US009476823B2

(12) **United States Patent**
Ward et al.

(10) **Patent No.: US 9,476,823 B2**
(45) **Date of Patent: Oct. 25, 2016**

(54) **BORESCOPE STEERING ADJUSTMENT SYSTEM AND METHOD**

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventors: **Thomas Charles Ward**, Auburn, NY (US); **Bryan David Maule**, Camillus, NY (US); **Melissa Rose Stancato**, Syracuse, NY (US); **Matthew William Pankow**, Camillus, NY (US); **David Scott Andreasen**, Boston, MA (US)

(73) Assignee: **General Electric Company**, Schenectady, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 322 days.

(21) Appl. No.: **13/949,010**

(22) Filed: **Jul. 23, 2013**

(65) **Prior Publication Data**

US 2015/0029500 A1 Jan. 29, 2015

(51) **Int. Cl.**

H04N 9/47	(2006.01)
A62B 1/04	(2006.01)
G01N 21/01	(2006.01)

(Continued)

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

CPC ***G01N 21/01*** (2013.01); ***B25J 9/1635*** (2013.01); ***E21B 47/0002*** (2013.01); ***G02B 23/24*** (2013.01); *G01N 2021/0112* (2013.01); *G01N 2021/0181* (2013.01); *G05B 2219/23092* (2013.01); *G05B 2219/35478* (2013.01); *G05B 2219/37396* (2013.01); *G05B 2219/39443* (2013.01); *G05B 2219/45066* (2013.01); *G06F 3/0482* (2013.01); *G06F 3/0488* (2013.01); *G06F 3/04847* (2013.01)

(58) **Field of Classification Search**

USPC 348/61, 63, 64, 65, 74, 77, 82

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,148,923 B2	12/2006	Harper
7,268,924 B2	9/2007	Hussey

(Continued)

FOREIGN PATENT DOCUMENTS

EP	1787572 A1	5/2007
FR	2965369 A1	3/2012

OTHER PUBLICATIONS

High Defineition VideoScope, User Guide, Extech Instruments a Flir Company, Oct. 12, 2012.*

(Continued)

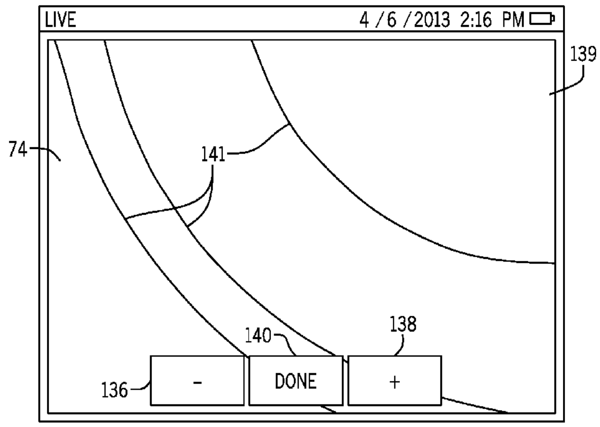
Primary Examiner — Daquan Zhao

(74) *Attorney, Agent, or Firm* — Fletcher Yoder, P.C.

(57) **ABSTRACT**

Systems and methods provided herein. In one embodiment, a borescope system includes a probe to capture images and a display a settings menu, measurements, the images captured by the probe, or any combination thereof. In addition, the borescope system a processor programmed to display a user interface to enable a user to control movement of the probe, adjust settings, navigate menus, make selections, or any combination thereof. The processor is communicatively coupled to the probe, and the display, and is programmed to instruct the borescope to enter a live menu view when an articulation mode is selected from the settings menu. In the live menu view, the processor is programmed to instruct the display to display the images captured by the probe, and to enable a user to control the movement of the probe and adjust articulation sensitivity of the probe while viewing the images on the display.

20 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

E21B 47/00	(2012.01)
B25J 9/16	(2006.01)
G02B 23/24	(2006.01)
A61B 1/04	(2006.01)
A61B 1/06	(2006.01)
G06F 3/0482	(2013.01)
G06F 3/0484	(2013.01)
G06F 3/0488	(2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,878,406 B2	2/2011	Pankow	
7,967,205 B2	6/2011	Pankow	
8,387,881 B2	3/2013	Volkinburg	
8,439,264 B2	5/2013	Barber	
2002/0125323 A1	9/2002	Marrs, Jr.	
2007/0226258 A1*	9/2007	Lambdin et al.	707/104.1
2009/0131753 A1	5/2009	Amano et al.	
2012/0193429 A1	8/2012	Volkinburg	
2013/0048734 A1	2/2013	Bianconi	
2013/0139112 A1	5/2013	Domke	
2014/0139658 A1*	5/2014	Dhanvantri et al.	348/85

OTHER PUBLICATIONS

PCT Search Report and Written Opinion issued in connection with corresponding Application No. PCT/US2014044085 on Oct. 7, 2014.

