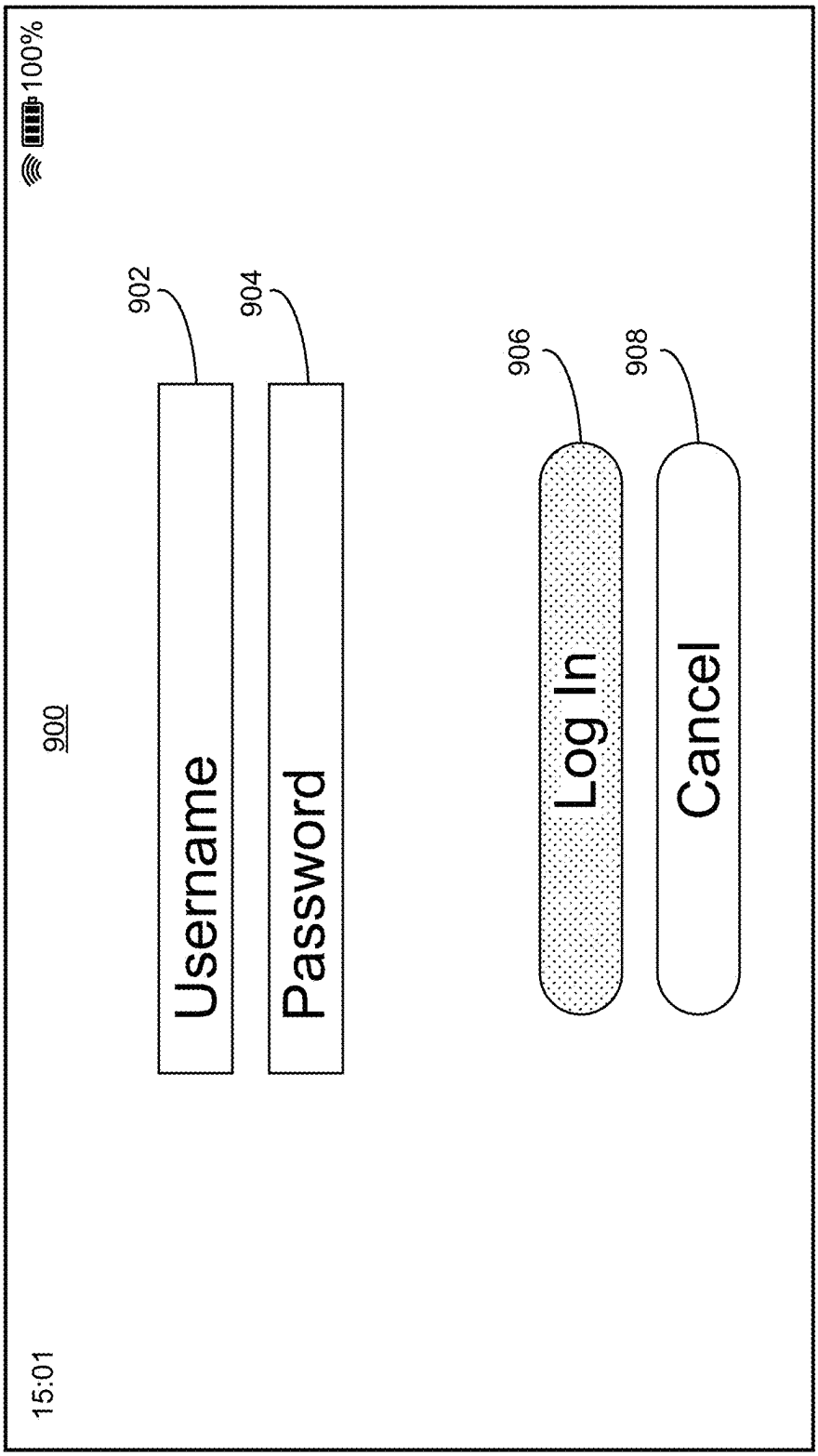


FIG. 9

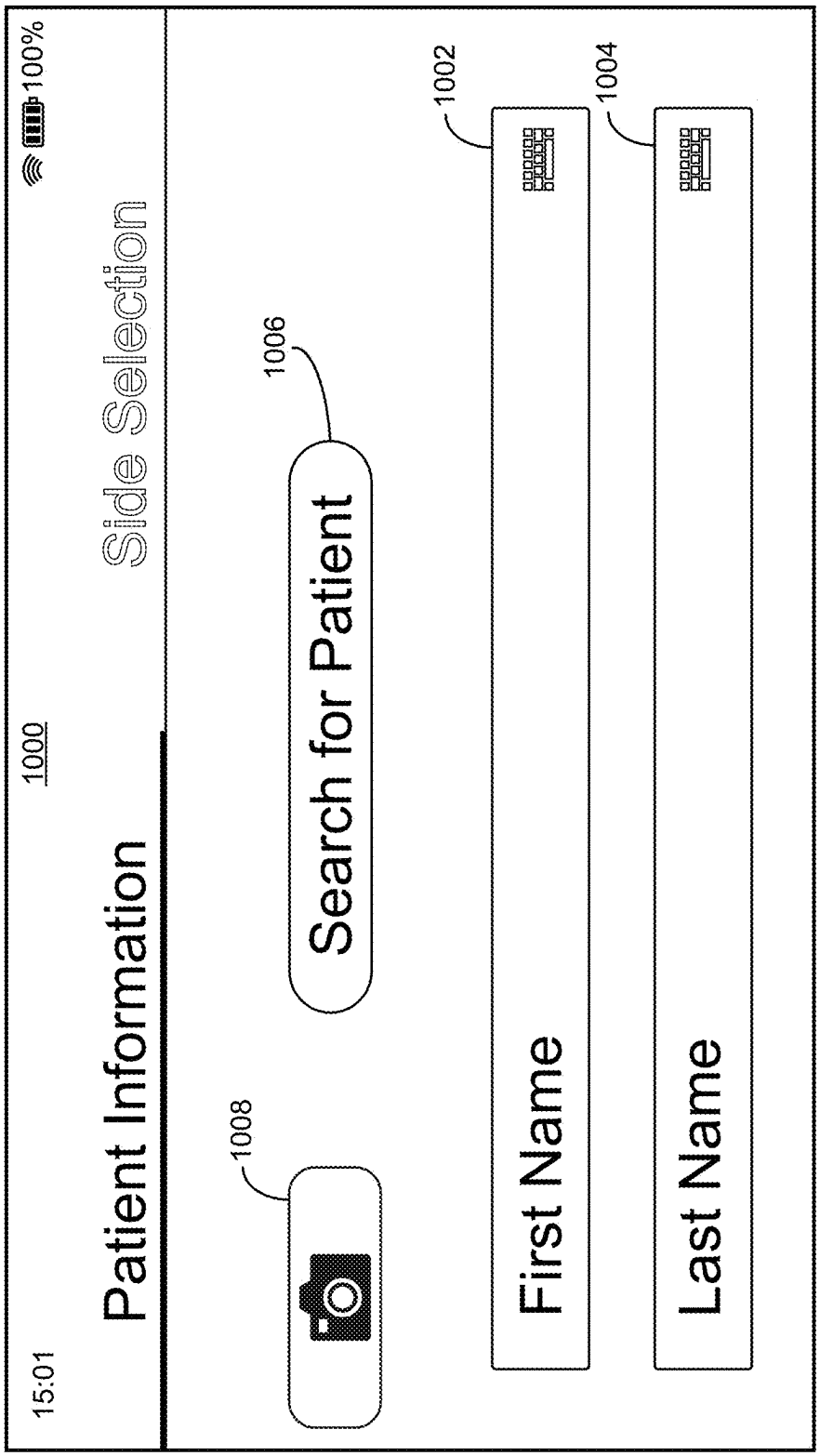

15:01
100%
1000
Patient Information
Side Selection
1002
1004
1006
1008
Search for Patient
First Name
Last Name

FIG. 10

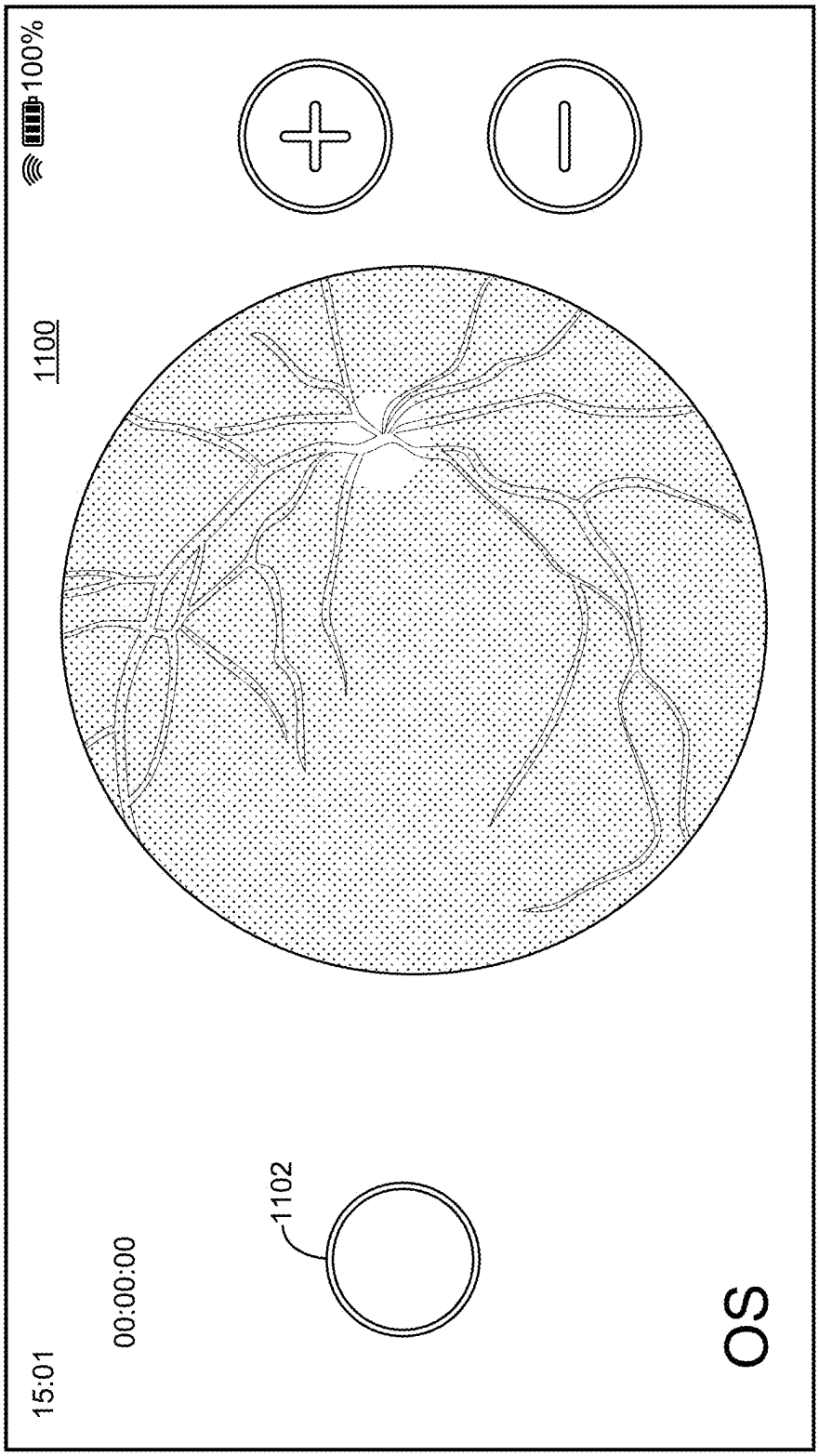


FIG. 11

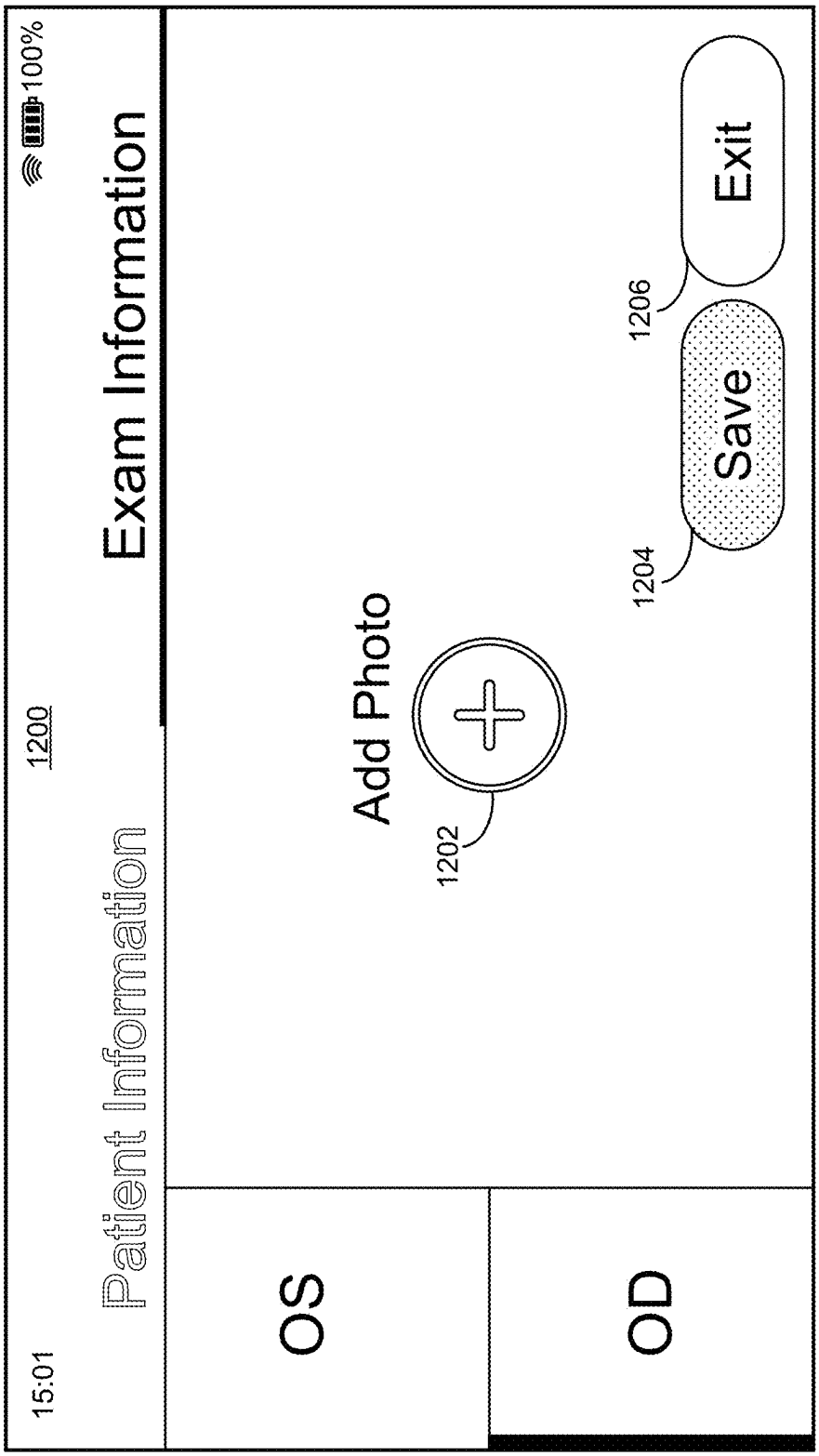

15:01
100%
1200
Patient Information
Exam Information
OS
OD
Add Photo
1202
1204
Save
1206
Exit

