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Powered endoscopic device with haptic feedback

Abstract

An endoscopic deployment device includes a body mountable on an endoscopic device, the body having a movable carrier couplable to an end effector device, the end effector device having an end effector shaft covered by an outer sheath and an end effector extending from a distal end of the end effector shaft, the outer sheath being sized and shaped for insertion through a working channel of the endoscopic device, the body having a carrier channel for the carrier to slide therein, wherein the end effecter is actuatable between an open position and a closed position; and a motor having a drive shaft coupled to the carrier, rotation of the drive shaft sliding the carrier in the carrier channel and actuating the end effector in response to a signal from one or more actuation buttons; wherein at least one vibration motor generates vibrations as an angular position of the motor changes.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) The present application is a continuation of U.S. patent application Ser. No. 17/118,748, filed Dec. 11, 2020, which claims the benefit of and priority to U.S. Provisional Patent Application Ser. No. 62/947,388, filed on Dec. 12, 2019, the disclosures of which are incorporated herein by reference.

FIELD

(1) The present disclosure relates to an endoscopic device and, in particular, an endoscope handle with powered features and/or accessories providing haptic feedback.

BACKGROUND

(2) Various accessory devices may be used with an endoscopic device to perform various diagnostic and treatment procedures in the imaged cavity. However, the accessory devices may not always be compatible with the endoscopic device. For example, the physical configurations of the devices may be difficult to use in conjunction, or the devices may not be programmatically compatible.

SUMMARY

(3) In a first example, an endoscopic deployment device may comprise a body mountable on an endoscopic device, the body having a movable carrier couplable to an elongated end effector device, the elongated end effector device having an end effector shaft covered by an outer sheath and an end effector extending from a distal end of the end effector shaft, the outer sheath being sized and shaped for insertion through a working channel of an endoscopic shaft of the endoscopic device, the body having a carrier channel sized for the carrier to slide therein, wherein the end effecter is actuatable between an extended open position and a retracted closed position by sliding the carrier in the carrier channel; and a motor having a drive shaft coupled to the carrier, rotation of the drive shaft sliding the carrier in the carrier channel and actuating the end effector in response to a signal from one or more actuation buttons. At least one vibration motor may generate vibrations as an angular position of the motor changes.

(4) In addition or alternatively, the one or more actuation buttons is a button pad physically separate from the body of the endoscopic deployment device and in operable communication with the motor.

(5) In addition or alternatively, wherein an intensity of the vibrations corresponds to the angular position of the motor.

(6) In addition or alternatively, the intensity of the vibrations is linear relative to the angular position of the motor.

(7) In addition or alternatively, the intensity of the vibrations is non-linear relative to the angular position of the motor.

(8) In addition or alternatively, the motor is a stepper motor.

(9) In addition or alternatively, the drive shaft has an arm extending orthogonally therefrom coupled to a slot in the carrier and the arm has a pin at an end of the arm opposite the drive shaft, the pin being coupled to the slot so that, when the drive shaft rotates, the pin slides in the slot in a direction orthogonal to the carrier channel and the carrier slides in the carrier channel.

(10) In addition or alternatively, the drive shaft is a lead screw coupled to a threaded through-hole extending through a portion of the carrier parallel to the carrier channel so that, when the drive shaft rotates, the carrier slides in the carrier channel.

(11) In addition or alternatively, a pinion gear is coupled to the drive shaft and to a rack that is an integral portion of the carrier so that, when the drive shaft rotates, the pinion gear drives the rack and the carrier slides in the carrier channel.

(12) In addition or alternatively, the end effector device is a retrieval device for capturing objects at a distal end of the endoscopic shaft.

(13) In addition or alternatively, the end effector device is a laser fiber for fragmenting or cauterizing objects at a distal end of the endoscopic shaft.

(14) In addition or alternatively, and in another example, an endoscopic device may comprise an elongated flexible endoscopic shaft including a working channel and a deflectable distal tip, the flexible endoscopic shaft being sized and shaped for insertion to a target site, the distal tip including a camera; and a handle from which the endoscopic shaft extends distally, the handle including a pull wire wheel disposed therein, the pull wire wheel comprising pull wire attachments from which first and second pull wires extend distally through the endoscopic shaft to the distal tip. Rotation of the pull wire wheel may deflect the distal tip by tensioning a first one of the first and second pull wires and slacking a second one of the first and second pull wires, the handle including a motor disposed within the handle, the motor having a rotatable drive shaft coupled to and configured to rotate the pull wire wheel in response to a signal from one or more actuation buttons. At least one vibration motor may generate vibrations as an angular position of the motor changes.