* cited by examiner

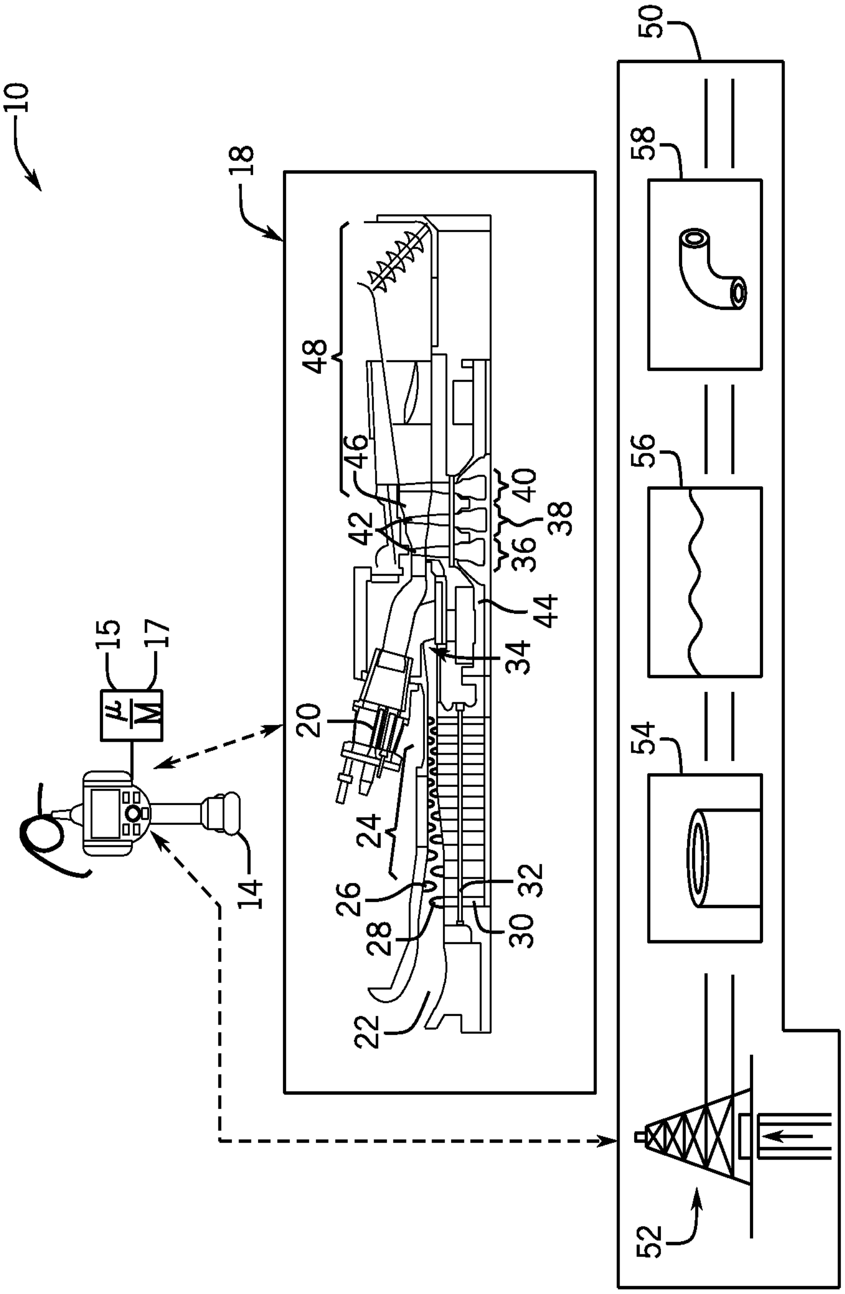

10
14
15
17
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58

FIG. 1

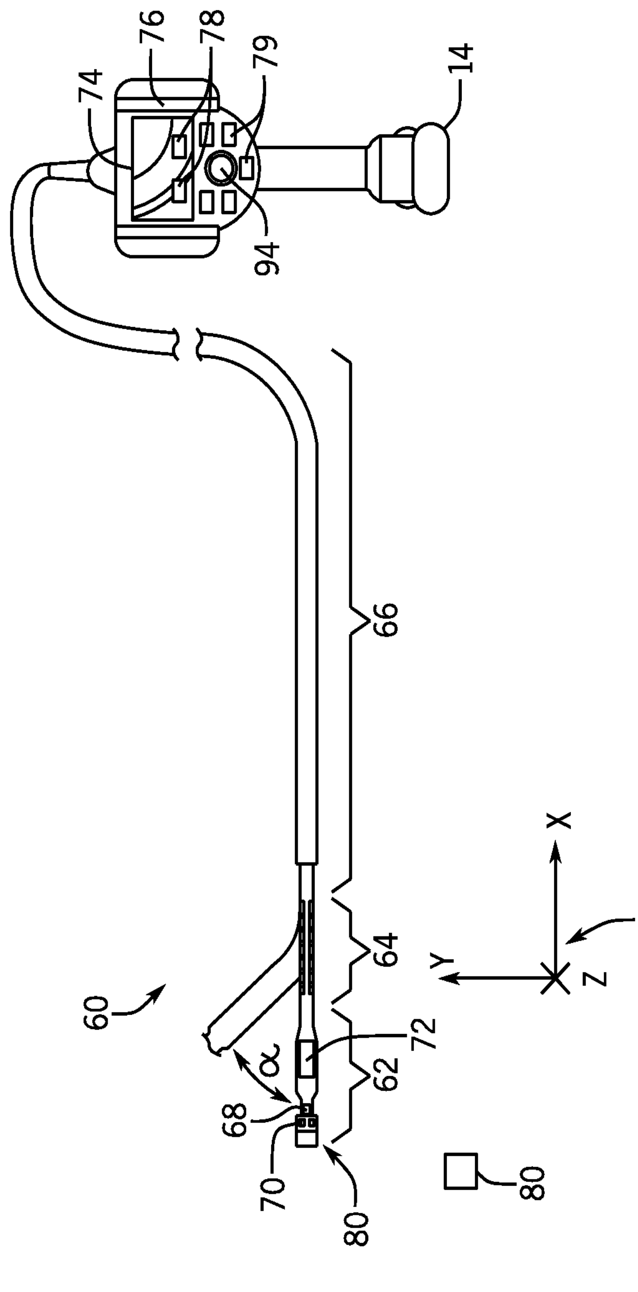


FIG. 2

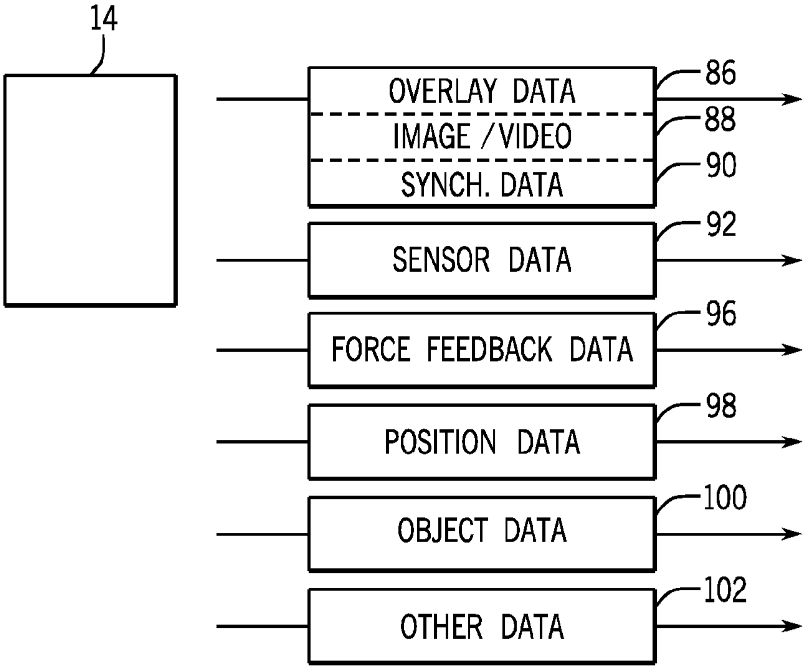

14
OVERLAY DATA
86
IMAGE / VIDEO
88
SYNCH. DATA
90
SENSOR DATA
92
FORCE FEEDBACK DATA
96
POSITION DATA
98
OBJECT DATA
100
OTHER DATA
102