FIG. 12

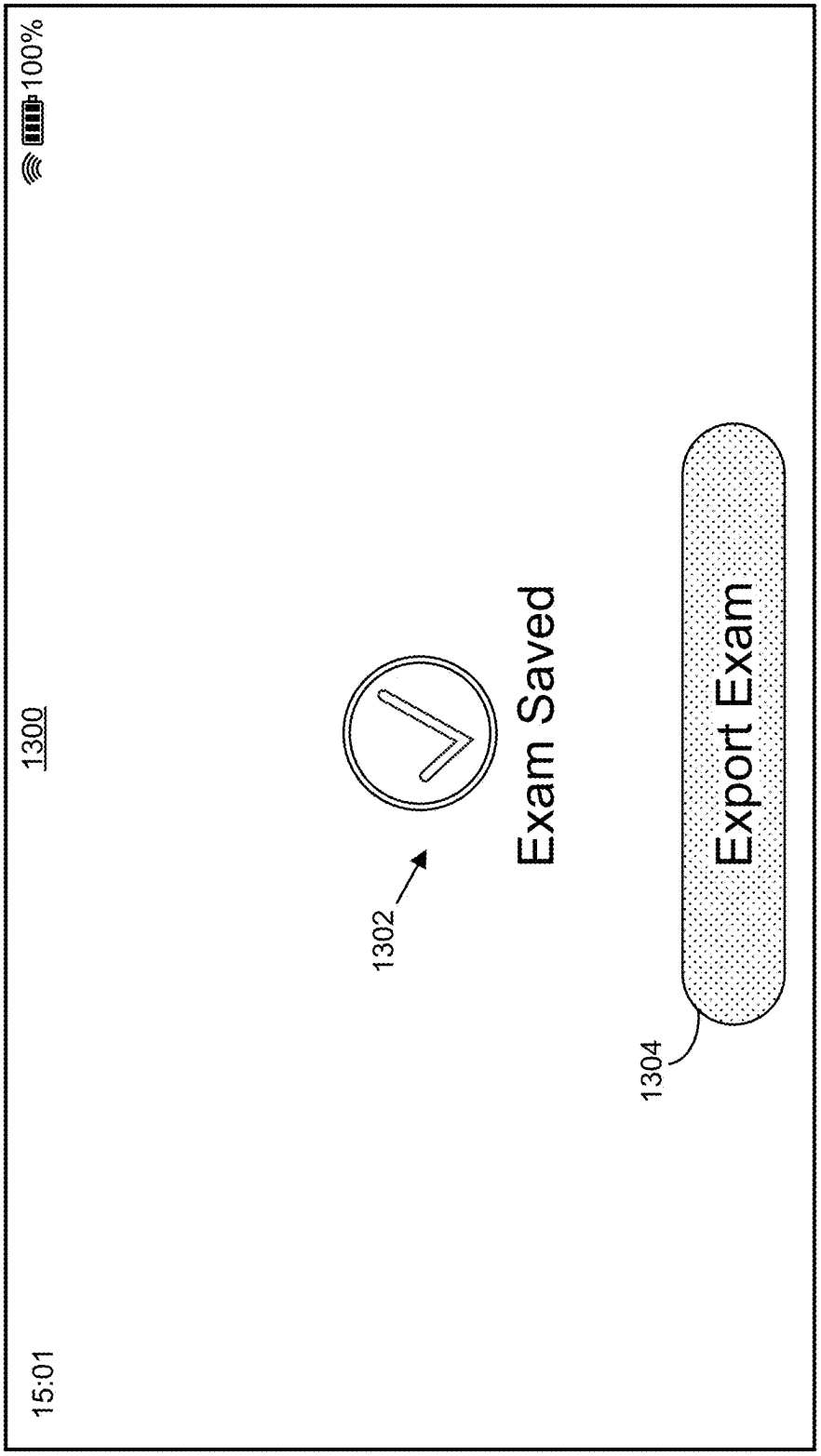


FIG. 13

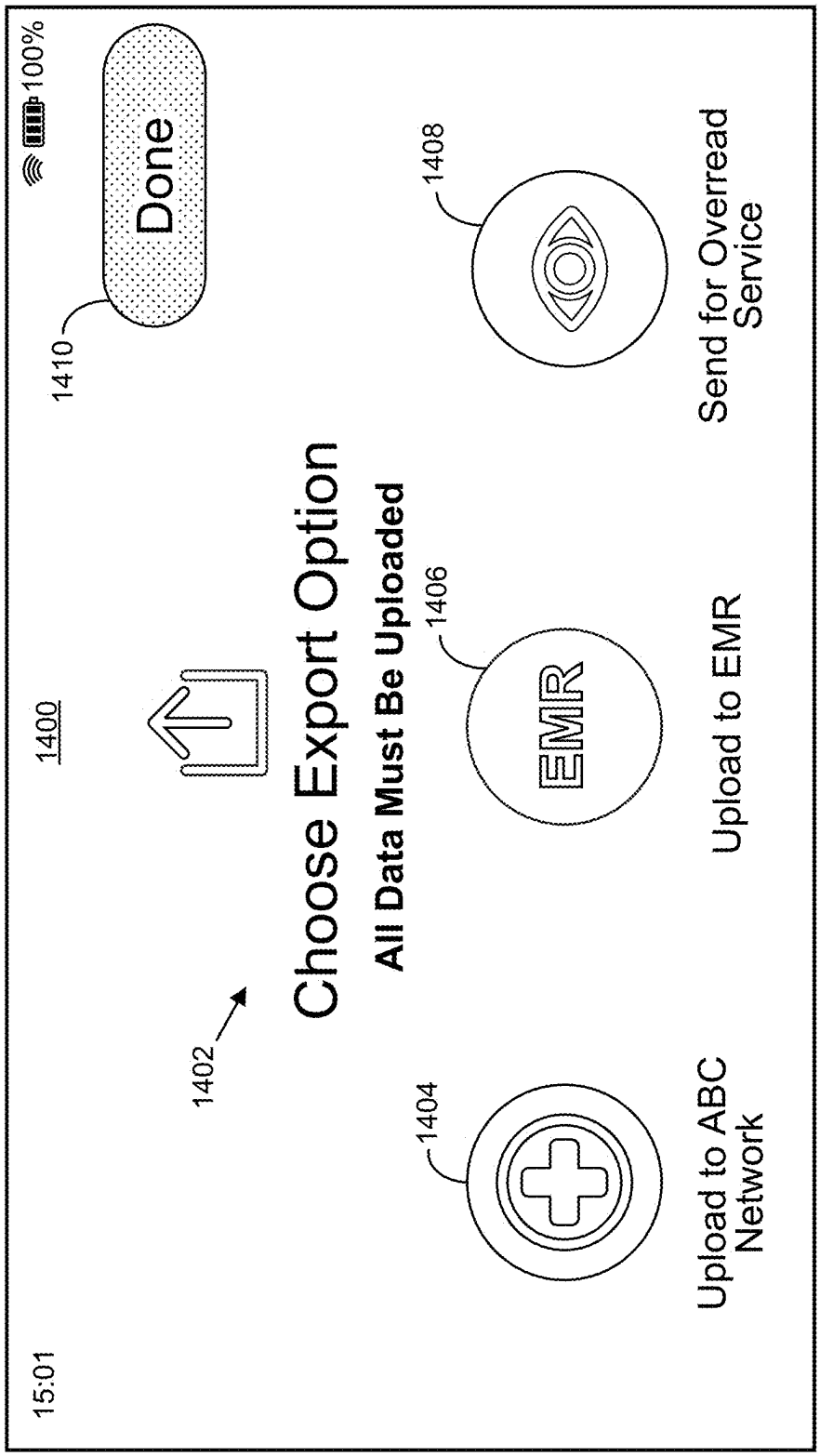

15:01
100%
1400
Done
1410
Choose Export Option
All Data Must Be Uploaded
1402
1404
Upload to ABC Network
1406
EMR
Upload to EMR
1408
Send for Overread Service

FIG. 14

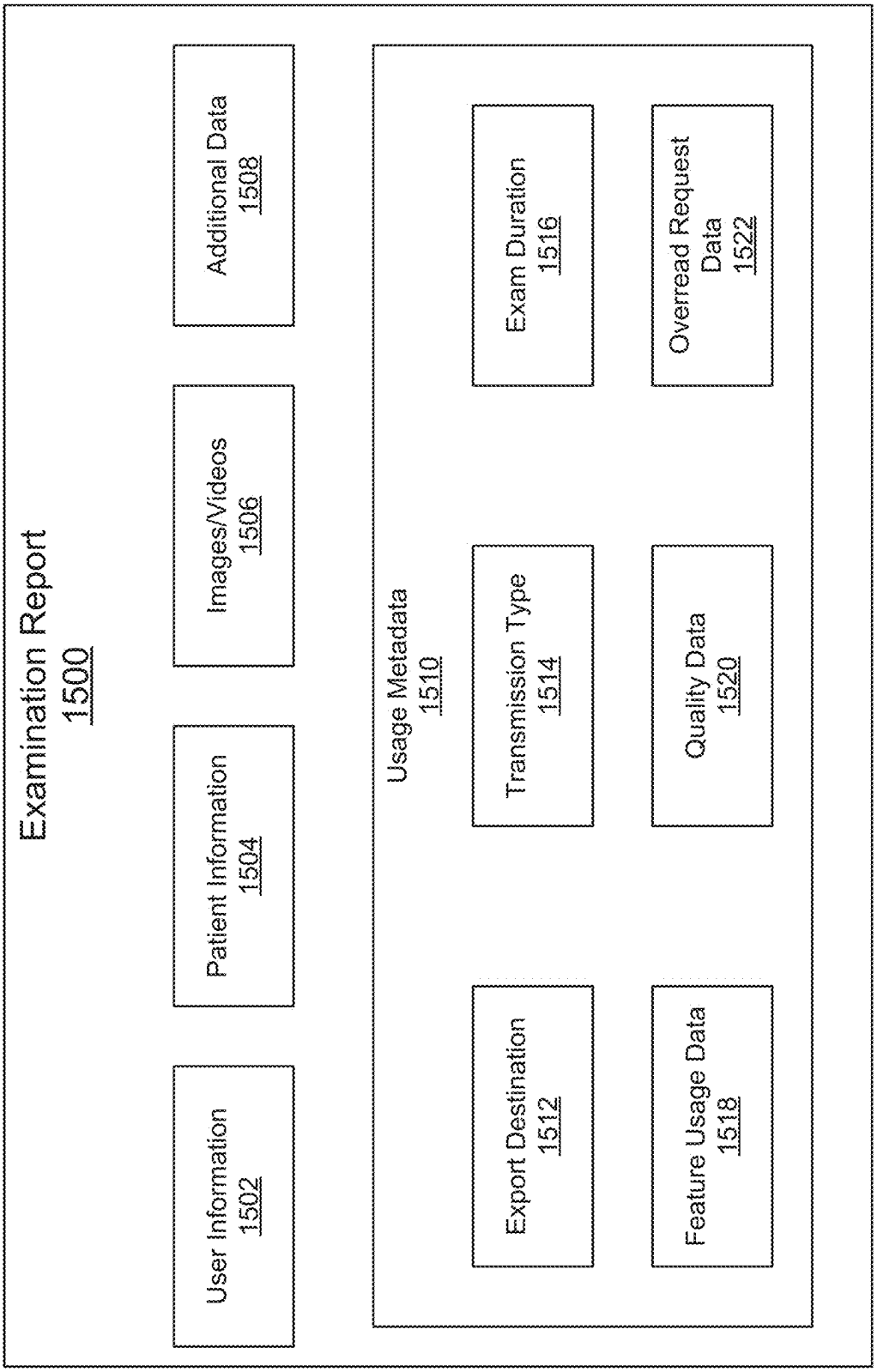

Examination Report
1500
User Information
1502
Patient Information
1504
Images/Videos
1506
Additional Data
1508
Usage Metadata
1510
Export Destination
1512
Transmission Type
1514
Exam Duration
1516
Feature Usage Data
1518
Quality Data
1520
Overread Request Data
1522