(15) In addition or alternatively, an intensity of the vibrations corresponds to the angular position of the motor.

(16) In addition or alternatively, the motor is a stepper motor.

(17) In addition or alternatively, the endoscopic device may further comprise an endoscopic deployment device, the endoscopic deployment device comprising: a body mounted on the handle of the endoscopic device, the body having a movable carrier couplable to an elongated end effector device, the elongated end effector device having an end effector shaft covered by an outer sheath and an end effector extending from a distal end of the end effector shaft, the outer sheath being sized and shaped for insertion through the working channel of the endoscopic shaft of the endoscopic device, the body having a carrier channel sized for the carrier to slide therein, wherein the end effecter is actuatable between an extended open position and a retracted closed position by sliding the carrier in the carrier channel; and a motor having a drive shaft coupled to the carrier, rotation of the drive shaft sliding the carrier in the carrier channel and actuating the end effector in response to a signal from one or more actuation buttons. At least one vibration motor may generate vibrations as an angular position of the motor changes.
(18) In addition or alternatively, and in another example, an endoscopic device may comprise an elongated flexible endoscopic shaft including a working channel and a deflectable distal tip, the flexible endoscopic shaft being sized and shaped for insertion to a target site, the distal tip including a camera; a handle from which the endoscopic shaft extends distally, the handle including a motor disposed within the handle and operably connected to the distal tip, the motor being configured to deflect the distal tip in response to a signal from a lever coupled to the handle; wherein a first vibration motor is configured to generate vibrations within the lever as an angular position of the motor within the handle changes; and a body mounted on the handle, the body having a movable carrier couplable to an elongated end effector device, the elongated end effector device having an end effector shaft covered by an outer sheath and an end effector extending from a distal end of the end effector shaft, the outer sheath being sized and shaped for insertion through the working channel of the endoscopic shaft, the body having a carrier channel sized for the carrier to slide therein. The body may include a motor having a drive shaft coupled to the carrier, wherein rotation of the drive shaft slides the carrier in the carrier channel and actuates the end effector in response to a signal from one or more actuation buttons on the handle. The handle may further include at least one vibration motor configured to generate vibrations within the one or more actuation buttons as an angular position of the motor within the body changes.
(19) In addition or alternatively, the at least one vibration motor includes a second vibration motor coupled to a first actuation button of the one or more actuation buttons and a third vibration motor coupled to a second actuation button of the one or more actuation buttons.
(20) In addition or alternatively, the second vibration motor is configured to generate vibrations within the first actuation button when the end effector is actuated toward a retracted closed position; and the third vibration motor is configured to generate vibrations within the second actuation button when the end effector is actuated toward an extended open position.
(21) In addition or alternatively, an intensity of the vibrations within the first actuation button increases as the end effector approaches the retracted closed position, and an intensity of the vibrations within the second actuation button increases as the end effector approaches the extended open position.
(22) In addition or alternatively, an intensity of the vibrations within the lever increases as deflection of the distal tip away from a central longitudinal axis of the endoscopic shaft increases.
(23) The above summary of some embodiments, aspects, and/or examples is not intended to describe each disclosed embodiment or every implementation of the present disclosure. The Figures, and Detailed Description, which follow, more particularly exemplify these embodiments.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1**A shows a front view of an endoscopic device compatible with powered accessories according to various exemplary embodiments of the present disclosure.
(2) FIG. **1**B shows a rear view of the endoscopic device of FIG. **1**A.
(3) FIG. **2** shows a pressure sensor device configured for compatibility with the endoscopic device of FIG. **1**A.
(4) FIG. **3** shows a flow sensor device configured for compatibility with the endoscopic device of FIG. **1**A.
(5) FIG. **4**A shows a transparent side view of a first embodiment of a motorized deployment device.
(6) FIG. **4**B shows a transparent perspective view of the motorized deployment device of FIG. **4**A.
(7) FIG. **5**A shows a transparent side view of a second embodiment of a motorized deployment device.
(8) FIG. **5**B shows a transparent perspective view of the motorized deployment device of FIG. **5**A.
(9) FIG. **6** shows an exemplary handle compatible with the motorized deployment devices of FIGS. **4**A-**5**B and an elongated end effector device.
(10) FIGS. **7**A-**7**F show exemplary elongated end effector devices compatible with a handle.
(11) FIG. **8** shows a stepper motor control board.
(12) FIG. **9** shows a handle of an endoscopic device with a motor for controlling the deflection of a distal tip.
(13) FIGS. **10**A-C show a gear train for driving a pull wire wheel of the device of FIG. **9**.
(14) FIG. **10**D shows the pull wire wheel of the device of FIG. **9** fashioned with a gear.
(15) FIG. **11** shows the gear train of FIGS. **10**A-C with a pulley.
(16) FIG. **12** shows an ergonomic button pad for controlling a scope tip and an elongated end effector device.
(17) FIG. **12**A shows a portion of a handle of an endoscopic device with a motorized deployment device mounted on the handle.
(18) FIG. **13** illustrates an example vibration motor.
(19) FIG. **14** illustrates an example vibration motor control board.
(20) FIG. **15** is graph showing one example configuration of vibration intensity versus motor angle.
(21) FIG. **16** is a graph showing another example configuration of vibration intensity versus motor angle.
(22) While aspects of the disclosure are amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit aspects of the disclosure to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure.