FIG. 3

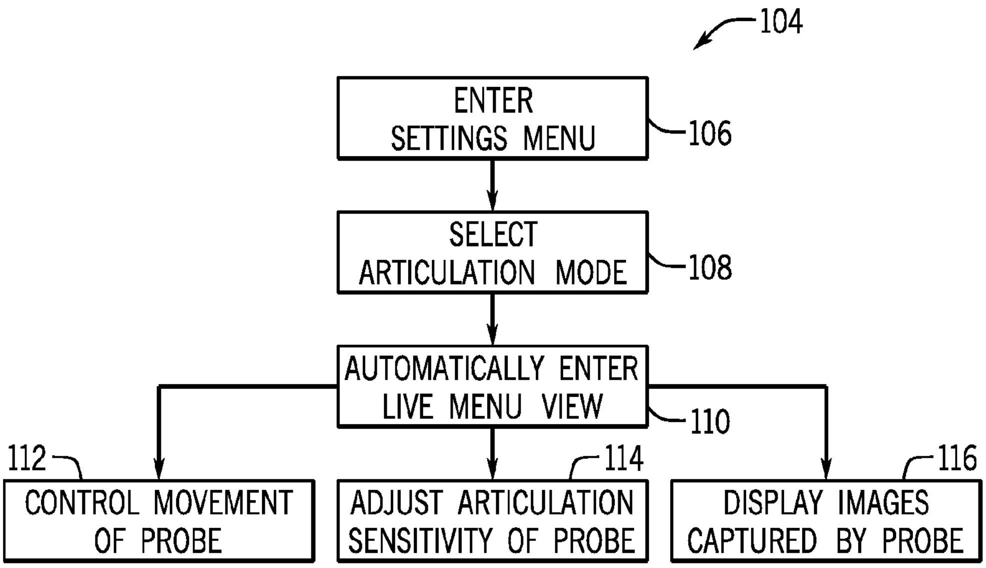

104
ENTER SETTINGS MENU
106
SELECT ARTICULATION MODE
108
AUTOMATICALLY ENTER LIVE MENU VIEW
110
112
CONTROL MOVEMENT OF PROBE
114
ADJUST ARTICULATION SENSITIVITY OF PROBE
116
DISPLAY IMAGES CAPTURED BY PROBE

FIG. 4

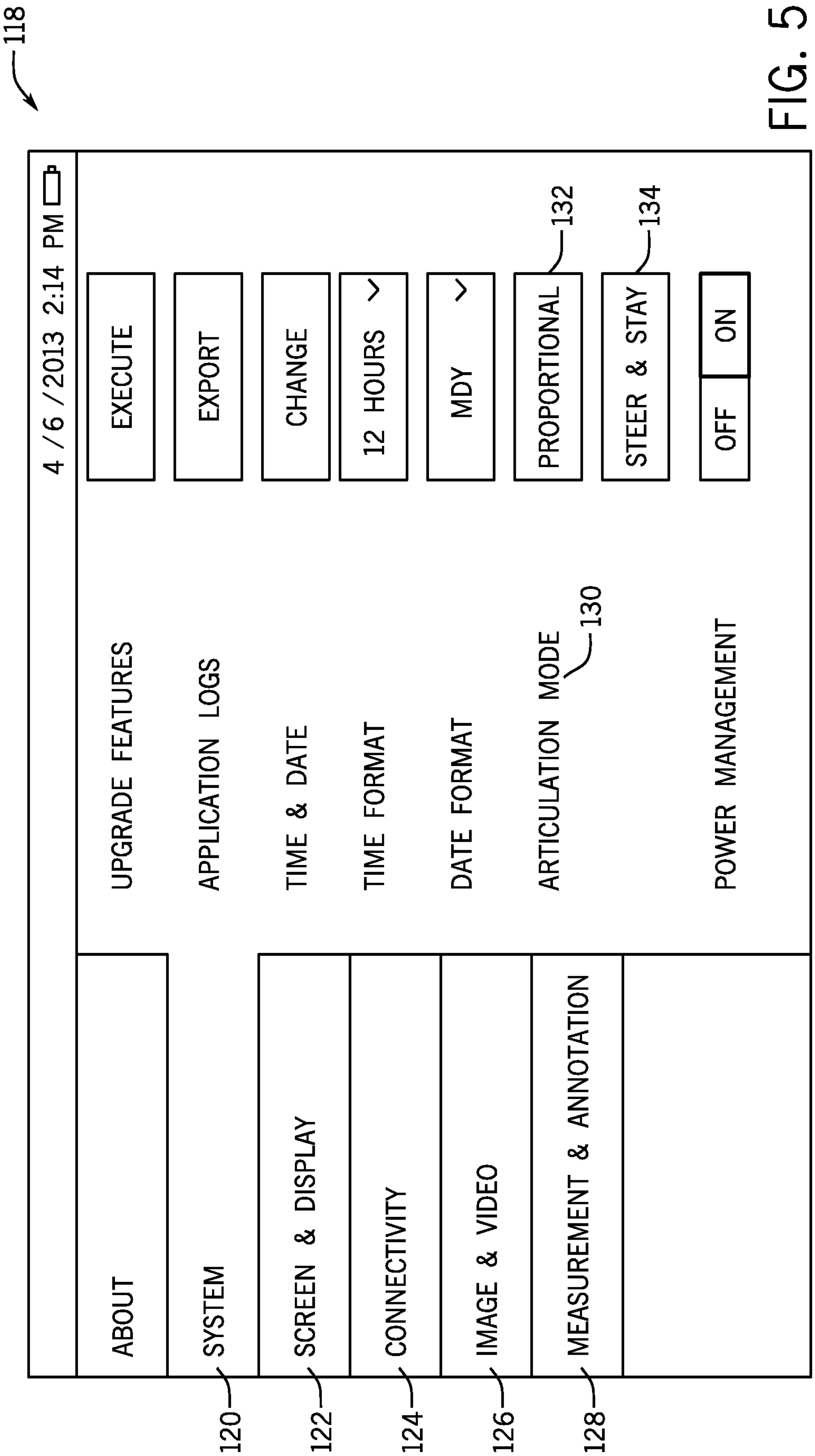

118
4 /6 /2013 2:14 PM
ABOUT
SYSTEM
SCREEN & DISPLAY
CONNECTIVITY
IMAGE & VIDEO
MEASUREMENT & ANNOTATION
120
122
124
126
128
UPGRADE FEATURES
APPLICATION LOGS
TIME & DATE
TIME FORMAT
DATE FORMAT
ARTICULATION MODE
130
POWER MANAGEMENT
EXECUTE
EXPORT
CHANGE
12 HOURS
MDY
PROPORTIONAL
132
STEER & STAY
134
OFF
ON