FIG. 15

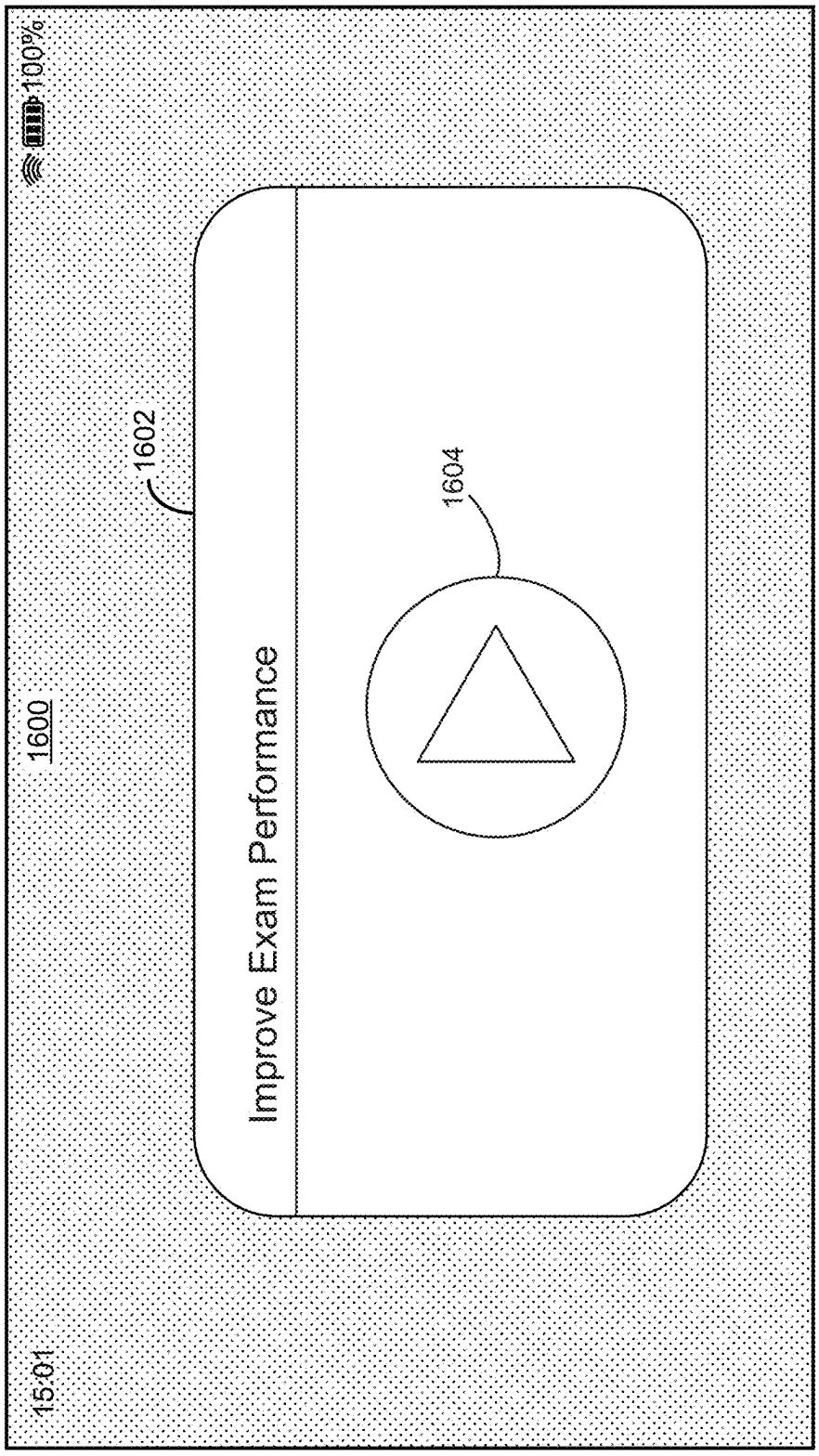


FIG. 16

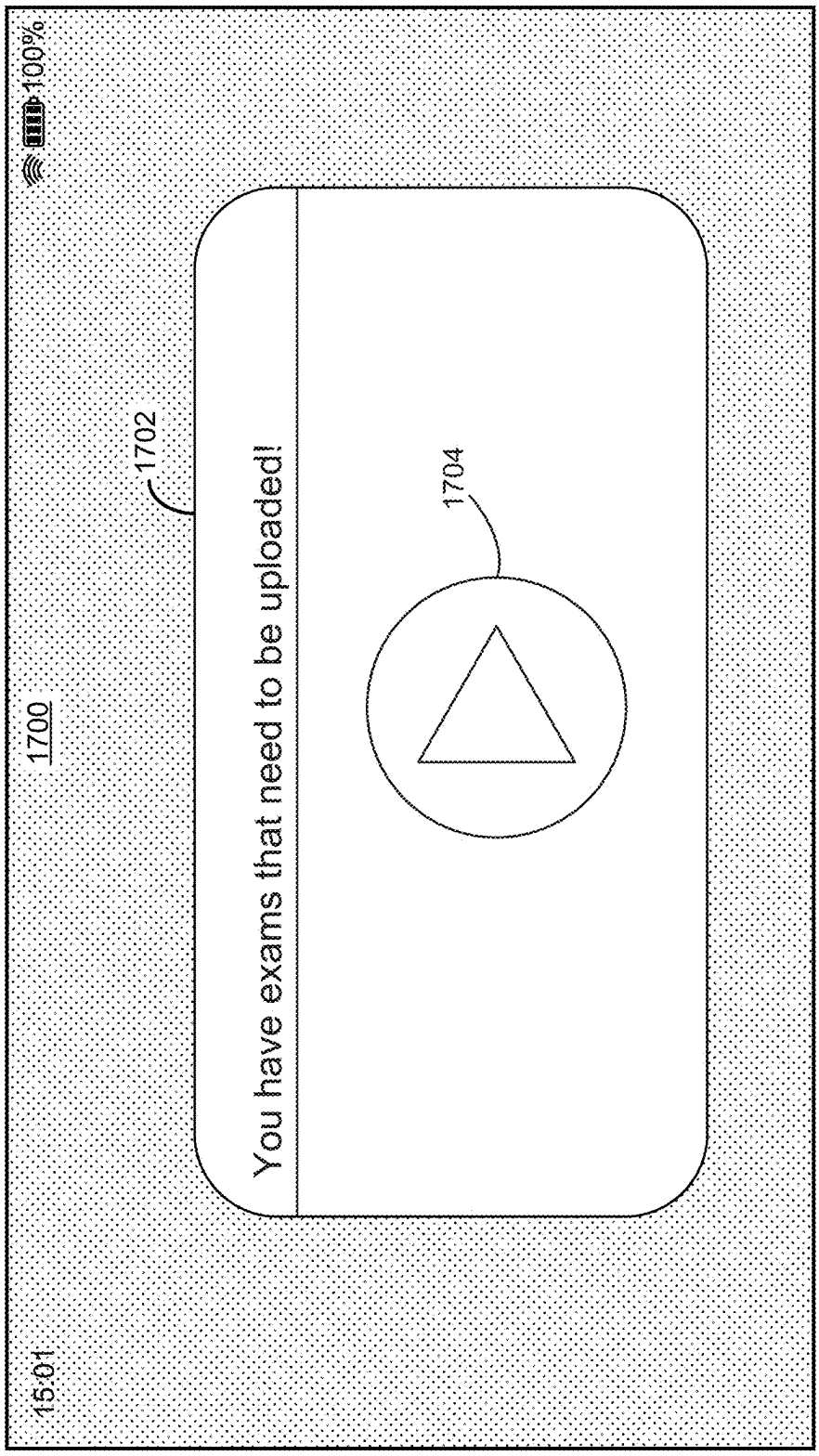

100%
1700
1702
You have exams that need to be uploaded!
1704
1501

FIG. 17

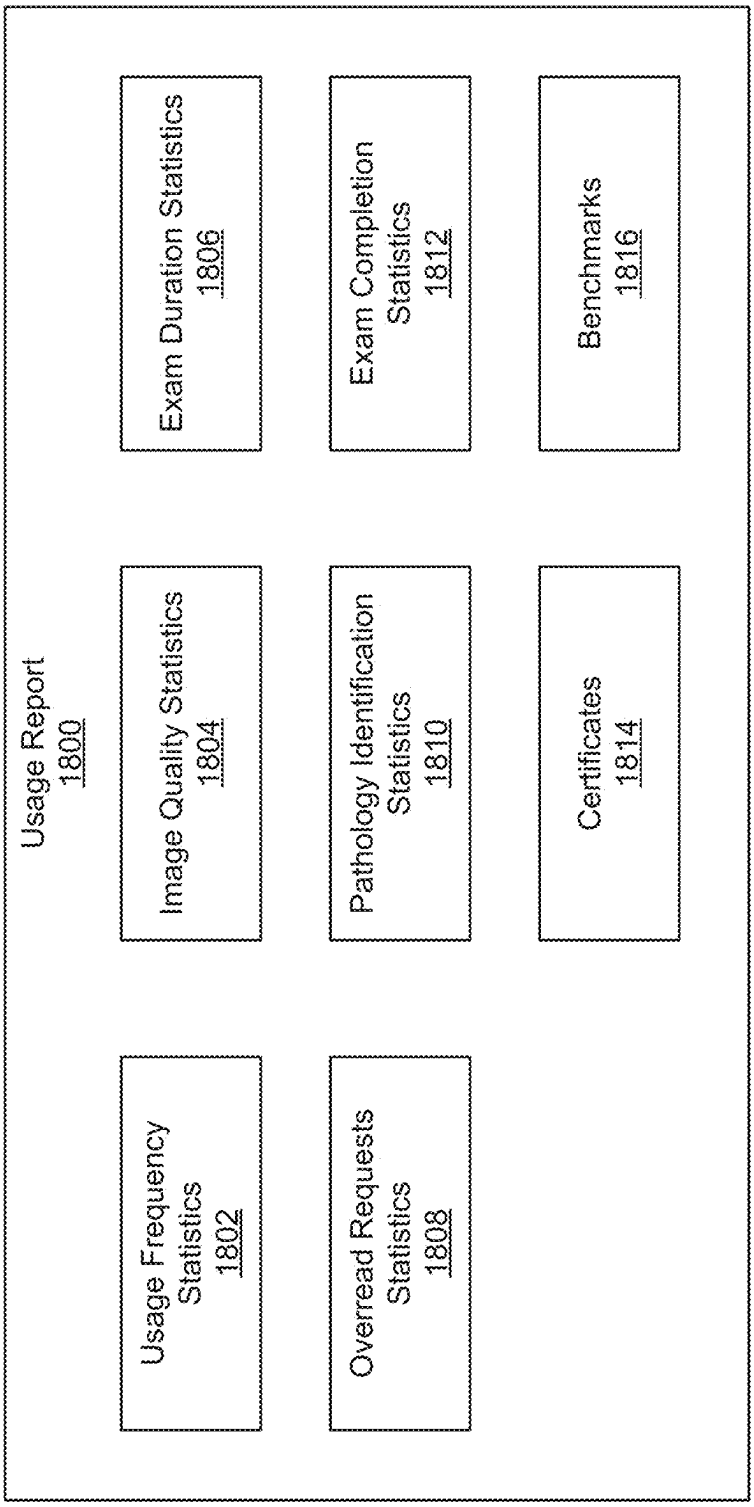

Usage Report
1800
Usage Frequency Statistics
1802
Image Quality Statistics
1804
Exam Duration Statistics
1806
Overread Requests Statistics
1808
Pathology Identification Statistics
1810
Exam Completion Statistics
1812
Certificates
1814
Benchmarks
1816

FIG. 18

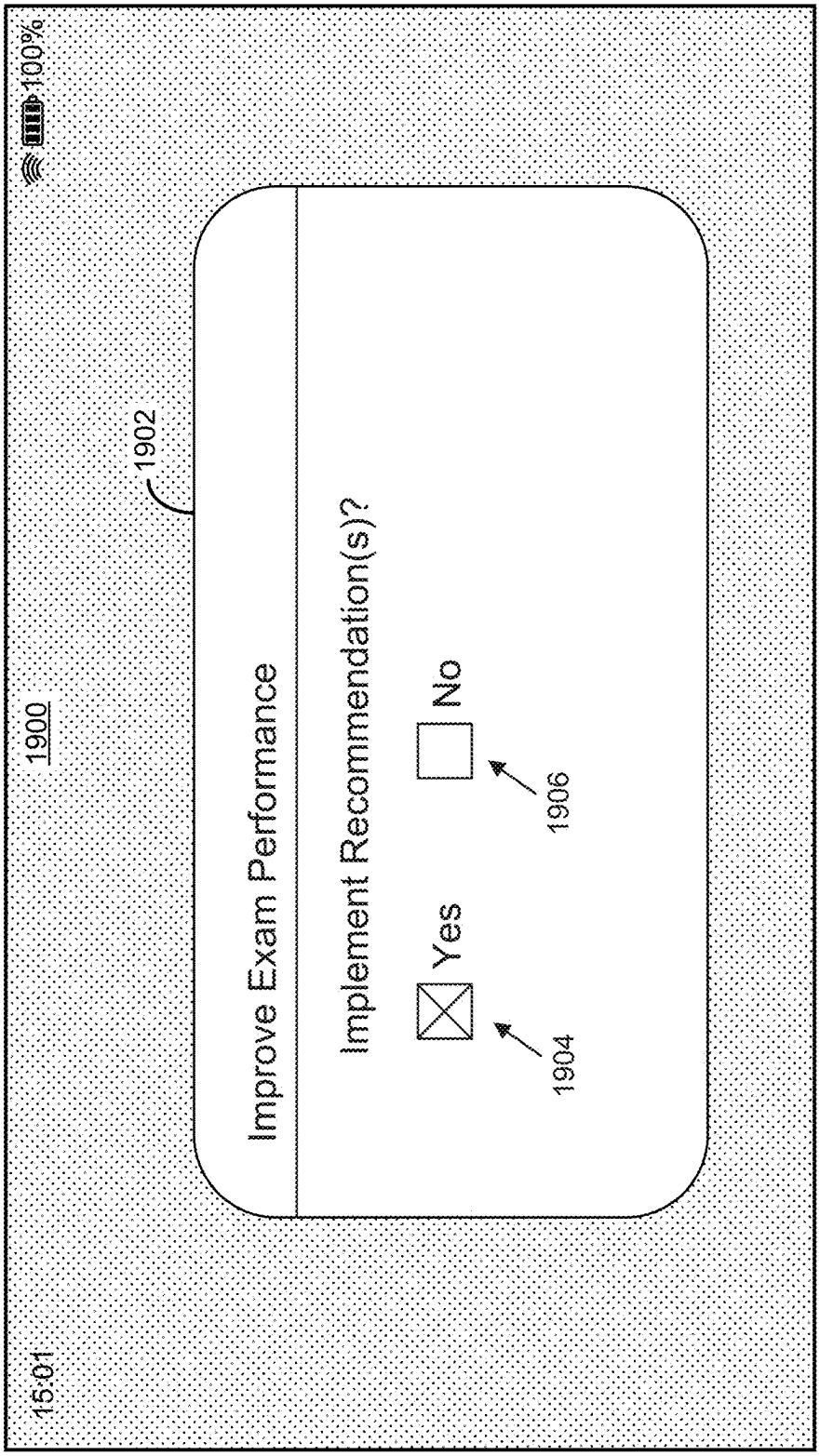

15:01
100%
1900
1902
Improve Exam Performance
Implement Recommendation(s)?
Yes
No
1904
1906