DETAILED DESCRIPTION

(23) The following description should be read with reference to the drawings, which are not necessarily to scale. The detailed description and drawings are intended to illustrate but not limit the claimed invention. Those skilled in the art will recognize that the various elements described and/or shown may be arranged in various combinations and configurations without departing from the scope of the disclosure. The detailed description and drawings illustrate example embodiments of the claimed invention.
(24) For the following defined terms, these definitions shall be applied, unless a different definition is given in the claims or elsewhere in this specification.
(25) All numeric values are herein assumed to be modified by the term “about,” whether or not explicitly indicated. The term “about”, in the context of numeric values, generally refers to a range of numbers that one of skill in the art would consider equivalent to the recited value (e.g., having

the same function or result). In many instances, the term “about” may include numbers that are rounded to the nearest significant figure. Other uses of the term “about” (e.g., in a context other than numeric values) may be assumed to have their ordinary and customary definition(s), as understood from and consistent with the context of the specification, unless otherwise specified.
(26) The recitation of numerical ranges by endpoints includes all numbers within that range, including the endpoints (e.g., 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5).
(27) Although some suitable dimensions, ranges, and/or values pertaining to various components, features and/or specifications may be disclosed, one of skill in the art, incited by the present disclosure, would understand desired dimensions, ranges, and/or values may deviate from those expressly disclosed.
(28) As used in this specification and the appended claims, the singular forms “a”, “an”, and “the” include plural referents unless the content clearly dictates otherwise. As used in this specification and the appended claims, the term “or” is generally employed in its sense including “and/or” unless the content clearly dictates otherwise. It is to be noted that in order to facilitate understanding, certain features of the disclosure may be described in the singular, even though those features may be plural or recurring within the disclosed embodiment(s). Each instance of the features may include and/or be encompassed by the singular disclosure(s), unless expressly stated to the contrary. For simplicity and clarity purposes, not all elements of the disclosed invention are necessarily shown in each figure or discussed in detail below. However, it will be understood that the following discussion may apply equally to any and/or all of the components for which there are more than one, unless explicitly stated to the contrary. Additionally, some instances of some elements or features may not be shown in each figure for clarity.
(29) Relative terms such as “proximal”, “distal”, “advance”, “retract”, variants thereof, and the like, may be generally considered with respect to the positioning, direction, and/or operation of various elements relative to a user/operator/manipulator of the device, wherein “proximal” and “retract” indicate or refer to closer to or toward the user and “distal” and “advance” indicate or refer to farther from or away from the user. In some instances, the terms “proximal” and “distal” may be arbitrarily assigned in an effort to facilitate understanding of the disclosure, and such instances will be readily apparent to the skilled artisan. Other relative terms, such as “upstream”, “downstream”, “inflow”, and “outflow” refer to a direction of fluid flow within a lumen, such as a body lumen, a blood vessel, or within a device. Still other relative terms, such as “axial”, “circumferential”, “longitudinal”, “lateral”, “radial”, etc. and/or variants thereof generally refer to direction and/or orientation relative to a central longitudinal axis of the disclosed structure or device.
(30) The term “extent” may be understood to mean a greatest measurement of a stated or identified dimension, unless the extent or dimension in question is preceded by or identified as a “minimum”, which may be understood to mean a smallest measurement of the stated or identified dimension. For example, “outer extent” may be understood to mean an outer dimension, “radial extent” may be understood to mean a radial dimension, “longitudinal extent” may be understood to mean a longitudinal dimension, etc. Each instance of an “extent” may be different (e.g., axial, longitudinal, lateral, radial, circumferential, etc.) and will be apparent to the skilled person from the context of the individual usage. Generally, an “extent” may be considered a greatest possible dimension measured according to the intended usage, while a “minimum extent” may be considered a smallest possible dimension measured according to the intended usage. In some instances, an “extent” may generally be measured orthogonally within a plane and/or cross-section, but may be, as will be apparent from the particular context, measured differently—such as, but not limited to, angularly, radially, circumferentially (e.g., along an arc), etc.
(31) The terms “monolithic” and “unitary” shall generally refer to an element or elements made from or consisting of a single structure or base unit/element. A monolithic and/or unitary element shall exclude structure and/or features made by assembling or otherwise joining multiple discrete

structures or elements together.