FIG. 5

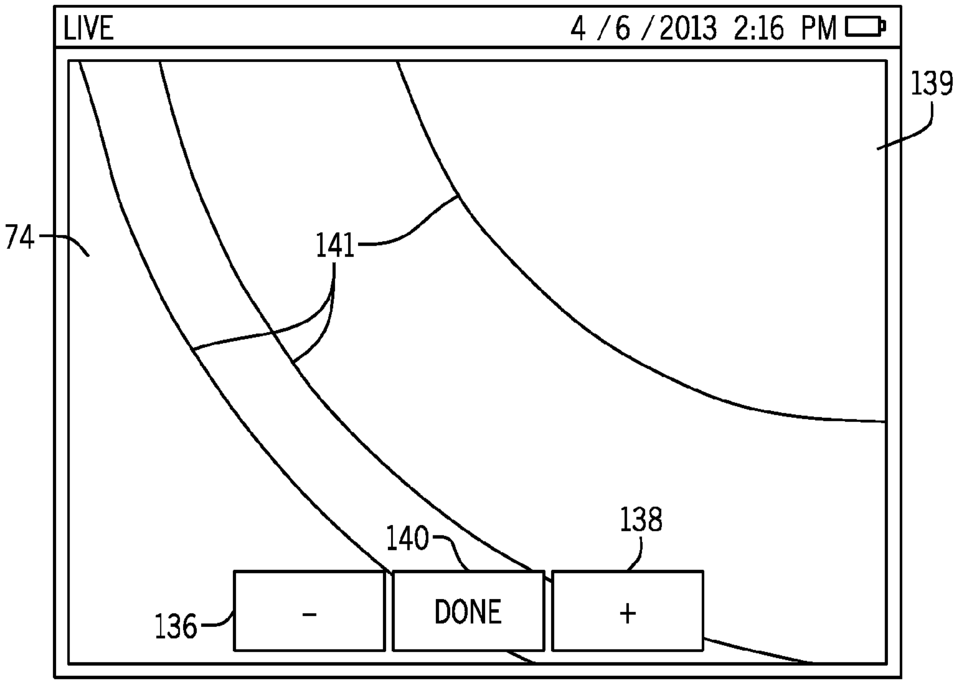

LIVE
4 / 6 / 2013 2:16 PM
139
74
141
140
138
136
–
DONE
+

FIG. 6

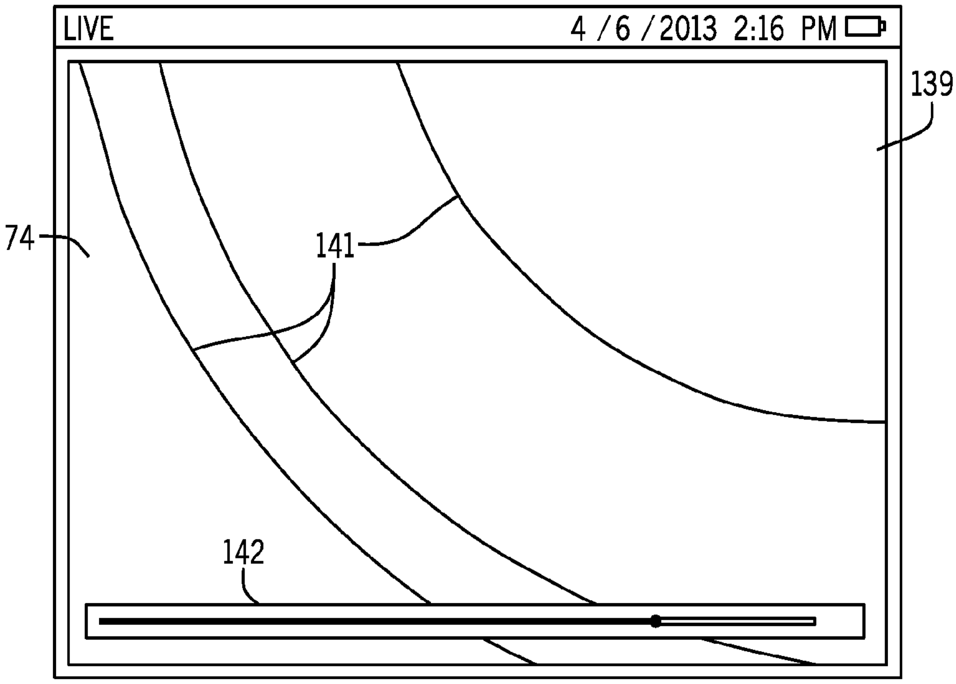

LIVE
4 / 6 / 2013 2:16 PM
139
74
141
142

FIG. 7

BORESCOPE STEERING ADJUSTMENT SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

The present disclosure relates generally to the inspection of equipment and facilities, and more particularly to borescope systems used for the inspection.

Certain equipment and facilities, such as power generation equipment and facilities, oil and gas equipment and facilities, aircraft equipment and facilities, manufacturing equipment and facilities, and the like, include a plurality of interrelated systems, and processes. For example, power generation plants may include turbine systems and processes for operating and maintaining the turbine systems. Likewise, oil and gas operations may include carbonaceous fuel retrieval systems and processing equipment interconnected via pipelines. Similarly, aircraft systems may include airplanes and maintenance hangars useful in maintaining airworthiness and providing for maintenance support.

Certain techniques, such as non-destructive inspection techniques or non-destructive testing (NDT) techniques, may be used to inspect and facilitate maintenance of such equipment and facilities. For example, a borescope system may be utilized in an NDT technique to inspect the internals without disassembly of a wide variety of equipment and facilities. Specifically, a borescope probe may be inserted into various openings of the equipment or facility to provide illumination and/or visual observations of the internals of the equipment or facility. Accordingly, it would be beneficial to improve the configuration of such borescope systems, for example, to enable a user to more accurately and efficiently adjust settings as desired.

BRIEF DESCRIPTION OF THE INVENTION

Certain embodiments commensurate in scope with the originally claimed invention are summarized below. These embodiments are not intended to limit the scope of the claimed invention, but rather these embodiments are intended only to provide a brief summary of possible forms of the invention. Indeed, the invention may encompass a variety of forms that may be similar to or different from the embodiments set forth below.

In a first embodiment, a borescope system includes a probe to capture images and a display a settings menu, measurements, the images captured by the probe, or any combination thereof. In addition, the borescope system includes a processor programmed to display a user interface to enable a user to control movement of the probe, adjust settings, navigate menus, make selections, or any combination thereof. The processor is communicatively coupled to the probe, and the display, and is programmed to instruct the borescope to enter a live menu view when an articulation mode is selected from the settings menu. In the live menu view, the processor is programmed to instruct the display to display the images captured by the probe, and to enable a user to control the movement of the probe and adjust articulation sensitivity of the probe while viewing the images on the display.