FIG. 19

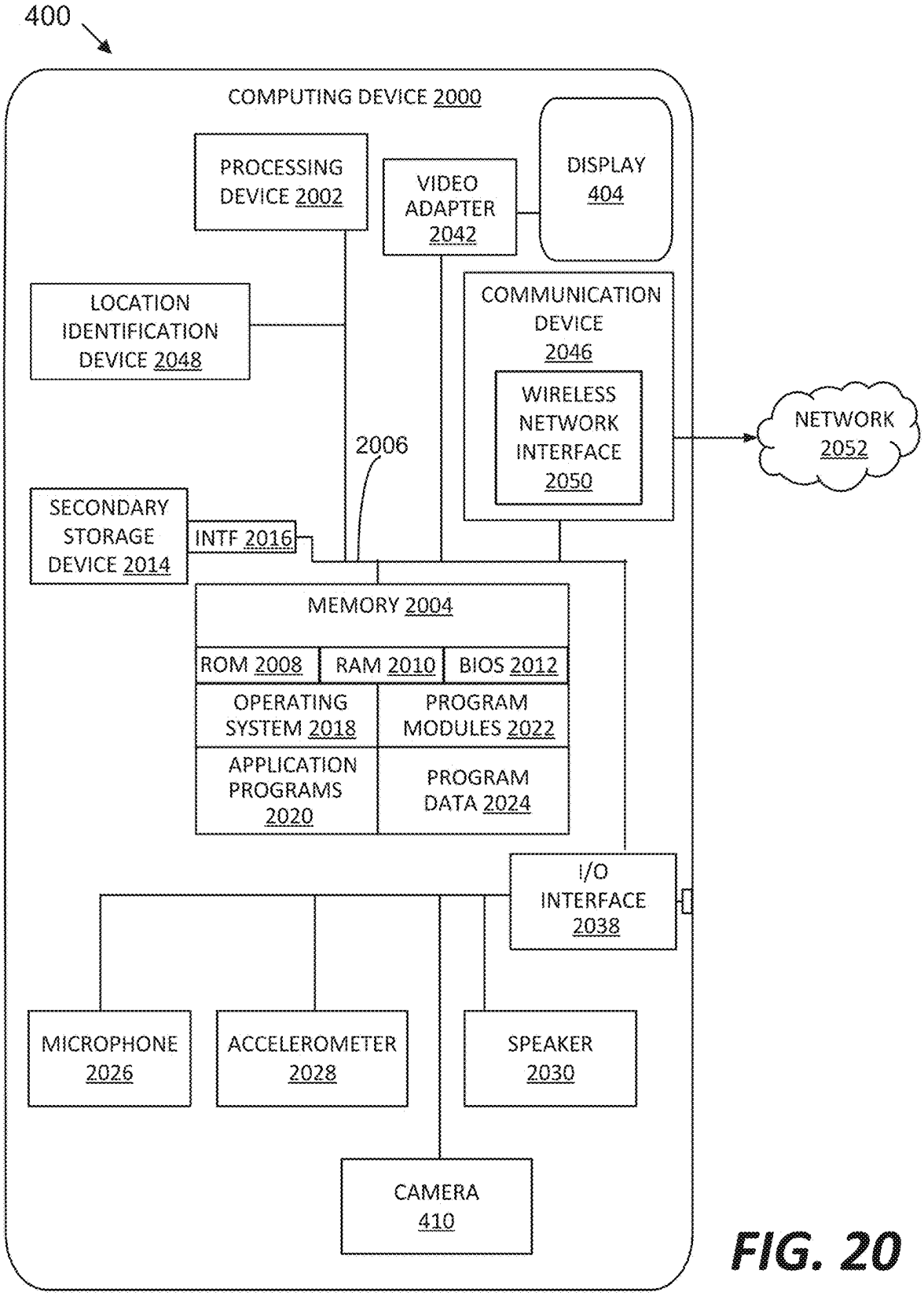

400
COMPUTING DEVICE 2000
PROCESSING DEVICE 2002
VIDEO ADAPTER 2042
DISPLAY 404
LOCATION IDENTIFICATION DEVICE 2048
COMMUNICATION DEVICE 2046
WIRELESS NETWORK INTERFACE 2050
NETWORK 2052
2006
SECONDARY STORAGE DEVICE 2014
INTF 2016
MEMORY 2004
ROM 2008
RAM 2010
BIOS 2012
OPERATING SYSTEM 2018
PROGRAM MODULES 2022
APPLICATION PROGRAMS 2020
PROGRAM DATA 2024
I/O INTERFACE 2038
MICROPHONE 2026
ACCELEROMETER 2028
SPEAKER 2030
CAMERA 410

FIG. 20

MEDICAL IMAGING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of and priority to U.S. Provisional Patent Application No. 63/555,491, filed Feb. 20, 2024, the entire disclosure of which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] Optical viewing devices are used for examining patients as part of routine examinations. Examples of optical viewing devices can include, without limitation, an otoscope for assessing the ears of a patient, an ophthalmoscope for assessing the eyes of a patient, and a dermatoscope for assessing the skin of a patient. Different types of examinations and workflows are typically performed based on the type of optical viewing device being used.

SUMMARY

[0003] In general terms, the present disclosure relates to imaging for optical viewing devices. In one possible configuration, an imaging device is configured for use on optical viewing devices, and the imaging device tracks usage and image quality metrics from examinations performed using the optical viewing devices. Various aspects are described in this disclosure, which include, but are not limited to, the following aspects.

[0004] One aspect relates to an imaging device for capturing images through an eyepiece of an optical viewing device, the imaging device comprising: a camera configured for alignment with the eyepiece of the optical viewing device for capturing the images viewed through the eyepiece; a display for displaying the images captured by the camera; at least one processing device; and at least one computer readable data storage device storing software instructions that, when executed by the at least one processing device, cause the imaging device to: determine a type of the optical viewing device; present a workflow on the display based on the type of the optical viewing device; and capture metrics related to user interactions with the workflow presented on the display and the images captured by the camera during the workflow.

[0005] Another aspect relates to a method of capturing images through an eyepiece of an optical viewing device, the method comprising: providing an imaging device for attachment to the optical viewing device; presenting a workflow on the imaging device for capturing the images based on a type of optical viewing device, the workflow including tools for annotating the images on a display; capturing metrics related to user interactions with the workflow, and quality characteristics of the images captured during the workflow; and generating a recommendation based on the metrics.

[0006] Another aspect relates to a system for imaging an anatomy, the system comprising: an optical viewing device including an instrument head having an eyepiece; and an imaging device attached to the optical viewing device, the imaging device including: a camera configured for alignment with the eyepiece of the instrument head for capturing the images viewed through the eyepiece; a display for displaying the images captured by the camera; at least one processing device; and at least one computer readable data storage device storing software instructions that, when executed by the at least one processing device, cause the device to: determine a type of the optical viewing device; present a workflow on the display based on the type of the optical viewing device; and capture metrics related to user interactions with the workflow presented on the display and the images captured by the camera during the workflow.

[0007] A variety of additional aspects will be set forth in the description that follows. The aspects can relate to individual features and to combination of features. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

DESCRIPTION OF THE FIGURES

[0008] The following drawing figures, which form a part of this application, are illustrative of the described technology and are not meant to limit the scope of the disclosure in any manner.

[0009] FIG. **1** shows examples of different types of optical viewing devices, each optical viewing device is shown attached to an imaging device.

[0010] FIG. **2** is an isometric view of an example of an optical viewing device shown in FIG. **1**, the optical viewing device shown from a physician perspective.

[0011] FIG. **3** is another isometric view of the optical viewing device of FIG. **2**, the optical viewing device shown from a patient perspective.

[0012] FIG. **4** is an isometric view of an example of the imaging device attached to the optical viewing device of FIG. **2**, the imaging device shown from the physician perspective.

[0013] FIG. **5** is a front isometric view of the imaging device of FIG. **4**.

[0014] FIG. **6**A is a front view of the imaging device of FIG. **4**.

[0015] FIG. **6**B is a rear view of the imaging device of FIG. **4**.

[0016] FIG. **6**C is a top view of the imaging device of FIG. **4**.

[0017] FIG. **7** is an isometric view showing a camera of the imaging device of FIG. **4**.

[0018] FIG. **8** schematically illustrates an example of a method of improving security of protected health information on the imaging device of FIGS. **1**-**7**.

[0019] FIG. **9** illustrates an example of a graphical user interface that can be used in operations of the method of FIG. **8** to request and receive user credentials.

[0020] FIG. **10** illustrates an example of a graphical user interface for searching for a patient in accordance with an example of a workflow presented in the method of FIG. **8**.

[0021] FIG. **11** illustrates an example of a graphical user interface optimized for capturing images and/or videos through an eyepiece of a type of optical viewing device in accordance within an example of the workflow presented in the method of FIG. **8**.

[0022] FIG. **12** illustrates an example of a graphical user interface for saving an examination in accordance with an example of the workflow presented in the method of FIG. **8**.

[0023] FIG. **13** illustrates an example of a graphical user interface displayed in the workflow of the method of FIG. **8** after a user selects a save icon in the graphical user interface of FIG. **12**.

[0024] FIG. **14** illustrates an example of an export screen that can be generated in an operation of the method of FIG. **8**.

[0025] FIG. **15** schematically illustrates an example of an examination report generated in an operation of the method of FIG. **8**.

[0026] FIG. **16** illustrates an example of a graphical user interface that can be displayed in an operation of the method of FIG. **8**, the graphical user interface includes a training window that has a play icon that is selectable to playback a video that provides tips and techniques to improve user competency of the imaging device and/or the optical viewing device of FIGS. **1-7**.

[0027] FIG. **17** illustrates another example of a graphical user interface that can be displayed in an operation of the method of FIG. **8**, the graphical user interface includes a training window that has a play icon that is selectable to playback a video that explains how to upload exams to a secure destination such as by using the export screen of FIG. **14**.

[0028] FIG. **18** schematically illustrates an example of a usage report that can be generated by a user analytics system communicatively connected to the imaging device of FIGS. **1-7**.

[0029] FIG. **19** illustrates an example of a graphical user interface that can be displayed on the imaging device of FIGS. **1-7**.

[0030] FIG. **20** illustrates an exemplary architecture of a computing device of the imaging device shown in any of the above figures.

DETAILED DESCRIPTION

[0031] FIG. **1** shows examples of different types of optical viewing devices **100**. The optical viewing devices **100** include a first type of optical viewing device **102**, a second type of optical viewing device **104**, and a third type of optical viewing device **106**. In the example illustrated in FIG. **1**, the first type of optical viewing device **102** is an otoscope, the second type of optical viewing device **104** is an ophthalmoscope, and the third type of optical viewing device **106** is a dermatoscope. Additional types of the optical viewing devices **100** can exist, and the disclosure provided herein is not limited to otoscopes, ophthalmoscopes, and dermatoscopes.

[0032] As shown in FIG. **1**, each type of optical viewing device **100** includes an instrument head **200** attached to an instrument handle **300**. The instrument head **200** can include a light source and optics for viewing an anatomical area of interest through an eyepiece.

[0033] The instrument handle **300** can include a power source that powers the light source and other components of the instrument head **200**. For example, the instrument handle **300** can include rechargeable batteries, disposable batteries, or a tether to a wall transformer for supplying electrical power to the components of the instrument head **200**.

[0034] As shown in FIG. **1**, the instrument head **200** of each type of optical viewing device **100** includes an imaging device **400** attached thereto. The imaging devices **400** are configured to capture images and videos through an eyepiece of the instrument head **200**. The images and videos are displayed on a display **404** mounted on a rear surface of the imaging device **400** (see FIGS. **4** and **6**B) for viewing by a physician. The imaging device **400** can include aspects described in U.S. Provisional Patent Application No. 63/503,219, entitled Imaging for Optical Viewing Devices, filed May 19, 2023, U.S. Provisional Patent Application No. 63/505,771, entitled Image Capture for Optical Viewing Devices, filed Jun. 2, 2023, and U.S. Provisional Patent Application No. 63/514,250, entitled Image Streaming for Optical Viewing Device, filed Jul. 18, 2023, which are herein incorporated by reference in their entireties.

[0035] As shown in FIG. **1**, the imaging devices **400** are universal with respect to the optical viewing devices **100** such that an imaging device **400** can be interchangeably used on the instrument head **200***a* of the first type of optical viewing device **102**, the instrument head **200***b* of the second type of optical viewing device **104**, and the instrument head **200***c* of the third type of optical viewing device **106**. The instrument handle **300** may also be universal with respect to the first type of optical viewing device **102**, the second type of optical viewing device **104**, and the third type of optical viewing device **106** such that the instrument handle **300** can be interchangeably used between the different types of optical viewing devices.

[0036] As shown in FIG. **1**, the imaging devices **400** are communicatively connected over the network **2052** to a user analytics system **500**. As will be described in more detail, the user analytics system **500** can analyze attributes related to the usage of the imaging devices **400** to prepare recommendations for implementation on the imaging devices **400** to improve user competency, and efficacy of the imaging devices **400** and/or the optical viewing devices **100**.

[0037] Images, videos, and other data captured by the imaging devices **400** can be transferred over the network **2052** to an EHR system **600** for storage in an electronic health record (EHR) **602**. As described herein, the terms electronic medical records (EMRs) and electronic patient record (EPRs) can be used interchangeably with EHRs. The EHR system **600** collects patient electronically stored health information in a digital format (e.g., EHRs **602**). As such, the EHR system **600** maintains a plurality of EHRs **602** for a plurality of patients. Each EHR **602** can be shared across different health care settings. For example, the EHRs **602** are shared through network-connected, enterprise-wide information systems or other information networks and exchanges. The EHRs **602** may include a range of data, including demographics, medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, personal statistics like age and weight, and billing information.

[0038] Additionally, the images, videos, and other data captured by the imaging devices **400** can be transferred over a network **2052** to an overread system **700**. The overread system **700** can provide the images, videos, and other data captured by the imaging devices **400** for review by trained medical specialists such as ear, nose, and throat (ENT) specialists, ophthalmologists, and dermatologists, or by trained technicians. Additionally, or alternatively, the overread system **700** can include algorithms, including artificial intelligence and machine learning algorithms, which can be used to analyze the images, videos, and data captured by the imaging devices **400**.