(32) It is noted that references in the specification to “an embodiment”, “some embodiments”, “other embodiments”, etc., indicate that the embodiment(s) described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it would be within the knowledge of one skilled in the art to implement the particular feature, structure, or characteristic in connection with other embodiments, whether or not explicitly described, unless clearly stated to the contrary. That is, the various individual elements described below, even if not explicitly shown in a particular combination, are nevertheless contemplated as being combinable or arrangeable with each other to form other additional embodiments or to complement and/or enrich the described embodiment(s), as would be understood by one of ordinary skill in the art.

(33) For the purpose of clarity, certain identifying numerical nomenclature (e.g., first, second, third, fourth, etc.) may be used throughout the description and/or claims to name and/or differentiate between various described and/or claimed features. It is to be understood that the numerical nomenclature is not intended to be limiting and is exemplary only. In some embodiments, alterations of and deviations from previously used numerical nomenclature may be made in the interest of brevity and clarity. That is, a feature identified as a “first” element may later be referred to as a “second” element, a “third” element, etc. or may be omitted entirely, and/or a different feature may be referred to as the “first” element. The meaning and/or designation in each instance will be apparent to the skilled practitioner.

(34) Some exemplary embodiments describe an endoscopic device (e.g., endoscope) having a scope handle with one or more external communication interfaces (e.g., USB ports) and accessory devices compatible with the endoscope and pluggable thereinto. For example, the accessory devices may include a pressure sensor, a temperature sensor, a flow sensor, an additional camera, an additional light, an optical sensor, a catheter, a laser time-of-flight distance sensor, a deployment device, other sensors or combinations thereof.

(35) In another embodiment, an accessory device is described that is a motorized endoscopic deployment device for controlling an elongated end effector device to capture e.g. kidney stones or the like. The motorized deployment device is compatible with the endoscope or may be integrated with the endoscope in a monolithic handle. The elongated end effector device refers to any one of a number of devices compatible with and actuated by the motorized deployment device. For example, the elongated end effector device may be the retrieval device for capturing kidney stones, a laser fiber device, a therapy needle, snares, forceps, band ligation devices, etc. Any of the elongated end effector devices may be fitted with, for example, a handle sized and shaped to be used with the motorized deployment device. Thus, any elongated end effector device compatible with and fitted with an appropriate handle (or a similar device) may also be used with the motorized deployment device.

(36) In still another embodiment, the endoscope handle has a motor for controlling articulation of the distal tip of the endoscopic shaft. The motor may be, e.g., a stepper motor allowing for precise positioning and holding of the shaft tip and/or precise control of the end effector feature of the elongated end effector device. The motor may be internal to the handle or may be externally coupled to the handle, e.g., connected by a flexible drive shaft extension or the like.

(37) In each of the embodiments, the communication interfaces between the scope handle and the accessory device(s), whether internal or via external communication interfaces, are arranged so that an operating physician may operate the articulation of the distal shaft tip and control the accessory device in an ergonomic manner. For example, in one embodiment, where the motorized deployment device is connected to the scope handle, the deflection knob for the distal tip of the endoscopic shaft and a button control for the motorized deployment device are arranged so that

both may be operated simultaneously or independently without overstressing the physician's hand. In another embodiment, where the motorized deployment device is monolithic with or otherwise compatible with the scope handle, a button pad may be used to operate both the distal tip of the endoscopic shaft and the elongated end effector device. The button pad may include, for example, four momentary buttons located on the bottom side of the scope handle and may be operated by the physician's grip hand thumb. Depressing a button causes a movement to occur to the scope shaft or the end effector, and releasing the button causes the stepper motor to stop and hold the current position. In another embodiment, a non-momentary button may be used such as a typical on/off switch. In another embodiment, one or more actuation buttons may be disposed on and/or may be a part of the handle (for example, a thumb lever and/or buttons operable by a user's grip hand fingertips). In still another embodiment, control is fully implemented remotely from the devices via, e.g., a console. Other configurations are also contemplated.