In a second embodiment, a tangible non-transitory computer readable medium storing instructions executable by a processor of a borescope system includes instructions to enter a settings menu displayed by a display included in the borescope system that further includes a probe, to select an articulation mode of the probe from the settings menu, to automatically enter a live menu view in response to selection of the articulation mode, and in the live menu view, to enable a user to control the probe and adjust the articulation sensitivity of the probe.

In a third embodiment, a method includes entering a settings menu, selecting an articulation mode of the borescope system probe from the settings menu, automatically entering a live menu view, and in the live menu view, enabling a user to control the borescope system probe and adjust the articulation sensitivity of the borescope system probe.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. **1** is a block diagram illustrating an embodiment of a non-destructive testing (NDT) system, including a borescope system, in accordance with an embodiment;

FIG. **2** is a front view of the borescope system of FIG. **1**, in accordance with an embodiment;

FIG. **3** is a block diagram illustrating data gathered by the borescope system of FIG. **1**, in accordance with an embodiment.

FIG. **4** is a flow diagram illustrating a process for adjusting the articulation settings of a borescope probe in the borescope system of FIG. **2**, in accordance with an embodiment;

FIG. **5** is a screen view of a settings menu displayed on the borescope system of FIG. **2**, in accordance with an embodiment;

FIG. **6** is a screen view of a first embodiment of a live menu view displayed on the borescope system of FIG. **2**, in accordance with an embodiment; and

FIG. **7** is a screen view of a second embodiment of a live menu view displayed on the borescope system of FIG. **2**, in accordance with an embodiment.

DETAILED DESCRIPTION OF THE INVENTION

One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

When introducing elements of various embodiments of the present invention, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

Embodiments of the present disclosure may apply to a variety of inspection techniques and systems, including non-destructive testing (NDT) techniques/systems. In some embodiments of an NDT system, a borescope system may be utilized to facilitate testing and/or inspection of equipment and facilities, such as power generation equipment and facilities, oil and gas equipment and facilities, and aircraft equipment and facilities, by providing illumination, visualization, and/or other data relating to the internals of the equipment or facilities.

A borescope generally includes a user controllable probe with a camera and an illumination device. More specifically, a user may control the movement (e.g., articulation) of the probe to illuminate or visually capture a desired location within the equipment or facility. In other embodiments, the borescope may include various other user controllable probes (i.e., tips) to facilitate x-ray inspection, eddy current inspection, and/or ultrasonic inspection. To enhance the user's control of the movement of the probe, the borescope may include field-adjustable settings, such as articulation sensitivity and articulation mode, which enable user configuration of the movement of the probe as desired. As used herein, "field-adjustable settings" describe settings that may be adjusted during operation of the borescope system **14** including remotely over a network (e.g., a wide area network or a local area network). Accordingly, by providing for field-adjustable settings, such as the articulation sensitivity and the articulation mode, the borescope system may provide a more efficient and detailed inspection of a desired machinery or process.

Accordingly, one embodiment of the present disclosure describes a borescope system including a probe that captures images, and a display that displays a settings menu, measurements, the images captured by the probe, or any combination thereof. In addition, the borescope system includes a processor programmed to display a user interface to enable a user to control movement of the probe, adjust settings, navigate menus, make selections, or any combination thereof. The processor is communicatively coupled to the probe, and the display, and is programmed to instruct the borescope to enter a live menu view when an articulation mode is selected from the settings menu. In the live menu view, the processor is programmed to instruct the display to display the images captured by the probe, and to enable a user to control the movement of the probe and adjust articulation sensitivity of the probe while viewing the images on the display. As will be appreciated by persons of ordinary skill in the relevant art, the techniques described in the present disclosure may be utilized in other NDT systems **10**, such as an endoscope system.

By way of introduction, FIG. **1** depicts an embodiment of a non-destructive testing (NDT) system **10**. As depicted, the NDT system **10** may include one or more NDT inspection devices, such as a borescope system **14**. In some embodiments, the borescope **14** may be a XL GO+ VideoProbe, a XLG3 VideoProbe, XL Vu VideoProbe, or the like, available from General Electric Company, of Schenectady, N.Y. The depicted borescope **14** includes one or more processors **15** and memory **17** that may be used to facilitate the functionality of the borescope, such as visually inspecting equipment and facilities. As used herein, a "processor" refers to any number of processor components related to the borescope system **14**. For example, in some embodiments, the processor **15** may be coupled to and programmed to instruct components of the borescope system **14** such as the probe, the display, and the user interface (e.g., buttons and joystick). Furthermore, in some embodiments, the processor **15** may be located locally or remotely, for example, in the "cloud."

In operation, the borescope **14** may be inserted into a plurality of access ports and other locations of equipment such as turbomachinery **18** to provide for illumination and visual observations of a number of components of the turbomachinery **18**, such as the nozzles **20**, intake **22**, compressor **24**, vanes **26**, blades **28**, wheels **30**, shaft **32**, diffuser **34**, stages **36**, **38**, and **40**, blades **42**, shaft **44**, casing **46**, and exhaust **48**. Other types of equipment that the borescope **14** may inspect include compressors, pumps, turbo expanders, wind turbines, hydroturbines, industrial equipment, residential equipment, and the like. Additionally, the borescope **14** may be used to inspect the facilities, such as an oil and gas facility **50**. For example, the borescope **14** may visually inspect oil and gas equipment **52** including the interior of pipes or conduits **54**, underwater (or underfluid) locations **56**, and difficult to observe locations such as locations having curves or bends **58**. While inspecting the equipment and facilities, the borescope **14** may gather data including but not limited to images, video, and sensor measurements, such as temperature, pressure, flow, clearance (e.g., measurement between a stationary component and a rotary component), and distance measurements.

The borescope **14** may includes various components such as the ones depicted in the schematic view of the borescope depicted in FIG. **2**. The borescope system **14** includes an insertion tube **60** suitable for insertion into a variety of location, such as inside of the turbomachinery **18**, equipment **52**, pipes or conduits **54**, underwater locations **56**, curves or bends, and so on. The insertion tube **60** includes a probe section **62**, an articulating section **64**, and a conduit section **66**. In the depicted embodiment, the probe **60** includes a camera **68**, one or more lights **70** (e.g., LEDs), and sensors **72**. The borescope's camera **68** provides images and video suitable for inspection and the lights **70** provide for illumination when the probe **62** is disposed in locations having low light or no light.

For example, the camera **68** may capture an image or video (e.g., a plurality of time-captured images) **74**, which is then displayed on a screen **76** of the borescope **14**. The screen **76** may display menus, measurements, images captured by the probe **62**, or any combination thereof. In some embodiments, the borescope screen **76** is a multi-touch-screen that uses capacitance techniques, resistive techniques, infrared grid techniques, and the like. The borescope screen **76** includes soft buttons **78** that detect the touch (e.g., activation) of a stylus and/or one or more human fingers. Additionally, hard buttons **79** may be included on the borescope **14** to replace or supplement the soft buttons **78**.