[0039] The overread system **700** generates results from analysis of the images, videos, and other data captured by the imaging device **400**. The overread system **700** can transfer the results to the imaging device **400** or to another device over the network **2052**. Accordingly, two-way communications between the imaging device **400** and the over-

read system **700** can be provided over the network **2052**. The overread system **700** can be remotely located with respect to the imaging device **400**. In some examples, the overread system **700** includes a cloud server.

[0040] The network **2052** can include any type of wired or wireless connections, or any combinations thereof. Examples of wireless connections include cellular network connections such as 4G or 5G. The wireless connections can also be accomplished using Wi-Fi, ultra-wideband (UWB), Bluetooth, radio frequency identification (RFID), and the like.

[0041] The images, videos, and other data captured by the imaging devices **400** can be transferred over the network **2052** to the EHR system **600**, the overread system **700**, and/or the user analytics system **500** using the Fast Healthcare Interoperability Resources (FHIR) standard, which is a set of rules and specifications for exchanging electronic healthcare data in a wide range of settings and with different health care information systems. The FHIR standard describes data formats and elements (known as "resources") and an application programming interface (API) for exchanging the EHRs **602**. Alternatively, the images, videos, and other data captured by the imaging devices **400** can be transferred over the network **2052** to the EHR system **600**, the overread system **700**, and/or the user analytics system **500** using the HL7 version 2.x and HL7 version 3.x data format standards for exchanging electronic healthcare data.

[0042] FIGS. **2** and **3** are isometric views of an example of the second type of optical viewing device **104**. In FIG. **2**, the second type of optical viewing device **104** is shown from a physician perspective. In FIG. **3**, the second type of optical viewing device **104** is shown from a patient perspective. As discussed above, the second type of optical viewing device **104** is an example of an ophthalmoscope. While FIGS. **2** and **3** show the second type of optical viewing device **104**, the first type of optical viewing device **102** and the third type of optical viewing device **106** can include similar components and features such that the following description can similarly apply to the first and third types of optical viewing device **102**, **106**.

[0043] Referring now to FIGS. **2** and **3**, the second type of optical viewing device **104** includes a diopter focus wheel **202** and a diopter readout **204**. The diopter focus wheel **202** can be used to adjust a focus of an eyepiece **201**. The diopter focus wheel **202** can be used to correct the refractive errors of the user of the optical viewing device **104** and the patient. For example, the diopter focus wheel **202** can be used to provide a positive dioptric value to accommodate for hyperopia eyesight (farsightedness) of both the user of the optical viewing device **104** and the patient, and to provide a negative dioptric value to accommodate for myopia eyesight (nearsightedness) of both the user of the optical viewing device **104** and the patient. The dioptric values adjusted by using the diopter focus wheel **202** are displayed in the diopter readout **204**.

[0044] The instrument head **200***b* of the second type of optical viewing device **104** can further include a filter wheel **206** to select a filter for viewing through the eyepiece **201**. For example, the filter wheel **206** can be used to select a reticle target to measure the optic disc, a cobalt blue filter to detect corneal abrasions, a red-free filter, and additional types of filters.

[0045] The second type of optical viewing device **104** can further include a light control **208** for controlling illumination from the light source, disc alignment lights **210** (e.g., red for right eye exams; yellow for left eye exams), an eyepiece bumper **212**, an optional patient eye cup **214**, an optional locking collar **216**, and an eyepiece housing **218**. As will be described in more detail below, the imaging device **400** includes a bracket that removably attaches to the eyepiece housing **218** for securing the imaging device **400** to the instrument head **200***b*.

[0046] As further shown in FIG. **2**, the second type of optical viewing device **104** can include an identifier **220**. While the identifier **220** is described with reference to the second type of optical viewing device **104**, the first and third types of optical viewing devices **102**, **106**, as well as additional types of optical viewing devices can similarly include the identifier **220**, as described herein. As will be described in more detail, the identifier **220** provides machine-readable data that can be detected by the imaging device **400** to detect attachment of the imaging device **400** to the instrument head **200**, and to convey additional information such as the type of the instrument head **200** (i.e., whether the instrument head **200** is for an otoscope, an ophthalmoscope, a dermatoscope, or another type of optical viewing device).

[0047] In some examples, the identifier **220** is a wireless antenna that transmits a wireless signal that is detected by the imaging device **400** when the imaging device **400** is attached to the instrument head **200**. In some examples, the wireless signal transmitted by the identifier **220** to the imaging device **400** can include a radio frequency identification (RFID) signal, a near field communication (NFC) signal, a Bluetooth signal, a Wi-Fi signal, or other similar wireless signals. The identifier **220** can include a passive antenna or tag that is activated by an active antenna on the imaging device **400** to transmit the wireless signal when the imaging device **400** is in close proximity to the instrument head **200** such as when it is attached thereto.

[0048] In some further examples, the identifier **220** can provide additional types of machine-readable data that can be detected by the imaging device **400**. For example, the identifier **220** can include a quick response (QR) code or other type of machine-readable label that can be read by a primary camera or a secondary camera of the imaging device **400**.

[0049] FIG. **4** is a rear isometric view of an example of the imaging device **400** attached to the second type of optical viewing device **104**, shown from the physician perspective. FIG. **5** is a front isometric view of the imaging device **400**. FIG. **6**A is a front view of the imaging device **400**. FIG. **6**B is a rear view of the imaging device **400**. FIG. **6**C is a top view of the imaging device **400**. FIG. **7** is an isometric view showing a camera **410** of the imaging device **400**. Referring now to FIGS. **4-7**, the imaging device **400** captures images viewed from the eyepiece **201** of the instrument head **200***b* of the second type of optical viewing device **104**.

[0050] While FIGS. **4-6** show the imaging device **400** attached to the instrument head **200***b* of the second type of optical viewing device **104**, the imaging device **400** can be similarly attached to the instrument heads **200***a*, **200***c* of the first type of optical viewing device **102** and the third type of optical viewing device **106** for capturing images and videos from the eyepieces of the first type of optical viewing device **102** and the third type of optical viewing device **106**.

[0051] As shown in FIGS. **4-6**, the imaging device **400** includes a housing **402**. In this example, a bracket **406** is

integrated with a back surface of the housing **402**. The bracket **406** allows the imaging device **400** to physically attach to the instrument head **200***b*. For example, the bracket **406** can be fixed around the eyepiece housing **218** (see FIGS. **2** and **3**) of the instrument head **200***b*. In alternative examples, the bracket **406** can be an accessory that attaches to the housing **402** for attachment of the imaging device **400** to the optical viewing devices **100**.

[0052] As shown in FIGS. **5** and **7**, the housing **402** further includes an aperture **412** for a lens **414** of the camera **410**. The camera **410** is mounted inside the housing **402** of the imaging device **400**. When the imaging device **400** is mounted to the instrument head **200***b*, the camera **410** is aligned with the eyepiece **201** of the instrument head **200***b* for capturing images viewed through the eyepiece **201** of the instrument head **200***b*. The camera **410** is centrally mounted inside the housing **402** to provide even balance and weight distribution for when the imaging device **400** is attached to the instrument head **200***b*, thereby improve the ergonomics of the assembly. A protrusion of the lens **414** beyond the back surface of the housing **402** is minimized such that the lens **414** is substantially flush with the back surface of the housing **402**.

[0053] The camera **410** can include features such as auto focus, auto-exposure, auto white-balance, and image stabilization. The camera **410** can include a 12MP color image sensor. As an illustrative example, the camera **410** can include an equivalent focal length (on 35 mm film) of 52-77 mm, 4K (30 FPS) video recording with 4000×3000 pixel resolution, and a record time of 90 minutes at 4K resolution, 1 minute per clip. Alternative camera parameters are possible.

[0054] The housing **402** is compact and lightweight. In some examples, the housing **402** includes a protective overmold having a base layer of plastic material, and a top layer of rubber to provide shock absorption and improved grip. The housing **402** can include one or more ports such as a USB-C port for charging the battery, and for data transferring including uploading images and videos captured by the camera **410** to another device. As an illustrative example, the housing **402** can have a thickness (e.g., distance between the lens **414** of the camera **410** and the display **404**) that is less than 25 mm, and a weight that is less than 250 g. The housing **402** can include a power button to turn on/off and wake up the imaging device **400**. The housing **402** houses an integrated, rechargeable battery that can, for example, power 90 minutes of 4K video recording by the camera **410**, and 3-4 hours of screen time on the display **404**.

[0055] As shown in FIG. **7**, the imaging device **400** can include a detector **408** that detects the machine-readable data from the identifier **220** on the instrument head **200** (see FIG. **2**) to detect attachment of the imaging device **400** to the instrument head **200**, and to detect additional information such as the type of the instrument head **200** (i.e., whether the instrument head **200** is for an otoscope, an ophthalmoscope, a dermatoscope, or another type of optical viewing device).

[0056] In some examples, the detector **408** is a wireless antenna that detects a wireless signal from the identifier **220** on the instrument head **200** when the imaging device **400** is attached to the instrument head **200**. In some examples, the detector **408** on the imaging device **400** can detect a radio frequency identification (RFID) signal, a near field communication (NFC) signal, a Bluetooth signal, a Wi-Fi signal, or other similar wireless signals emitted from the instrument head **200**. The detector **408** can include an active antenna or tag that activates a passive antenna or tag on the instrument head **200** to receive a transmission of the wireless signal. In some examples, the active antenna is mounted on the imaging device **400** in a location that corresponds to the placement of the passive antenna on the instrument head **200** such that the active antenna activates the passive antenna when in close proximity to the passive antenna such as when the imaging device **400** is attached to the instrument head **200**.

[0057] In some further examples, the detector **408** can include a secondary camera that can read a quick response (QR) code or other type of machine-readable label placed on the instrument head **200**. The secondary camera can read the machine-readable label to detect attachment of the imaging device **400** to the instrument head **200**, as well as to determine the type of the instrument head **200** (i.e., whether the instrument head **200** is for an otoscope, an ophthalmoscope, a dermatoscope, or another type of optical viewing device). The secondary camera can be mounted on the imaging device **400** in a location that corresponds to the placement of the machine-readable label on the instrument head **200**.

[0058] As further shown in FIGS. **4-7**, the imaging device **400** includes the display **404** for displaying the images, videos, and other data captured by the imaging device **400**. The display **404** can include a touchscreen that displays the images, the videos, and the other data, and that also receives inputs from a user. For example, the display **404** can be used by a user of the imaging device **400** to adjust the settings of the camera **410** (e.g., focus, exposure, white balance, FOV/zoom); tapping the display **404** to trigger focus and lock; adjust settings of the display **404** such as the screen brightness; provide a virtual keyboard to type in information; display a battery-life indicator; provide video recording controls (e.g., start, stop, save, delete, review, upload; provide a sliding bar to go through video frames, pinch-zoom to enlarge; display arrow(s) to indicate image orientation; and display one or more stamps (e.g., date, time, filter type, and the like) on saved images and videos.

[0059] The display **404** can include a true color multi-touch screen (in-plane switching (IPS), or light-emitting diode (LED)). The display **404** can have a bezel-less design (e.g., full-screen display). The display **404** can have a resolution of at least 250 pixels per inch (PPI), a diagonal screen size of about 2 inches to about 5 inches, an aspect ratio of 16:9/4:3, a maximum brightness of 500 nits. The display **404** can also include features such as screen auto off, and wake up by power button or tapping the display **404**.

[0060] Additionally, the imaging device **400** can provide haptic feedback based on touches detected on the display **404**, or selection of one or more physical push buttons on the housing **402** of the imaging device **400**. The haptic feedback can include vibrations to give feedback rather than audible beeps to quickly communicate to the user actions such as when video capture has initiated or when a captured video is ready for playback.

[0061] Healthcare facilities such as hospitals, medical offices, clinics, and the like generally have secure protocols for handling, storing, and transferring medical data in view of regulations established under the Health Insurance Portability and Accountability Act (HIPAA) that address the use and disclosure of protected health information by covered

entities. The images, videos, and other data captured by the imaging device **400** can include protected health information.

[0062] To maintain the confidentiality of protected health information captured on the imaging device **400**, the images, videos, and other data captured by the imaging device **400** are deleted from the imaging device **400** after the images, videos, and other data are transferred to another device or system such as the EHR system **600** or the overread system **700**. For example, the images, videos, and other data can be stored on a random-access memory (RAM) **2010** of the imaging device **400** (see FIG. **20**) while the imaging device **400** is being used to capture images and/or videos during an examination performed using an optical viewing device **100** with the imaging device **400** attached thereto. When the examination is complete, a report is generated on the imaging device **400** using the images, videos, and other data stored on the random-access memory (RAM) **2010**. After the report is transferred to another device or system such as the EHR system **600** or the overread system **700**, the images, videos, and other data are deleted from the RAM **2010** to mitigate risk that such information is accessed by an unauthorized entity.

[0063] When an examination recorded by the imaging device **400** is incomplete or the report is not transferred to another device or system, the images, videos, and other data captured during the examination can remain on the RAM **2010** of the imaging device **400**. This can lead to potential security vulnerabilities in which the images, videos, and other data can be accessed or stolen by an unauthorized user or entity. To mitigate such security vulnerabilities, it can be desirable to track usage and data transfer metrics from the imaging device **400** to improve the security of protected health information that may reside on the imaging device **400**. Additionally, user competency and training for improving exam efficacy and image quality can be identified by tracking usage and data transfer metrics from the imaging device **400**.

[0064] FIG. **8** schematically illustrates an example of a method **800** of improving security of protected health information on the imaging device **400**. The method **800** can be implemented on the imaging device **400**. In some examples, the method **800** is performed by execution of software instructions stored on a memory of the imaging device **400**.

[0065] As shown in FIG. **8**, the method **800** includes an operation **802** of requesting user credentials. As an illustrative example, when the imaging device **400** is powered on, the imaging device **400** displays a graphical user interface on the display **404** that requests a user of the imaging device **400** to enter their user credentials for authentication. The user credentials can include a username and password, a personal identification number (PIN), machine-readable data, biometric data, or some other type of data that can be used to authenticate the user.

[0066] The method **800** includes an operation **804** of receiving the user credentials. In some examples, the user credentials are received in operation **804** from a scan of a machine-readable label such as a barcode or QR code that identifies the user of the imaging device **400**. For example, the user can use the camera **410** to scan a machine-readable label that is printed on a lanyard or other accessory possessed by the user. Alternatively, operation **804** can include receiving the user credentials from the user entering a username, password, and/or PIN. As further example, operation **804** can include receiving a scan of the user's face, fingerprint, or some other type of biometric data that can be used to authenticate the user. In some instances, two-factor authentication is performed where the user enters a code included in a notification, a text message, or an email sent to another device associated with the user such as a smartphone.