(38) Some embodiments have a data bus in the scope handle where data may be received via the various accessory devices and control for the devices may be implemented. The handle may be coupled to an endoscopic console or the like via a cable, with data from the devices being sent thereto or control of the devices being implemented therefrom. In some embodiments, the handle may be electronically connected to the endoscopic console or the like using one or more wireless technologies (e.g., Wi-Fi, Bluetooth, etc.). In some embodiments, data from one of the accessory devices and/or the endoscope may be used to control the operation of another one of the accessory devices and/or the endoscope. For example, a reading from a pressure sensor may trigger an operation of an irrigation mechanism. In another example the output from a laser-distance sensor may adjust/optimize the distance from a laser fiber tip to a ureteral stone via the stepper motor to maximize laser efficiency during stone fragmentation. In another embodiment the data from an accessory device is displayed on e.g. a monitor screen for the physician to evaluate and react accordingly.

(39) FIGS. **1**A-**1**B show a front view and a rear view of an endoscopic device **100** compatible with powered and data accessories according to various exemplary embodiments of the present disclosure. The endoscopic device **100** may be specific to a particular endoscopic procedure, such as, e.g., ureteroscopy, or may be a general-purpose device suitable for a wide variety of procedures. The endoscopic device **100** includes a handle **102** connected to an endoscopic shaft **104** with a deflectable distal tip **106** at a distal end **103**. The distal tip **106** has a camera and may, for example, have full 270° deflection capabilities in more than one direction for viewing patient anatomy as would be understood by those skilled in the art.

(40) The handle **102** of the endoscopic device **100** has a plurality of elements configured to facilitate the endoscopic procedure. A cable **108** extends from the handle **102** and is configured for attachment to an electronic device (not pictured) such as e.g. a computer system, a console, a microcontroller, etc. for providing power, analyzing endoscopic data, controlling the endoscopic intervention, or performing other functions. The electronic device to which the cable **108** is connected may have functionality for recognizing and exchanging data with other endoscopic accessories, to be described in detail below. The handle **102** has a grip area **118** for the operating physician to grasp while performing the endoscopic procedure. A deflection knob **116** at a proximal end **105** of the device may be actuated to control the deflection of the distal tip **106** as would be understood by those skilled in the art. Even when an endoscopic device **100** has a motorized deflection means, to be described in detail below, a short handle version of the deflection knob **116** is present, in this embodiment, for manually straightening the distal tip **106** and removing the **104** endoscopic shaft **104** from the patient anatomy in case of e.g. power failure.

(41) The handle **102** further has at least one communication interface for attaching accessory devices. In the present embodiment, the handle **102** has a first communication interface **112** and second communication interface **114** that are, in this embodiment, Universal Serial Bus type-C (USB-C) ports. However, more or less communication interface of various types, including, for

example, custom interfaces, may be used. In other embodiments, the handle **102** has only one communication interface but may receive e.g. a USB hub with multiple ports for connecting multiple accessories. The communication interfaces **112**, **114** may provide power to the accessory devices in addition to exchanging data therewith. Thus, the accessory devices need not have separate cables running to the console or a battery that adds additional weigh to the handle **102**. The accessory device may be uniquely associated with the endoscopic device **100** and recognized by the console through "plug and play" functionality without any user setup required.

(42) A T-connector **110** extends from a distal portion of the handle **102** and provides first and second ports **124**, **126** for accessing the working channel of the endoscopic shaft **104**. In this embodiment, the first and second ports **124**, **126** are arranged perpendicularly to one another with the first port **124** facing distally and the second port **126** facing proximally. An accessory device or an elongated end effector device may be passed through either one of the first and second ports **124**, **126**, however, the second port **126** may be preferred when the device is proximal to the T-connector **110**. In another embodiment, a Y-connector is used with first and second ports both facing proximally, such that two devices may be passed into the working channel of the endoscopic shaft **104** from a position proximal to the Y-connector.

(43) Various accessory devices may be mated with either of the two communication interfaces **112**, **114**, however, certain of the accessory devices are more compatible with either one of the two interfaces **112**, **114**. The first communication interface **112** is located distally on the handle **102**. Certain of the accessory devices have corresponding communication interfaces, e.g., male USB-C ports, extending from the devices that lend themselves to spatial compatibility with the first communication interface **112**.