The borescope system **14** increases the information displayed by overlaying certain data onto the image **74**. For example, a borescope tip map may be overlaid on the video to show an approximation of the disposition of the probe **62** during insertion so as to guide a user to more accurately position the borescope camera **68**. A variety of other overlays may be provided including measurement overlays, menu overlays, annotation overlays, and object identification overlays. The image or video **74** may then be displayed with the overlays generally displayed on top of the image or video **74**.

In addition to collecting visual data, the borescope **14** may collect other data, such as sensor **72** data. Accordingly, in certain embodiments, the borescope **14** may include a plurality of removable replacement probes **80** to facilitate capturing data such as temperature data, distance data, clearance data (e.g., distance between a rotating and a stationary component), flow data, and so on. For example, one replacement probe **80** may project a shadow onto the image captured by the probe to indicate distance. Another replacement probe **80** may utilize a prism to display both a right and a left view. Other examples of the replacement probes **80** include retrieval tips such as snares, magnetic tips, or gripper tips; and cleaning and obstruction removal tools, such as wire brushes, or wire cutters.

One embodiment of the data collected by the borescope **14** is depicted in FIG. **3**. As depicted, the image **74** and overlays is separated into two or more data streams **86** and **88**. The data stream **86** may include only overlay data, while the data stream **88** may include images or video data. In one embodiment, the images or video data **88** may be synchronized with the overlay data **86** using a synchronization signal **90**. Additionally the sensor data **92** gathered by the sensor **72** may also be synchronized with the overlay data **86**. For example, this enables overlay tip maps to be displayed alongside with temperature information, pressure information, flow information, clearance, and so on. Likewise, sensor data **92** may be displayed alongside the image or video data **88**.

Turning back to FIG. **2**, a user controls the articulating section **64** with, for example, a physical joystick **94** to move the position of the probe **62**. Accordingly, the articulation sections **64** steers or "bends" in various dimensions. For example, the articulation section **64** may enable movement of the probe **62** in an X-Y plane X-Z plane and/or Y-Z plane of the depicted XYZ axes **96**. Accordingly, the physical joystick **94** may be used to provide control actions suitable for disposing the probe **62** in a variety of angles, such as the depicted angle a. Indeed, probe **62** may be disposed in any angle a with respect to the XYZ axes **96** to observe a desired location. In this manner, the borescope probe **62** may be positioned to visually inspect desired locations. Furthermore, in some embodiments, the physical joystick **94** may provide force feedback or haptic feedback to the user. For example, the joystick **94** may utilize haptic feedback to communicate that the probe **62** is abutting or contacting a structure, vibrations felt by the probe **62**, force related to flows, temperatures, clearances, pressures, articulation sensitivity of the probe **62** and the like. Accordingly, as depicted in FIG. **3**, the data collected by the borescope **14** includes force feedback data **96**.

Additionally, the borescope system **14** collects position data **98**, object data **100**, and other types of data **102**. For example, the position data **98** may include locations of the borescope **14** in relation to equipment **18**, and/or facilities **50**. Object data **100** may include data related to the object under inspection. For example, the object data **180** may include identifying information (e.g., serial numbers), observations on equipment condition, annotations (textual annotations, voice annotations), and so on. Other types of data **102** include menu-driven inspection data, which when used provides a set of pre-defined "tags" that can be applied as text annotations and metadata.

As described above, a user may utilize the physical joystick **94** to control the positioning of the probe **62**. The borescope system **14** includes various settings, such as articulation mode and articulation sensitivity, to enable the user to better control the movement of the probe **62**. One example of a process **104** for configuring the articulation settings (e.g., mode and sensitivity) of the probe **62** is depicted in FIG. **4**. As depicted, the process **104** begins when a settings menu is entered (process block **106**). In the settings menu, an articulation mode is selected (process block **108**). The articulation mode describes "how" the probe **62** articulates. Once the articulation mode is selected, the borescope **14** automatically enters a live menu view (process block **110**). In the live menu view, a user is able to control the movement of the probe via the articulation section (process block **112**) and adjust the articulation sensitivity of the probe (process block **114**) while viewing the images captured by the probe (process block **116**). In other words, process **104** enables the user to adjust articulation settings and immediately experiment with the results. The articulation sensitivity describes the probe's reaction to user controls. Additionally or alternatively, the borescope **14** may enter the live menu view in response to other indications of the user's desire to adjust the articulation sensitivity of the probe **62**. For example, this may include the user activating a dedicated articulation sensitivity button.

More specifically, an embodiment of a settings menu **118** is depicted in FIG. **5**. The settings menu **118** is displayed to a user on the borescope screen **76**, which as described above may be a multi-touchscreen. The user may interact with the settings menu **118** by selecting various soft buttons with a finger or a stylus. The settings menu **118** may be broken down into smaller categories to assist the user in locating the desired setting. In the depicted embodiment, the settings menu **118** includes a System settings menu **120**, a Screen & Display settings menu **122**, a Connectivity settings menu **124**, an Image & Video settings menu **126**, and a Measurement & Annotation settings menu **128**. The user may navigate between each of the menus (e.g., **118**-**126**) by selecting (e.g., activating) the name of the desired menu from the settings menu **118**.

Each menu includes various settings that enable a user to configure the borescope system **14**. For example, the depicted System settings menu **120** enables the user to upgrade features, export application logs, set/format the time and date, choose an articulation mode, and turn on/off power management. The setting of particular interest in the present disclosure is the Articulation Mode setting **130**, which configures "how" the probe **62** moves. As depicted, the Articulation Mode setting **130** includes a choice between a Proportional mode **132** and a Steer & Stay mode **134**. In both the Proportional mode **132** and the Steer & Stay mode **134**, the probe **62** is configured to move based on user input into the physical joystick **94**. For example, when a user moves the joystick **94** right, the probe **62** also moves to the right and when the user moves the joystick **94**, the probe **62** also moves up, and so on. However, in a Proportional mode **132**, when the user releases the joystick **94** (i.e., stops controlling the movement of the probe **62**), the probe **62** moves back to its neutral or central position. On the other hand, in a Steer & Stay mode, the probe **62** remains in its last position.