[0067] FIG. **9** illustrates an example of a graphical user interface **900** that can be used in operations **802**, **804** of the method **800** to request and receive the user credentials. The graphical user interface **900** has a first field **902** for the user to enter their username, and a second field **904** for the user to enter their password. Once the user has entered the requested data in the first and second fields **902**, **904**, the user can select an input **906** to submit the username and password for authentication. Alternatively, the user can select an input **908** to cancel the request.

[0068] Referring back to FIG. **8**, the method **800** includes an operation **806** of determining whether the user credentials received in operation **804** are valid for authenticating the user of the imaging device **400**. When the user credentials are invalid (i.e., "No" in operation **806**), such as when the username and/or password entered by the user are not recognized as belonging to an authorized user, the method **800** returns to operation **802** of requesting the user credentials. In this manner, only authorized users are allowed to use the imaging device **400**.

[0069] In some examples, the imaging device **400** permits use of the device without requiring valid user credentials such as during a training or testing mode. In such training or testing mode, the imaging device **400** can be used to capture images, videos, and/or other types of data without associating the data with a real patient such that protected health information is not generated on the device. In some examples, the training or testing mode allows the images, videos, and/or other types of data to be saved on the RAM **2010** of the imaging device **400**.

[0070] As shown in FIG. **8**, when the user credentials are valid (i.e., "Yes" in operation **806**), the method **800** proceeds to an operation **808** of capturing metrics during use of the imaging device **400**. The metrics captured in operation **808** can be stored in the RAM **2010** of the imaging device **400**. As will be described in more detail below, the metrics can be used to enhance security of protected health information on the imaging device **400**, as well as improve user competency and training by identifying areas where the imaging device **400** and/or the optical viewing device **100** can be more effectively used to examine a patient.

[0071] The method **800** includes an operation **810** of determining a type of optical viewing device **100** that the imaging device **400** is attached to. Operation **810** can include determining the instrument head **200** belongs to the first type of optical viewing device **102** (e.g., an otoscope), the second type of optical viewing device **104** (e.g., an ophthalmoscope), the third type of optical viewing device **106** (e.g., a dermatoscope), or another type of optical viewing device.

[0072] Operation **810** can include determining the type of optical viewing device **100** based on a detection of the instrument head **200** such as by the detector **408** detecting the identifier **220** on the instrument head **200** or the camera **410** reading a machine-readable label on the instrument head **200**. Alternatively, or additionally, operation **810** can include determining the type of optical viewing device **100** based on

a confirmation received on the display **404** (in examples where the display **404** is a touch sensitive touchscreen). Examples of determining the type of optical viewing device **100** are described in U.S. Provisional Patent Application No. 63/607,600, entitled Workflows and Graphical User Interfaces for Optical Viewing Devices, filed Dec. 8, 2023, and U.S. Provisional Patent Application No. 63/617,234, entitled Workflows and Graphical User Interfaces for Optical Viewing Devices, filed Jan. 3, 2024, which are herein incorporated by reference in their entireties.

[0073] The metrics captured in operation **808** of the method **800** can include the type of optical viewing device **100** determined in operation **810** such as whether the imaging device **400** is attached to the first type of optical viewing device **102** (e.g., an otoscope), the second type of optical viewing device **104** (e.g., an ophthalmoscope), the third type of optical viewing device **106** (e.g., a dermatoscope), or another type of optical viewing device.

[0074] The method **800** includes an operation **812** of presenting a workflow on the display **404** of the imaging device **400** based on the type of optical viewing device **100** determined in operation **810**. The workflow can include a series of graphical user interfaces that are displayed on the display **404** for recording an examination of a patient performed by using the type of optical viewing device **100** determined in operation **810**.

[0075] FIG. **10** illustrates an example of a graphical user interface **1000** that can be displayed in the workflow presented in operation **812** of the method **800**. The graphical user interface **1000** allows the user to search for a patient in the EHR system **600**, and to select the patient such that the examination recorded by the imaging device **400** is associated with the patient. This enables storage of the examination recorded by the imaging device **400** in the EHR **602** of the patient. Further, the metrics captured in operation **808** can include identification of the patient.

[0076] In the example provided in FIG. **10**, the graphical user interface **1000** includes a first field **1002** for the user to enter a first name of the patient, and a second field **1004** for the user to enter a last name of the patient. The graphical user interface **1000** can include additional fields for entering additional information such as for entering a medical record number of the patient. Once one or more inputs are entered in the fields displayed on the graphical user interface **1000**, the user can select a search icon **1006** to search for the patient within the EHR system **600**.

[0077] The user can alternatively select a scan icon **1008** that causes display of a graphical user interface on the display **404** enabling the camera **410** to scan a machine-readable label such as a barcode or QR code to identify the patient in the workflow presented in operation **812**.

[0078] The graphical user interfaces in the workflow presented in operation **812** are based on the type of optical viewing device **100** determined in operation **810**. The graphical user interfaces are optimized for capturing images and/or videos of an anatomy that is typically examined by the type of optical viewing device **100** determined in operation **810** such as an eye anatomy examined by an ophthalmoscope, an ear anatomy examined by an otoscope, and a skin anatomy examined by a dermatoscope. The graphical user interfaces in the workflow presented in operation **812** can further include one or more tools for annotating a video of the anatomy captured by the imaging device **400**, or one or more images or frames selected from the video.

[0079] For example, the workflow can include tools such as predefined annotations associated with a type of anatomy typically examined by the type of optical viewing device **100** determined in operation **810**. The predefined annotations are selectable on the display **404** to indicate presence of a condition or disease state associated with the type of anatomy. The workflow can also include tools such as filters based on the type of anatomy typically examined by the type of optical viewing device **100** determined in operation **810**. Filters such as a grayscale filter, a high-contrast filter, and a red-free filter can be presented for use on the imaging device **400** based on the type of optical viewing device **100** determined in operation **810**. The workflow can also include tools such as a ruler superimposed on an image or frame selected from the video of the anatomy, and the ruler is scaled based on the type of anatomy typically examined by the type of optical viewing device **100** determined in operation **810**. The ruler can provide a reference for one or more anatomical features included in the selected frame.

[0080] FIG. **11** illustrates an example of a graphical user interface **1100** that is optimized for capturing a video and/or images through the eyepiece **201** of an ophthalmoscope (e.g., the second type of optical viewing device **104**). The graphical user interface **1100** includes a record icon **1102** that can be selected by the user to record the video of the eye anatomy. Additional types of graphical user interfaces can be displayed on the display **404** such as a graphical user interface that is optimized for capturing a video and/or images through the eyepiece **201** of an otoscope (e.g., the first type of optical viewing device **102**), a graphical user interface that is optimized for capturing a video and/or images through the eyepiece **201** of a dermatoscope (e.g., the third type of optical viewing device **102**), or of another type of optical viewing device.

[0081] FIG. **12** illustrates an example of a graphical user interface **1200** that can be displayed in the workflow presented in operation **812**. The graphical user interface **1200** is generated for use when the imaging device is attached to an ophthalmoscope (e.g., the second type of optical viewing device **104**). The graphical user interface **1200** includes an icon **1202** that when selected allows the user to capture another image or video of the left eye (OS) or right eye (OD). The graphical user interface **1200** further includes a save icon **1204** to save the examination, and an exit icon **1206** to exit the examination and discard the captured images and/or videos.

[0082] FIG. **13** illustrates an example of a graphical user interface **1300** that can be displayed in the workflow presented in operation **812** after the user selects the save icon **1204** in the graphical user interface **1200** of FIG. **12**. The graphical user interface **1300** includes a confirmation **1302** that the recording of the examination by the imaging device **400** is saved. The graphical user interface **1300** further includes an export icon **1304** that when selected allows the user to export an examination report to another device or system such as the EHR system **600** or the overread system **700** (see FIG. **1**). An export screen **1400** (see FIG. **14**) is generated in response to selection of the export icon **1304**, as will be described in more detail further below.

[0083] Referring back to FIG. **8**, the method **800** includes an operation **814** of determining whether the examination that is being recorded by the imaging device **400** is complete. Operation **814** can include determining the examination is complete when the save icon **1204** is selected on the

graphical user interface **1200**. As another example, operation **814** can include determining the examination is complete when the imaging device **400** remains idle for more than a predetermined period of time. As another example, operation **814** can include determining the examination is complete when the optical viewing device **100** is moved away from an anatomy such as an ear, eye, or skin surface for a predetermined period of time such that the imaging device **400** is no longer capturing an image or video of the anatomy.

[0084] When operation **814** determines the examination is not complete (i.e., "No" in operation **814**), the method **800** can continue to present the workflow (operation **812**) and capture the metrics (operation **808**). When operation **814** determines the examination is complete (i.e., "Yes" in operation **814**), the method **800** proceeds to an operation **816** of presenting an export screen, which as described above, allows the user to export a report that includes the images, videos, and other data captured by the imaging device **400** during the examination to another device or system such as the EHR system **600** or the overread system **700** (see FIG. **1**).

[0085] FIG. **14** illustrates an example of the export screen **1400** that is generated in operation **816** of the method **800**. The export screen **1400** displays a warning **1402** that all data including the images, videos, and other data captured during the examination must be uploaded to another device or system such as the EHR system **600** or the overread system **700**. As described above, the images, videos, and other data are deleted from the RAM **2010** of the imaging device **400** after the images, videos, and other data are uploaded to another device or system to maintain the confidentiality of protected health information captured on the imaging device **400**.

[0086] The export screen **1400** includes a first export option **1404** selectable to export the images, videos, and other data to a secure network. For example, selection of the first export option **1404** causes the images, videos, and other data to be sent to a file hosting service such as Microsoft OneDrive®, Google Drive®, iCloud®, and other similar file hosting services. Alternatively, selection of the first export option **1404** causes the images, videos, and other data to be sent to a proprietary network maintained by a manufacturer of the imaging device **400**.

[0087] The export screen **1400** includes a second export option **1406** selectable to export the images, videos, and other data to the EHR **602** hosted on the EHR system **600**. The images, videos, and other data captured by the imaging device **400** can be stored directly in the EHR of a patient after examination of the patient by using the optical viewing device **100** is complete.

[0088] The export screen **1400** includes a third export option **1408** that is selectable to export the images, videos, and other data to the overread system **700** (see FIG. **1**). As described above, the overread system **700** can provide the images, videos, and other data captured by the imaging devices **400** for review by trained medical specialists or technicians for disease screening and diagnosis. Alternatively, or additionally, the overread system **700** can perform algorithms such as artificial intelligence and machine learning to analyze the images, videos, and data captured by the imaging devices **400** for disease screening and diagnosis.

[0089] The first export option **1404**, the second export option **1406**, and the third export option **1408** can be selected either individually or in combination with one another. For example, a user of the imaging device **400** can decide to upload the images, videos, and other data to both the EHR **602** of the patient, and to the overread system **700**. When the user is satisfied with one or more selections of the first export option **1404**, and/or the second export option **1406**, and/or the third export option **1408**, the user can select the done icon **1410** to enter the selection(s).

[0090] The export screen **1400** prevents insecure data transmission by limiting the export of the images, videos, and other data captured by the imaging device **400** to secure destinations such as a secure network, the EHR system **600**, and the overread system **700**. For example, the export screen **1400** prevents exporting the images, videos, and other data captured by the imaging device **400** to a universal serial bus (USB) drive, which can be stolen and accessed by an unauthorized user. Also, the export screen **1400** prevents exporting the images, videos, and other data captured by the imaging device **400** via e-mail or text message which are insecure data transfer methods. Instead, the export screen **1400** causes the images, videos, and other data captured by the imaging device **400** to be exported to secure destinations that require appropriate user credentials to retrieve and access the data such as username, password, PIN, and the like.

[0091] In some examples, instead of, or in addition to receiving inputs on the export screen **1400**, the images, videos, and other data captured by the imaging device **400** are automatically sent to a secure destination when the imaging device **400** connects to a computing device that is recognized by the software installed on the imaging device **400**. Such computing device can have installed thereon proprietary software developed by the manufacturer of the imaging device **400**. Also, the images, videos, and other data captured by the imaging device **400** can be automatically sent to a secure destination when the imaging device **400** connects to a recognized network or cloud server. In such examples, the images, videos, and other data captured by the imaging device **400** can be automatically synchronized between the imaging device **400** and one or more secured destinations without requiring input on the export screen **1400**.

[0092] In some examples, the imaging device **400** requests a wireless handshake to connect the imaging device **400** to another device. For example, the wireless handshake can include an exchange of one or more keys over Bluetooth® or other wireless protocol to authenticate the other device. After the other device is authenticated, the imaging device **400** can transfer the images, videos, and other data to the other device over Wi-Fi or other suitable wireless network protocol. In some examples, the images, videos, and other data captured by the imaging device **400** are encrypted for communication over wired and/or wireless networks to further ensure confidentiality of the protected health information captured on the imaging device **400**.

[0093] Referring back to FIG. **8**, the method **800** includes an operation **818** of receiving export instructions. Operation **818** includes receiving the export instructions based on the selection(s) made on the export screen **1400** such as a selection of the first export option **1404** to upload the examination report to a secure network, and/or a selection of the second export option **1406** to upload the examination report to the EHR **602** of the patient, and/or a section of the third export option **1408** to upload the examination report to the overread system **700**. Additionally, or alternatively,

operation **818** can include receiving the export instructions when the imaging device **400** connects to a computing device, network, or cloud server that is recognized by the software installed on the imaging device **400**.

[0094] The method **800** includes an operation **820** of generating an examination report based on the images, videos, and other data captured by the imaging device **400**. As discussed above, the images, videos, and other data captured by the imaging device **400** can be of an ear anatomy when the imaging device **400** is attached to an otoscope (e.g., the first type of optical viewing device **102**). Alternatively, the images, videos, and other data captured by the imaging device **400** can be of an eye anatomy when the imaging device **400** is attached to an ophthalmoscope (e.g., the second type of optical viewing device **104**). Alternatively, the images, videos, and other data captured by the imaging device **400** can be of a skin anatomy when the imaging device **400** is attached to a dermatoscope (e.g., the third type of optical viewing device **106**).