(44) For example, FIG. **2** shows a pressure sensor device **200** configured for compatibility with the endoscopic device **100**, particularly with the first communication interface **112** of the endoscopic device **100**. The pressure sensor device **200** has a communication interface **202** that may be mated with, e.g., inserted into, the first communication interface **112** of the endoscopic device **100**. The pressure sensor device **200** has a shaft **204** extending from a proximal end **205** of the pressure sensor device **200** to a distal end **203** of the pressure sensor device **200**. The shaft **204** has a through-lumen, i.e., channel, extending through its length. The proximal end of the shaft **204** has a female luer hub **210** extending therefrom and the communication interface **202** adjacent thereto. The communication interface **112** of the endoscopic device **100** is angled so that when the pressure sensor device **200** is attached to the endoscopic device **100**, the female luer hub **210** is oriented in a manner similar to the second port **126** of the T-connector **110**. Thus, the pressure sensor device **200** is more easily coupled with a male luer port for e.g. fluid communication during use.

(45) The pressure sensor device **200** has a pressure sensor **206** at a distal end of the shaft **204** and a plurality of clips **208** adjacent thereto for securing the shaft **204** of the pressure sensor device **200** to the endoscopic shaft **104**. Although the present embodiment uses the clips **208**, the shaft **204** may be secured to the endoscopic shaft **104** by other means such as, e.g., holders or the like.

(46) As noted above, the pressure sensor device **200** may also be mated with the second communication interface **114** of the endoscopic device **100**. However, in the presently described embodiment, mating with the first communication interface **112** is preferable in view of the ease with which the shaft **204** of the pressure sensor device **200** may be clipped to the endoscopic shaft **104** of the endoscopic device **100** as well as the positioning of the female luer hub **210**.

(47) In another example, FIG. **3** shows a flow sensor device **300** configured for compatibility with the endoscopic device **100**, particularly with the first communication interface **112** of the endoscopic device. Similar to the pressure sensor device **200**, the flow sensor device **300** has a communication interface **302** that may be mated with the first communication interface **112** of the endoscopic device **100**. The flow sensor device **300** has a shaft **304** extending from a proximal end **305** of the flow sensor device **300** to a distal end **303** of the flow sensor device **300**. The shaft **304** has a through-lumen extending through its length. The proximal end of the shaft **304** has a female

luer hub **310** extending therefrom, the communication interface **302** adjacent thereto and a handle **312**. Similar to the pressure sensor device **200**, the flow sensor device **300** is easily coupled with a male luer port for fluid communication or any other reason.

(48) The flow sensor device **300** has a flow sensor **306** adjacent to the handle **312** and a plurality of clips **308** adjacent to a distal end of the shaft **304** for securing the shaft **304** of the flow sensor device **300** to the endoscopic shaft **104**. Similar to the pressure sensor device **200**, the flow sensor device **300** may use attachment means other than the clips **308** such as, e.g. holders or the like. The pressure sensor device **200** may also be mated with the second communication interface **114** of the endoscopic device **100**, however, mating with the first communication interface **112** is preferable in view of the spatial benefits discussed above.

(49) Returning to FIGS. **1**A and **1**B, the second communication interface **114** is positioned proximally on the handle **102** and is compatible with accessory devices configured for insertion through a working channel of the endoscopic shaft **104** via, for example, the second port **126**. For example, an accessory device such as an additional camera, an additional light, an optical sensor, or other device may be mated with the second communication interface **114** and inserted into the working channel. In this way, the cables/shafts of the devices are out of the way of the operating physician and can be used without significant bending of the accessory. However, these devices may also have a flexible cable that is inserted into the first communication interface **112** and flexed into the working channel without damaging the cable. Because the second communication interface **114** is proximal to the T-connector **110**, with the second port **126** of the T-connector **110** directed proximally, there may be instances where a fluid being used during a ureteroscopic procedure leaks and/or splashes proximally. Thus, the proximal second communication interface **114** may have a fluid seal such as a Tuohy borst adapter or other configuration. The console cable **108** of the endoscopic device **100** may be associated with one of the communication interfaces **112**, **114** such that an interface on the handle **102** is not necessary. For example, the cable **108** may be bifurcated and have an interface, e.g., USB port, extending from the bifurcated part of the cable **108**.

(50) The handle **102** of the endoscopic device **100** in the present embodiment has two mount holes **120**, **122** positioned to couple to, for example, a motorized endoscopic deployment device **400** compatible with an elongated end effector device. The elongated end effector device may be any one of a number of devices having a variety of purposes such as, e.g., capturing and removing objects such as kidney stones, to be explained in further detail below.