When one of the articulation modes (e.g., proportional mode or steer & stay mode) is selected, the borescope automatically enters a live menu view in response, which enables a user to adjust the articulation sensitivity of the probe **62**. Embodiments of the live menu view are depicted in FIGS. **6** and **7**. In both embodiments, a live view of the images **74** captured by the probe **62** is displayed on the borescope screen **76**. In other words, as the probe **62** moves, the images **74** displayed on the screen **76** will change accordingly. In addition, while viewing the images **74**, the user may increase and/or decrease the articulation sensitivity of the probe **62**. More specifically, the user may increase the articulation sensitivity of the probe **62** so that the probe will be more responsive to movements of the joystick **94**. On the other hand, the user may decrease the articulation sensitivity of the probe **62** so that the probe will be less responsive to movements of the joystick **94**. In other words, as the articulation sensitivity increases the probe **62** moves more in relation to each joystick **94** movement and vice versa. In some embodiments, this may include utilizing a stepper motor in the articulation section **64**. For example, when the articulation sensitivity is set at 50%, a 1 mm move of the joystick **94** may cause the stepper motor to move five steps in the direction the joystick **94** was moved, and when the articulation sensitivity is increase to 60%, a 1 mm move of the joystick **94** may cause the stepper motor to move six steps in the direction the joystick **94** was moved.

As described above, the haptic feedback may be provided based on the articulation sensitivity of probe **62**. More specifically, the joystick **94** may be stiffer (e.g., more resistant to movement) when the sensitivity is lower to facilitate more precise movement of the probe **62**, and looser (e.g., less resistant to movement) when the sensitivity is higher to enable quicker movement of the probe **62**.

In the embodiments depicted in FIGS. **6** and **7**, soft buttons displayed on the screen **76** are utilized to adjust the articulation sensitivity. For example, in FIG. **6**, the screen **76** displays a decrease button (–) **136**, an increase button (+) **138**, and a Done button **140**. The FIGS. **6** and **7** also depict an image **139** having features **141**. The image **139** (e.g., static image or video image) corresponds to a component undergoing observation. The features **141** may correspond to, for example, ridges manufactured into the component. In the depicted embodiments, when the decrease button **136** is selected, the articulation sensitivity will decrease, and when the increase button **138** is selected, the articulation sensitivity increases. Accordingly, the articulation sensitivity may be adjusted so that the features **141** may be more easily observed. For example, by decreasing the articulation sensitivity, a movement of the joystick **94** may result in the image **139** shifting a smaller distance more suitable to observe the features **141** at higher magnification. Likewise, increasing the articulation sensitivity may provide for faster observations at lower magnifications with less movement of the joystick **94**. In other words, the articulation sensitivity may be adjusted so that a certain joystick **94** movement (e.g., 0.5, 1, 2, 3, 4, 5, 6, 7, 10 mm or more) corresponds to a larger of smaller movement of the articulation section 64 (e.g., 0.05, 0.5, 1, 2, 3, 4, 5, 6, 7, 10 mm or more), and thus movement of the image.

Similarly, in FIG. **7**, the screen **76** displays a slider **142**. In the depicted embodiment, when the slider **142** is slid to the right, the articulation sensitivity increases, and when the slider is slid to the left, the articulation sensitivity decreases. For example, moving the slider 1, 2, 3, 5, 6, 7, 8% or more of the total slider length may result in increases or decreases of (e.g., 0.5, 1, 2, 3, 4, 5, 6, 7, 10 mm or more) of movement of the articulation section **64** with the same amount of movement of the joystick **94**. As should be appreciated, hard buttons **79** on the borescope **14** may also be utilized to supplement or replace the soft buttons (e.g., **136**, **138**, **140**, and **142**). By overlaying the slider **142** (and buttons **136**, **138**, **140**) on the image **139**, adjustments to the articulation sensitivity may be performed during inspection, and the results of the adjustments may then be observed. It is to be noted that other controls may be used in addition to or in lieu of the slider **142** and buttons **136**, **138**, **140**. For example, a textbox may be used to enter a desired articulation sensitivity as a numeric value or as a percentage. Likewise, a touch-control dial, selectable preset settings (e.g., “high”, “medium,” and “low”), radio buttons, dropdown menus having various articulation sensitivity values, and so on, may be used. It is also to be noted that, in another embodiment, the slider **142** may be displayed vertically or at an angle.

As described above, as the articulation sensitivity is adjusted, the user can experiment with the adjusted settings to determine whether further adjustment is desired. For example, a user may select the increase button **138** to increase the articulation sensitivity. After the articulation sensitivity is increased, the user may test the movement of the probe **62** with the increased sensitivity. The user may then decide whether to adjust the articulation sensitivity further. Once the user is satisfied with the articulation sensitivity, in some embodiments, the user may select the Done button **140** and return to the settings menu **118**. In other embodiments, the user may simply continue using the borescope **14** with the articulation sensitivity controls (e.g., **136**, **138** and **142**) on the screen. In other words, the articulation sensitivity may continue to be adjustable during normal operation of the borescope **14**. For example, this may enable the user to better navigate tight areas by decreasing articulation sensitivity and to increase articulation sensitivity to expedite the movement of the probe **14**.

Technical effects of the invention include providing systems and methods that improve the configuration of a borescope **14**. More specifically, adjustments to the settings of the borescope **14** may be tested in a live menu view. For example, in the live menu view, when the articulation sensitivity of the borescope **14** is increased/decreased, the movement of the probe **62** may be tested to determine whether further adjustment is desired. In other words, embodiments of the present disclosure improve the efficiency and accuracy of configuring the settings of the borescope **14** by enabling the settings to be adjusted in a live view.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

The invention claimed is:

1. A borescope system comprising:
a probe configured to capture images;
input devices configured to receive user inputs to the borescope system, wherein the input devices comprises a physical joystick, a hard button, one or more soft controls, or any combination thereof; and
a display configured to:
display a settings menu configured to enable the user inputs to select an articulation mode setting of the probe from the settings menu; and
display a live menu view when the articulation mode is selected, wherein the live menu view comprises:
a first image captured by the probe; and
a second image of a first soft control overlaid on the first image to enable the user inputs to adjust an articulation sensitivity setting of the probe via the first soft control and to control articulation of the probe based at least in part on the articulation sensitivity setting while the images captured by the probe are displayed, wherein the articulation sensitivity setting indicates an amount the probe moves in response to the user inputs that control articulation of the probe.

2. The borescope system of claim 1, wherein, in the live menu view, the first soft control is configured to enable the user inputs to increase, decrease, or a combination thereof, the articulation sensitivity setting of the probe.

3. The borescope system of claim 2, wherein the live menu view comprises a third image of a second soft control overlaid on the first image;

wherein the borescope system is configured to increase the articulation sensitivity setting when the user inputs select the second soft control and to decrease the articulation sensitivity setting when the user inputs select the first soft control.

4. The borescope system of claim 2, wherein the first soft control comprises a slider displayed horizontally across the display, wherein the borescope system is configured to increase the articulation sensitivity setting when the user inputs comprise a first slide of the slider right and to decrease the articulation sensitivity setting when the user inputs comprise a second slide of the slider left.