[0095] FIG. **15** schematically illustrates an example of an examination report **1500** generated in operation **820** of the method **800**. The examination report **1500** includes user information **1502** such as the user's name, employment location (e.g., a healthcare facility such as a hospital or a medical clinic or office where the user is employed), title/role (e.g., physician, registered nurse, and the like), and specialty (e.g., whether the user is general practitioner or has a specialty such as an ear, nose, and throat (ENT) specialist, an ophthalmologist, or a dermatologist). The user information **1502** can be retrieved from a database located off the imaging device **400** based on the user credentials received in operation **804** (see also graphical user interface **900** of FIG. **9**).

[0096] The examination report **1500** includes patient information **1504** such as patient name, date of birth, gender, and/or medical record number. The patient information **1504** can be retrieved from a database located off the imaging device **400** based on the patient selected from the search criteria entered in the graphical user interface **1000** of FIG. **10**.

[0097] The examination report **1500** includes images and/or videos **1506** captured by the camera **410** of the imaging device **400**. The images and/or videos **1506** are captured using the graphical user interfaces optimized for capturing the images and/or videos through the eyepiece **201** of the optical viewing device **100** such as the graphical user interface **1100** of FIG. **11**.

[0098] The examination report **1500** includes additional data **1508** such as annotations, markings, notes, and the like that can be added by the user to the images and/or videos that are captured by the camera **410** of the imaging device **400**. The additional data **1508** can also include preliminary diagnoses of diseases or conditions observed by the user. The additional data **1508** can be added by the using the tools included on the graphical user interfaces in the workflow presented on the display **404** of the imaging device in accordance with operation **812**.

[0099] The examination report **1500** further includes usage metadata **1510** based on the metrics captured in operation **808**. In alternative examples, the usage metadata **1510** can be attached to a video file or an image file that is sent from the imaging device **400** to the user analytics system **500**, the EHR system **600**, and/or the overread system **700**.

[0100] As shown in FIG. **15**, the usage metadata **1510** includes an export destination **1512** based on whether the user selected one or more secure destinations for exporting the images, videos, and other data captured by the imaging device **400** such as a secure network, an EHR **602** of the patient hosted on the EHR system **600**, and/or the overread system **700**.

[0101] The usage metadata **1510** can further include a transmission type **1514** such as whether the images, videos, and other data captured by the imaging device **400** are exported to the one or more secure destinations via a wireless connection via the network **2052**, or through a wired connection to a computing device recognized by the imaging device **400**.

[0102] The usage metadata **1510** can further include an exam duration **1516** recorded by the imaging device **400**. For example, the metrics captured in operation **808** of the method **800** can include how long it took the user to complete the examination of the left and/or right ears using an otoscope (e.g., the first type of optical viewing device **102**), or how long it took the user to complete the examination of the left and/or right eyes using an ophthalmoscope (e.g., the second type of optical viewing device **104**), or how long it took the user to complete the examination of a skin surface using a dermatoscope (e.g., the third type of optical viewing device **106**). By tracking the exam duration **1516**, the efficiency of the user can be monitored.

[0103] The usage metadata **1510** can further include data related to the users interactions with the graphical user interfaces in the workflow presented in operation **812** of the method **800**. For examples, the usage metadata **1510** can include feature usage data **1518** that identifies which features or tools were used by the user of the imaging device **400**. The feature usage data **1518** is captured in operation **808** of the method **800**. As discussed above, the features or tools can include predefined annotations, filters, rulers, and the like for annotating a video or an image of an anatomy seen through the eyepiece **201** of the optical viewing devices **100**.

[0104] As an illustrative example, the feature usage data **1518** can identify which tools were used by the user of the imaging device **400** while examining the left and/or right ears using an otoscope (e.g., the first type of optical viewing device **102**). As another example, the feature usage data **1518** can identify which tools were used by the user of the imaging device **400** while examining the left and/or right eyes using an ophthalmoscope (e.g., the second type of optical viewing device **104**). As a further example, the feature usage data **1518** can identify which tools were used by the user of the imaging device **400** while examining a skin surface using a dermatoscope (e.g., the third type of optical viewing device **106**).

[0105] The usage metadata **1510** can further include image quality data **1520** which characterizes the quality of the videos and/or images captured by the imaging device **400**. The image quality data **1520** can include an overall quality score that is computed based on the video or images captured by the camera **410**. The overall quality score can range in a scale such as from 0 to 100. The image quality data **1520** can further include individual quality characteristics such as lighting, contrast, sharpness, artifacts, noise, flare, color accuracy, distortion, and other image quality attributes. The

image quality data **1520** can further include whether desired anatomical features are within the videos and/or images captured by the camera **410**.

[0106] In some examples, the image quality data **1520** can be determined by one or more local algorithms that run on the imaging device **400**. In such examples, the image quality data **1520** can be captured in operation **808** of the method **800** while the imaging device **400** is being used to capture the videos and/or images during an examination of a patient.

[0107] Alternatively, the image quality data **1520** can be determined by another system such as the overread system **700**. For example, the overread system **700** can utilize one or more algorithms including artificial intelligence and/or machine learning to characterize the quality of the videos and/or images transmitted from the imaging device **400** to the overread system **700**. Thereafter, the overread system **700** can transfer the image quality data **1520** to the user analytics system **500**, or the imaging device **400** for inclusion in the examination report **1500**.

[0108] The usage metadata **1510** can include overread request data **1522** such as whether one or more overread services or referrals are requested by the user of the imaging device **400**. The overread request data **1522** can specify a type of overread service request such as whether review by a human technician, or review by an algorithm such as artificial intelligence.

[0109] Referring back to FIG. **8**, the method **800** includes an operation **822** of sending the examination report **1500** to a secure destination such as a secure network, the EHR system **600**, and/or the overread system **700**. As described above, certain aspects are implemented to protect the confidentiality of protected health information that may be included in the examination report. For example, when the imaging device **400** is physically connected to another device to transfer of the examination report **1500**, the imaging device **400** can require that the other device have installed thereon proprietary software developed by the manufacturer of the imaging device **400** such that the other device is recognizable by the imaging device **400**. Further, the imaging device **400** can require a handshake to connect the imaging device **400** to a wireless network. Also, the images, videos, and other data captured by the imaging device **400** are encrypted for communication over wired and/or wireless networks to further ensure confidentiality of the protected health information that is captured and transferred by the imaging device **400**.

[0110] The method **800** includes an operation **824** of deleting the images, the videos, and the other data from a memory of the imaging device **400** after the examination report **1500** is sent in operation **822**. This ensures that protected health information does not remain on the imaging device **400**, and thereby improves the confidentiality of the protected health information.

[0111] The method **800** further includes an operation **826** of displaying training on the display **404** of the imaging device. The training is based on the usage metadata **1510** included in the examination report **1500**. The usage metadata **1510** can be used to identify one or more areas to improve user competency of the imaging device **400** and/or the optical viewing device **100**. For example, the usage metadata **1510** can identify efficiency issues related to use of the imaging device **400** and/or the optical viewing device **100**, image quality issues related to use of the imaging device **400** and/or the optical viewing device **100**, and/or issues related to utilizing the tools on the imaging device **400** including usage of the overread system **700** that could improve the efficacy of the imaging device **400** and/or the optical viewing device **100**.

[0112] FIG. **16** illustrates an example of a graphical user interface **1600** that can be displayed in operation **826** of the method **800** after the examination report is sent (operation **822**) and the images, the videos, and the other data are deleted from the memory of the imaging device **400** (operation **824**). The graphical user interface **1600** includes a training window **1602** that includes a play icon **1604** that is selectable to playback a video that describes techniques to improve user competency of the imaging device **400** and/or the optical viewing device **100** based on the usage metadata **1510** collected by the imaging device **400**.

[0113] As an example, when the exam duration **1516** in the usage metadata **1510** indicates that the user is taking longer than what is typically necessary to complete an examination of the left and/or right ears using an otoscope (e.g., the first type of optical viewing device **102**), an examination of the left and/or right eyes using an ophthalmoscope (e.g., the second type of optical viewing device **104**), or an examination of a skin surface using a dermatoscope (e.g., the third type of optical viewing device **106**), the play icon **1604** when selected causes playback of a training video inside the training window **1602** that provides tips for using the imaging device **400** and/or the optical viewing device **100** more efficiently. For example, the tips on how to adjust one or more parameters such as lighting and/or zoom on the optical viewing device **100** that can make examination of a desired anatomy easier, thereby improving exam efficiency.

[0114] As another example, when the image quality data **1520** in the usage metadata **1510** indicates that the quality of the videos and images captured by the camera **410** of the imaging device **400** is poor, the play icon **1604** when selected causes playback of a training video inside the training window **1602** that provides tips to improve image quality. The training video can provide suggestions to adjust the lighting, or hold the optical viewing device **100** closer or farther away from an anatomical area of interest, or hold the optical viewing device **100** more steadily to mitigate blurred imaging that results from movements of the user's hand.

[0115] As another illustrative example, when the feature usage data **1518** included in the usage metadata **1510** indicates that the user did not utilize one or more tools to annotate the videos and images captured by the camera **410** of the imaging device **400**, the play icon **1604** when selected causes playback of a training video inside the training window **1602** that provides a recommendation on how to use the one or more tools to improve exam efficacy.

[0116] As another illustrative example, when the overread request data **1522** in the usage metadata **1510** indicates that the user did not elect to export the images, videos, and other data to the overread system **700** (i.e., no selection of the third export option **1408** in the export screen **1400**), the play icon **1604** when selected causes playback of a training video inside the training window **1602** that recommends use the overread system **700** to improve disease screening.

[0117] In some examples, the imaging device **400** presents a graphical user interface that enables the user to adjust one or more settings of the imaging device **400** based on the recommendations included in the training displayed in operation **826**. In some further examples, the imaging device **400** automatically adjusts one or more settings of the imag-

ing device **400** based on the recommendations included in the training displayed in operation **826**.

[0118] FIG. **17** illustrates another example of a graphical user interface **1700** that can be displayed in operation **826**. Alternatively, the graphical user interface **1700** can be displayed after the user credentials are validated in operation **806** of the method **800**. The graphical user interface **1700** includes a training window **1702** that includes a message that the user has exams the need to be uploaded to a secure destination such as a secure network, the EHR system **600**, or the overread system **700**. The training window **1702** further includes a play icon **1704** that is selectable to playback a video inside the training window **1702** that explains how to upload the exams to a secure destination such as by using the export screen **1400**.

[0119] FIG. **18** schematically illustrates an example of a usage report **1800** that can be generated by the user analytics system **500**. The usage report **1800** displays usage statistics for one or more imaging devices **400** that are used by a plurality of users within a healthcare facility such as a hospital, a medical clinic, medical office, and the like. The usage report **1800** is generated based on the usage metadata **1510** included in the examination reports **1500** that are generated by the one or more imaging devices **400**. The usage report **1800** can further include recommendations to improve user competency of the one or more imaging devices **400** and/or the optical viewing devices **100**. The usage report **1800** can be generated by the user analytics system **500** periodically such as weekly, monthly, or quarterly.

[0120] The usage report **1800** includes usage frequency statistics **1802**, image quality statistics **1804**, exam duration statistics **1806**, overread requests statistics **1808**, pathology identification statistics **1810**, and exam completion statistics **1812**, which can be calculated per individual user, or per user population such as doctors, registered nurses, medical residents, trainees, students, and other user populations within the medical facility.

[0121] The usage frequency statistics **1802** include data on how frequently the imaging devices **400** were used per individual user, or per user population. For example, the usage frequency statistics **1802** can identify that the imaging devices **400** were used more frequently by nurse practitioners or other allied health providers than by doctors. The usage frequency statistics **1802** can further identify which particular users used the imaging devices **400** most frequently, and which particular users used the imaging devices **400** least frequently. The usage frequency statistics **1802** can be used to identify a particular user population or an individual user who should be targeted for additional training to increase their use of the imaging devices **400** on the optical viewing devices **100** to improve patient screenings within the medical facility.

[0122] The image quality statistics **1804** include data on the quality of the videos and images captured using the imaging devices **400** per individual user, or per user population. For example, the image quality statistics **1804** can identify which users captured the best quality videos and images, and which users captured the videos and images having the poorest quality. The image quality statistics **1804** can be used to identify a particular user population or an individual user who should be targeted for additional training to improve their competency of the imaging devices **400** such as how to effectively use the devices to improve video and image quality.

[0123] The exam duration statistics **1806** include data on exam duration per individual user, or per user population. For example, the exam duration statistics **1806** can identify which users took the longest time to complete an examination of the left and/or right ears using an otoscope (i.e., the first type of optical viewing device **102**), which users took the longest time to complete an examination of the left and/or right eyes using an ophthalmoscope (i.e., the second type of optical viewing device **104**), or which users took the longest time to complete an examination of a skin surface using a dermatoscope (i.e., the third type of optical viewing device **106**). The exam duration statistics **1806** can be used to identify a particular user population or an individual user who should be targeted for additional training to improve their efficiency by reducing exam duration when using the imaging devices **400** on the optical viewing devices **100**.

[0124] The overread requests statistics **1808** include data on the quantity of overread requests sent using the imaging devices **400** per individual user, or per user population. For example, the overread requests statistics **1808** can identify which user population or individual user sent the most amount of overread requests, and which user population or individual user sent the least amount of overread requests. The overread requests statistics **1808** can be used to identify a particular user population or an individual user who should be targeted for additional training to improve disease screening by increasing overread requests sent by the imaging devices **400**.

[0125] The pathology identification statistics **1810** include data on quantities of diseases, medical conditions, and pathologies identified per individual user, or per user population. For example, the pathology identification statistics **1810** can quantify which diseases, medical conditions, and pathologies were identified per user population or individual user based on the videos and images captured by the imaging devices **400**. The pathology identification statistics **1810** can further identify which user population or individual user had the highest false positive rate and highest false negative rate based on confirmation of the diseases, medical conditions, and pathologies by the overread system **700**. The pathology identification statistics **1810** can be used to identify a particular user population or an individual user who should be targeted for additional training to reduce false positive rates and reduce false negative rates.

[0126] The exam completion statistics **1812** include data on a quantity of incomplete exams per individual user, or per user population. For example, the exam completion statistics **1812** can identify which user population or individual user has the largest quantity of incomplete exams. The exam completion statistics **1812** can be used to identify a particular user population or an individual user who should be targeted for additional training to reduce the quantities of incomplete exams stored on the imaging devices **400**.