(51) FIG. **4**A shows a transparent side view and FIG. **4**B shows a transparent perspective view of the motorized endoscopic deployment device **400**. The motorized endoscopic deployment device **400** may be coupled to the endoscopic device **100** at the mount holes **120**, **122** with corresponding mount pins **402**, **404**. The endoscopic deployment device **400** has a communication interface **406** that may be mated with, e.g., inserted into, the second communication interface **114** of the endoscopic device **100**. The communication interface **406** may be, e.g., a male USB-C port. The communication interface **406** is connected via a flexible cable **408** to a control board **410** for a motor **412**. The control board **410** includes an electrical port, in this case for connecting a USB, driver circuitry and motor terminals for connecting the motor **412**. The motor **412** may be, e.g., a stepper motor. The motor **412** may be actuated by a signal provided by one or more actuation buttons **430** (or alternately, the button pad **1200** shown in FIG. **12**, the first actuation button **1210** and the second actuation button **1212** shown in FIG. **12**A, etc.). In another embodiment, the signal is generated in response to an endoscopic sensor reading. If the flexible cable **408** is sufficiently long the communication interface **406** may be mated with the first communication interface **112** of the endoscopic device **100**, however, in the presently described embodiment, the motorized endoscopic deployment device **400** is particularly suited for connection via the second communication interface **114**. In some embodiments, connection to the endoscopic deployment device **400** via one of the communication interfaces **112**, **114** allows for actuation of the endoscopic deployment device **400** via controls on the handle **102**.

(52) The motorized endoscopic deployment device **400** has a handle coupler **414** extending from a distal end **403** of the endoscopic deployment device **400** to a proximal end **405** of the endoscopic deployment device **400**. The handle coupler **414** is configured to receive a handle of the elongated end effector device, to be described below with respect to FIGS. **6-7**. The elongated end effector device comprises a pull wire and an outer sheath to be fed through the working channel of the endoscopic shaft **104** via the T-connector **110** of the endoscopic device **100** or other embodiments of the endoscopic device. The elongated end effector device includes a handle at the proximal end and an end effector at the distal end of the pull wire, the end effector being actuatable by a slide on the handle between an extended open position and a retracted closed position for, for example, grasping objects or extending/retracting a laser fiber or a therapy needle during the endoscopic procedure. In an alternate embodiment, the elongated end effector device and the motorized endoscopic deployment device **400** are fashioned in a single monolithic unit. The end effector is actuatable via linear motion of a carrier **416** coupled to the slide of the elongated end effector device handle, to be described in detail below. For example, when the elongated device handle is inserted into the handle coupler **414**, distal movement of the carrier **416** may cause the slide of the elongated end effector device to close the end effector, while proximal movement of the carrier **416** may cause the end effector to open. The motion of the carrier **416** is implemented via the motor **412** via an actuation linkage internal to the endoscopic deployment device **400**, to be described below.
(53) The carrier **416** of the endoscopic deployment device **400** is configured to slide within a carrier channel **424** of the endoscopic deployment device **400**. The carrier channel **424** prevents any movement other than the proximal and/or distal sliding. The carrier **416** has a slot **422** where a pin **420** is configured to slide, the pin **420** being connected to the motor **412** via an arm **418**. When the motor **412** is actuated the arm **418** is caused to rotate about a predefined arc **426**. The linkage of the pin **420** with the slot **422** translates the angular motion of the arm **418** into linear motion of the carrier **416**. The slot **422** allows the pin **420** to translate slightly in a direction orthogonal to the proximal/distal direction while driving the carrier **416** in the proximal/distal direction. When the carrier **416** is brought to its most distal position the end effector is fully closed (e.g., the retracted closed position), and when the carrier **416** is brought to its most proximal position the end effector is fully open (e.g., the extended open position), with varying degrees of openness/closedness between its most distal and most proximal positions.
(54) The endoscopic deployment device **400** has one or more actuation buttons **430** for controlling movement of the carrier **416** via the control board **410** and the motor **412**. The control board **410** may direct the motor **412** to rotate and/or to change its angular position based on signals from the one or more actuation buttons **430**. The endoscopic deployment device **400** preferably has at least two actuation buttons **430**. For example, a first button may be depressed to advance the carrier in the distal direction and stop when the button is released. A second button may be depressed to advance the carrier in the proximal direction and stop when the button is released. A double tap of either button (e.g., the first button or the second button) may bring the carrier to its most distal or most proximal position, respectively. Other button depression configurations may, for example, increase or decrease a speed of the carrier motion. In some embodiments, the endoscopic deployment device **400** may include at least one vibration motor **431** configured to generate vibrations as an angular position of the motor **412** changes to provide haptic feedback to the user. When using a powered accessory and/or device, tactile feedback normally associated with manual operations may not be available or felt by the user. Haptic feedback provided in accordance with the disclosure addresses the loss of tactile feedback associated with using powered accessories and/or devices, thereby restoring feedback to the user. The at least one vibration motor **431** may be positioned in proximity to (e.g., attached to, disposed under, etc.) the one or more actuation buttons **430** such that the user can feel the vibrations generated by the vibration motor **431** with the user's finger contacting the associated actuation button **430**. In at least one embodiment, each of the one or more actuation buttons **430** may have one corresponding and/or adjacent vibration motor **431**. In