5. The borescope system of claim 1, wherein the probe is configured to return to center when the user inputs are not controlling the articulation of the probe and the user inputs select a proportional mode as the articulation mode setting.

6. The borescope system of claim 1, wherein the probe is configured to remain in a last articulated position when the user inputs are not controlling the articulation of the probe and the user inputs select a steer & stay mode as the articulation mode setting.

7. The borescope of system claim 1, wherein the input devices comprise a haptic device configured to provide haptic feedback to a user of the borescope system based at least in part on the articulation of the probe, the articulation sensitivity setting of the probe, or both.

8. A tangible, non-transitory, computer-readable medium configured to store instructions executable by a processor of a borescope system, wherein the instructions comprise instructions to:

instruct, using the processor, a display of the borescope system to display a settings menu, wherein the settings menu is configured to enable selection of an articulation mode setting used to control articulation of a probe of the borescope system; and

instruct, using the processor, the display to automatically-display a live menu view when the articulation mode setting is selected by a first user input, wherein the live menu view comprises:

a first image captured by the probe; and

a second image of a soft control overlaid on the first image to enable adjustment of an articulation sensitivity setting of the probe via a second user input and control over articulation of the probe via a third user input based at least in part on the articulation mode setting and the articulation sensitivity setting while images captured by the probe are displayed on the display, wherein the articulation sensitivity setting indicates an amount the probe moves in response to the third user input.

9. The computer readable medium of claim 8, wherein the instruction to automatically display the live menu view comprise instructions to instruct, using the processor, an input device of the borescope system to detect the second user input, wherein the second user input increase or decreases the articulation sensitivity setting of the probe.

10. The computer readable medium of claim 9, wherein:

the soft control comprises a first soft button configured to increase the articulation sensitivity setting when activated by the second user input; and

the live menu view comprises a third image of a second soft button overlaid on the first image, wherein the second soft button is configured to decrease the articulation sensitivity setting when activated by the second user input.

11. The computer readable medium of claim 9, wherein the first soft control comprises a slider configured to increase the articulation sensitivity setting when the second user input slides the slider right and to decrease the articulation sensitivity setting when the second user input slides the slider left.

12. The computer readable medium of claim 8, comprising instructions to instruct, using the processor, the borescope system to exit the Live menu view and return to the settings menu after a fourth user input indicates completion of adjustments to the articulation sensitivity setting of the probe.

13. The computer readable medium of claim 12, wherein the live menu view comprises a third image of a soft button overlaid on the first image, wherein the soft button is configured to detect the completion of the adjustments to the articulation sensitivity setting when selected by the fourth user input.

14. A method of controlling articulation of a probe in a borescope system, comprising:

displaying, using a display of the borescope system, a settings menu comprising an articulation mode setting of the probe;

detecting, using input devices of the borescope system, a first user input selecting the articulation mode setting;

displaying, using the display, a live menu view when the first user input is detected, wherein the live menu view comprises:

a first image captured by the probe; and

a second image of a soft control overlaid on the first image to enable a second user input to adjust an articulation sensitivity setting of the-probe via the soft control and to enable a third user input to control articulation of the probe based at least in part on the articulation sensitivity setting while the images captured by the probe are displayed, wherein the articulation sensitivity setting indicates an amount the probe moves in response to the third user input.

15. The method of claim 14, wherein enabling the second user input to adjust the articulation sensitivity setting comprises:

detecting, using the user input devices, the second user input; and

increasing or decreasing, using the borescope system, the articulation sensitivity setting of the probe based at least in part on the second user input.

16. The method of claim 15, wherein:

the first soft control comprises a first soft button configured to increase the articulation sensitivity setting when activated by the second user input; and

the live menu view comprises a third image of a second soft button configured to decrease the articulation sensitivity setting when activated by the second user input.

17. The method of claim 15, wherein the soft control comprises a slider configured to increase the articulation sensitivity setting when the second user input slides the slider right and to decrease the articulation sensitivity setting when the second user input slides the slider left.

18. The method of claim 14, comprising:

detecting, using the input devices, a third user input indicating desire to adjust the articulation sensitivity setting; and displaying, using the display, the live menu view when the third user input is detected.

19. The method of claim **14**, wherein the live menu view comprises a third image of a soft button overlaid on the first image, wherein the soft button is configured to indicate completion of adjustment of the articulation sensitivity setting when selected by a third user input.

20. The method of claim **14**, wherein detecting the first user input comprises determining whether the first user input selects a proportional mode or a steer & stay mode.

* * * * *

patsnap

专利名称(译)	内窥镜转向调节系统和方法		
公开(公告)号	US9476823	公开(公告)日	2016-10-25
申请号	US13/949010	申请日	2013-07-23
[标]申请(专利权)人(译)	通用电气公司		
申请(专利权)人(译)	通用电气公司		
当前申请(专利权)人(译)	通用电气公司		
[标]发明人	WARD THOMAS CHARLES MAULE BRYAN DAVID STANCATO MELISSA ROSE PANKOW MATTHEW WILLIAM ANDREASEN DAVID SCOTT		
发明人	WARD, THOMAS CHARLES MAULE, BRYAN DAVID STANCATO, MELISSA ROSE PANKOW, MATTHEW WILLIAM ANDREASEN, DAVID SCOTT		
IPC分类号	H04N9/47 B25J9/16 E21B47/00 G01N21/01 A62B1/04 G02B23/24 A61B1/04 A61B1/06 G06F3/0482 G06F3/0484 G06F3/0488		
CPC分类号	G01N21/01 B25J9/1635 E21B47/0002 G02B23/24 G01N2021/0112 G01N2021/0181 G05B2219/23092 G05B2219/35478 G05B2219/37396 G05B2219/39443 G05B2219/45066 G06F3/0482 G06F3/0488 G06F3/04847 G02B23/2484		
审查员(译)	赵，DAQUAN		
其他公开文献	US20150029500A1		
外部链接	Espacenet USPTO		

摘要(译)

本文提供的系统和方法。在一个实施例中，管道镜系统包括用于捕获图像的探针和显示器设置菜单，测量值，探针捕获的图像或其任何组合。另外，管道镜系统处理器被编程为显示用户界面以使用户能够控制探头的移动，调整设置，导航菜单，进行选择或其任何组合。处理器通信地耦合到探头和显示器，并且被编程为当从设置菜单中选择关节运动模式时指示管道镜进入实时菜单视图。在实时菜单视图中，处理器被编程为指示显示器显示由探头捕获的图像，并使用户能够控制探头的移动并在观看显示器上的图像时调整探头的关节灵敏度。