[0127] The user analytics system **500** can generate certificates **1814** to reward individual users of the imaging devices **400** and/or user populations within the medical facility. The certificate **1814** are generated by the user analytics system **500** based on the usage frequency statistics **1802**, the image quality statistics **1804**, the exam duration statistics **1806**, the overread requests statistics **1808**, the pathology identification statistics **1810**, and exam completion statistics **1812**. As

an illustrative example, the user analytics system **500** can generate a certificate **1814** to reward an individual user and/or user population who uses the imaging device **400** most frequently based on the usage frequency statistics **1802**.

[0128] As another example, the user analytics system **500** can generate a certificate **1814** to reward an individual user and/or user population who captures the highest quality videos and images using the imaging device **400** based on the image quality statistics **1804**.

[0129] As a further example, the user analytics system **500** can generate a certificate **1814** to reward an individual user and/or user population who has a lowest false positive rate and/or a lowest false negative rate based on the pathology identification statistics **1810**.

[0130] As another example, the user analytics system **500** can generate a certificate **1814** to reward an individual user and/or user population who has the fewest number of incomplete exams based on the exam completion statistics **1812**.

[0131] Further, the user analytics system **500** can generate benchmarks **1816** for comparing a medical facility with a benchmark medical facility that shares one or more common characteristics such as geographical location, size (e.g., patient capacity, number of trained medical staff, square footage, etc.), and/or medical specialty (e.g., whether general practice, or specialized practice such as ear, nose, and throat (ENT), ophthalmology, dermatology, etc.).

[0132] The benchmarks **1816** are generated by the user analytics system **500** based on the usage frequency statistics **1802**, the image quality statistics **1804**, the exam duration statistics **1806**, the overread requests statistics **1808**, the pathology identification statistics **1810**, and the exam completion statistics **1812**. The benchmarks **1816** can be used to display one or more statistical comparisons such as to indicate whether the imaging devices **400** are used more frequently or less frequently in the medical facility than in the benchmark medical facility.

[0133] In a further example, the benchmarks **1816** can be used to display a comparison of one or more average quality characteristics of the images and videos captured by the imaging devices **400** in the medical facility with one or more average quality characteristics of the images and videos captured by imaging devices **400** in the benchmark medical facility.

[0134] As another example, the benchmarks **1816** can be used to display a comparison of the average exam duration captured by the imaging devices **400** in the medical facility with the average exam duration captured by imaging devices **400** in the benchmark medical facility.

[0135] Also, the benchmarks **1816** can be used to display a comparison of a quantity of overread requests sent from the imaging devices **400** in the medical facility with a quantity of overread requests sent from the imaging devices **400** in the benchmark medical facility.

[0136] Additionally, the benchmarks **1816** can be used to display a comparison of a quantity of pathologies identified using the imaging devices **400** in the medical facility with a quantity of pathologies identified using the imaging devices **400** in the benchmark medical facility.

[0137] Also, the benchmarks **1816** can be used to display a comparison of a quantity of exams that remain incomplete on the imaging devices **400** in the medical facility with a quantity of exams that remain incomplete on the imaging devices **400** in the benchmark medical facility.

[0138] The benchmarks **1816** can also be used to display comparisons between one or more different time periods or ranges (e.g., weeks, months, quarters, and the like). For example, the benchmarks **1816** can be used to compare usage frequency, image quality statistics, average exam duration, overread request statistics, pathology identification statistics, and exam completion statistics for the imaging devices **400** within the medical facility during a first time period with a second time period such that a user or administrator in the medical facility can visually view competency progress in using the imaging devices **400** and/or the optical viewing devices **100** based on the training provided on the graphical user interfaces **1600**, **1700**.

[0139] FIG. **19** illustrates an example of a graphical user interface **1900** that can be displayed on the imaging device **400**. The graphical user interface **1900** includes a training window **1902** that is displayed after playback of a video that describes techniques to improve user competency of the imaging device **400** and/or the optical viewing device **100** based on the usage metadata **1510** collected by the imaging device **400** (e.g., see graphical user interface **1600** of FIG. **16**). Alternatively, the training window **1902** is displayed after playback of a video that explains how to upload the exams to a secure destination (e.g., see graphical user interface **1700** of FIG. **17**).

[0140] In FIG. **19**, the training window **1902** includes a first input option **1904** that when selected causes one or more recommendations that are suggested in the video to be implemented on the imaging device **400**. The training window **1902** also includes a second input option **1906** that when selected declines to implement the recommendations that are suggested in the video.

[0141] As an illustrative example, the first input option **1904** when selected causes one or more settings such as illumination, zoom, and the like to be adjusted on the imaging device **400** to improve quality of the images and/or videos captured by the camera **410**, improve efficiency by shortening exam duration, and/or improve user competency of the imaging device **400** and/or the optical viewing devices **100**. As another illustrative example, the first input option **1904** when selected causes one or more features to switch from disabled to enabled to take full advantages of the features of the imaging device **400** to enhance disease screening.

[0142] FIG. **20** illustrates an exemplary architecture of a computing device **2000** of the imaging device **400**. The computing device **2000** is used to execute the functionality of the imaging device **400** described herein. The imaging device **400** can include all or some of the elements described with reference to FIG. **20**, with or without additional elements.

[0143] The computing device **2000** includes at least one processing device **2002**. Examples of the at least one processing device **2002** can include central processing units (CPUs), digital signal processors, field-programmable gate arrays, and other types of electronic computing circuits. The at least one processing device **2002** can be part of a processing circuitry having a memory for storing instructions which, when executed by the processing circuitry, cause the processing circuitry to perform the functionalities described herein.

[0144] The computing device **2000** also includes a system memory **2004**, and a system bus **2006** that couples various system components including the system memory **2004** to the at least one processing device **2002**. The system bus **2006** can include any type of bus structure including a memory bus, or memory controller, a peripheral bus, and a local bus.

[0145] The system memory **2004** may include a read only memory (ROM) **2008** and a random-access memory (RAM) **2010**. An input/output system containing routines to transfer information within the computing device **2000**, such as during start up, can be stored in the read only memory (ROM) **2008**. The system memory **2004** can be housed inside the housing **402**.

[0146] The computing device **2000** can further include a secondary storage device **2014** for storing digital data. The secondary storage device **2014** is connected to the system bus **2006** by a secondary storage interface **2016**. The secondary storage devices and computer-readable media provide nonvolatile storage of computer-readable instructions including application programs and program devices, data structures, and other data.

[0147] A number of program devices can be stored in secondary storage device **2014** or the system memory **2004**, including an operating system **2018**, one or more application programs **2020**, other program modules **2022**, and program data **2024**. The system memory **2004** and the secondary storage device **2014** are examples of computer-readable data storage devices.

[0148] The computing device **2000** can include one or more input devices such as the display **404** (in examples where the display **404** is a touch sensitive touchscreen), one or more physical push buttons on the housing **402** of the imaging device **400**, and the camera **410**. Additional examples of input devices include a microphone **2026**, and an accelerometer **2028** for image orientation on the display **404**. The computing device **2000** can also include output devices such as the display **404**, and a speaker **2030**.

[0149] The input and output devices are connected to the at least one processing device **2002** through an input/output interface **2038** coupled to the system bus **2006**. The input and output devices can be connected by any number of input/output interfaces, such as a parallel port, serial port, game port, or a universal serial bus. Wireless communication between the input and output devices and the input/output interface **2038** is possible as well, and can include Wi-Fi, Bluetooth, infrared, 802.11a/b/g/n, cellular, or other wireless communications.

[0150] In some examples, the display **404** is touch sensitive and is connected to the system bus **2006** via an interface, such as a video adapter **2042**. The display **404** includes touch sensors for receiving input from a user when the user touches the display. Such sensors can be capacitive sensors, pressure sensors, or other touch sensors. The sensors detect contact with the display, and also the location and movement of the contact over time. For example, a user can move a finger or stylus across the display **404** to provide inputs.

[0151] The computing device **2000** further includes a communication device **2046** configured to establish communication across a network **2052**. In some examples, when used in a local area networking environment or a wide area networking environment (such as the Internet), the computing device **2000** is typically connected to the network **2052** through a network interface, such as a wireless network interface **2050**. The wireless network interface **2050** can provide Wi-Fi functionality such as for image and video transferring, live streaming, and providing a mobile hotspot. In some further examples, the wireless network interface **2050** can provide Bluetooth connectivity. Other possible examples using other wired and/or wireless communications are possible. For example, the computing device **2000** can include an Ethernet network interface, or a modem for communicating across the network.

[0152] In further examples, the communication device **2046** provides short-range wireless communication. The short-range wireless communication can include one-way or two-way short-range to medium-range wireless communication. Short-range wireless communication can be established according to various technologies and protocols. Examples of short-range wireless communication include a radio frequency identification (RFID), a near field communication (NFC), a Bluetooth technology, a Wi-Fi technology, or similar wireless technologies.

[0153] The computing device **2000** typically includes at least some form of computer-readable media. Computer-readable media includes any available media that can be accessed by the computing device **2000**. By way of example, computer-readable media can include computer-readable storage media and computer-readable communication media.

[0154] Computer-readable storage media includes volatile and nonvolatile, removable, and non-removable media implemented in any device configured to store information such as computer-readable instructions, data structures, program devices, or other data. Computer-readable storage media includes, but is not limited to, random access memory, read only memory, electrically erasable programmable read only memory, flash memory or other memory technology, or any other medium that can be used to store the desired information and that can be accessed by the computing device **2000**.

[0155] Computer-readable communication media embodies computer-readable instructions, data structures, program devices or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media. Modulated data signal refers to a signal having one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, computer-readable communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency, infrared, and other wireless media. Combinations of any of the above are also included within the scope of computer-readable media.

[0156] The computing device **2000** is an example of programmable electronics, which may include one or more computing devices, and when multiple computing devices are included, such computing devices can be coupled together with a suitable data communication network so as to collectively perform the various functions, methods, or operations disclosed herein.

[0157] The computing device **2000** can include a location identification device **2048**. The location identification device **2048** is configured to identify the geolocation of the computing device **2000**. The location identification device **2048** can use various types of geolocating or positioning systems, such as network-based systems, handset-based systems, SIM-based systems, Wi-Fi positioning systems, and hybrid

positioning systems. Network-based systems utilize service provider's network infrastructure, such as cell tower triangulation. Handset-based systems typically use the Global Positioning System (GPS). Wi-Fi positioning systems can be used when GPS is inadequate due to various causes including multipath and signal blockage indoors. Hybrid positioning systems use a combination of network-based and handset-based technologies for location determination, such as Assisted GPS.

[0158] The various embodiments described above are provided by way of illustration only and should not be construed to be limiting in any way. Various modifications can be made to the embodiments described above without departing from the true spirit and scope of the disclosure.

What is claimed is:

1. An imaging device for capturing images through an eyepiece of an optical viewing device, the imaging device comprising:
- a camera configured for alignment with the eyepiece of the optical viewing device for capturing the images viewed through the eyepiece;
- a display for displaying the images captured by the camera;
- at least one processing device; and
- at least one computer readable data storage device storing software instructions that, when executed by the at least one processing device, cause the imaging device to:
  - determine a type of the optical viewing device;
  - present a workflow on the display based on the type of the optical viewing device; and
  - capture metrics related to user interactions with the workflow presented on the display and the images captured by the camera during the workflow.

2. The imaging device of claim **1**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:
- generate a recommendation based on the metrics.

3. The imaging device of claim **2**, wherein the recommendation is to upload the images to at least one of a secure network, an electronic health record system, and an overread system.

4. The imaging device of claim **3**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:
- delete the images after the images are uploaded to the at least one of the secure network, the electronic health record system, and the overread system.

5. The imaging device of claim **2**, wherein the recommendation is to adjust one or more settings on the imaging device.

6. The imaging device of claim **2**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:
- provide a video on the display that is selectable for playback, the video describing the recommendation to improve competency of the imaging device.

7. The imaging device of claim **2**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:
- provide an input on the display that when selected causes the recommendation to be implemented on the imaging device.

8. A method of capturing images through an eyepiece of an optical viewing device, the method comprising:
- providing an imaging device for attachment to the optical viewing device;
- presenting a workflow on the imaging device for capturing the images based on a type of optical viewing device, the workflow including tools for annotating the images on a display;
- capturing metrics related to user interactions with the workflow, and quality characteristics of the images captured during the workflow; and
- generating a recommendation based on the metrics.

9. The method of claim **8**, wherein the recommendation is to upload the images to at least one of a secure network, an electronic health record system, and an overread system.

10. The method of claim **9**, further comprising:
- deleting the images after the images are uploaded to the at least one of the secure network, the electronic health record system, and the overread system.

11. The method of claim **8**, wherein the recommendation is to adjust one or more settings on the imaging device based on the quality characteristics of the images.

12. The method of claim **8**, further comprising:
- providing a video that is selectable for playback on the display, the video describing the recommendation to improve competency of the imaging device.

13. The method of claim **8**, further comprising:
- providing an input on the display that when selected causes the recommendation to be implemented on the imaging device.

14. A system for imaging an anatomy, the system comprising:
- an optical viewing device including an instrument head having an eyepiece; and
- an imaging device attached to the optical viewing device, the imaging device including:
  - a camera configured for alignment with the eyepiece of the instrument head for capturing the images viewed through the eyepiece;
  - a display for displaying the images captured by the camera;
  - at least one processing device; and
  - at least one computer readable data storage device storing software instructions that, when executed by the at least one processing device, cause the device to:
    - determine a type of the optical viewing device;
    - present a workflow on the display based on the type of the optical viewing device; and
    - capture metrics related to user interactions with the workflow presented on the display and the images captured by the camera during the workflow.

15. The system of claim **14**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:
- generate a recommendation based on the metrics.

16. The system of claim **15**, wherein the recommendation is to upload the images to at least one of a secure network, an electronic health record system, and an overread system.

17. The system of claim **16**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:
- delete the images after the images are uploaded to the at least one of the secure network, the electronic health record system, and the overread system.

18. The system of claim **15**, wherein the recommendation is to adjust one or more settings on the imaging device.

19. The system of claim **15**, wherein the instructions, when executed by the at least one processing device, further cause the imaging device to:

provide an input on the display that when selected causes the recommendation to be implemented on the imaging device.

20. The system of claim **14**, wherein the optical viewing device is an otoscope, an ophthalmoscope, or a dermatoscope.

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