other embodiments, the vibration motor(s) **431** may be positioned at a different location of the endoscopic deployment device **400**, if desired. In some instances, the user can detect an audible change in tone/sound resonating from the vibration motor(s) **431** to provide feedback. In some embodiments, the endoscopic deployment device **400** may include a vibration motor control board **411** configured to control the at least one vibration motor **431** in response to signals from the one or more actuation buttons **430** and/or the position of the carrier **416**. In some embodiments, the control board **410** may also control the at least one vibration motor **431**.

(55) In some embodiments, an intensity of the vibrations corresponds to the angular position of the motor **412** and/or the linear position of the carrier **416**. Thus, the intensity of the vibrations may correspond with the degree that the end effector is open or closed. In some embodiments, the intensity of the vibrations is non-linear relative to the angular position of the motor **412**, as illustrated in FIG. **15** for example. In some embodiments, the intensity of the vibrations is linear relative to the angular position of the motor **412**, as illustrated in FIG. **16** for example. Thus, in some embodiments, the intensity of the vibrations changes (e.g., increases or decreases) as the end effector is opened to a greater extent and/or the intensity of the vibrations changes (e.g., decreases or increases) as the end effector is closed to a greater extent. Thus, the intensity of the vibrations may provide the user with hepatic feedback regarding the current state of the end effector or other device coupled to the carrier **416**.

(56) Placement of the one or more actuation buttons **430** adjacent to the grip area **118** and/or deflection knob **116** of the endoscopic device **100** (e.g., when the endoscopic deployment device **400** is attached, coupled, and/or mounted to the handle **102** of the endoscopic device **100**) provides ergonomic benefits to the user of the devices. For example, a typical user may have difficulty operating an endoscopic deployment device and a distal tip deflection mechanism simultaneously, especially when the thumb is extended on the deflection knob **116** at full deflection, and especially if the user has a small hand. The spatial configuration of the endoscopic device **100** and the endoscopic deployment device **400** allow for ease of use due to the proximity of the one or more actuation buttons **430**, the deflection knob **116**, and/or the grip area **118**.

(57) In an alternate embodiment, voice commands may be implemented for controlling the end effector, such as, but not limited to, “open,” “close,” “stop,” “faster,” “slower,” “load,” etc.

(58) In an alternate embodiment, as shown in FIGS. **5**A-**5**B, an endoscopic deployment device **500** extends from a distal end **503** to a proximal end **505** and may drive a carrier **516** using a lead screw in lieu of the linkage described with respect to the endoscopic deployment device **400**. Similar to the endoscopic deployment device **400**, the endoscopic deployment device **500** has mount pins **502**, **504** for attaching the endoscopic deployment device **500** to the endoscopic device **100**. Additionally, a communication interface **506**, a flexible cable **508**, a driver and control board **510**, a handle coupler **514**, the carrier **516** and a carrier channel **528** are substantially similar to those described with respect to the endoscopic deployment device **400**. However, the endoscopic deployment device **500** has two location options for a motor **512**, both of which are coupled to lead screws, i.e. screws used as a linkage to translate rotational motion into linear motion.

(59) In some embodiments, the motor **512** is disposed at a location adjacent to and oriented parallel to the carrier channel **528** housing the carrier **516**. When the motor **512** is actuated, a lead screw **518** extending from the motor is rotated. The lead screw **518** is coupled to a threaded through-hole **520** extending through a portion of the carrier **516**. Thus, as the lead screw **518** is rotated, the carrier **516** is driven in a proximal/distal direction. In some embodiments, a second motor **522** is disposed at a location proximal to the carrier channel **528** housing the carrier **516**. A lead screw **524** extends from the second motor **522** and is coupled to a threaded through-hole **526** extending through a proximal portion of the carrier **516**. The second motor **522** drives the carrier **516** in a substantially similar manner as the motor **512**.

(60) In another alternate embodiment, the endoscopic deployment devices **400**, **500** may implement a rack and pinion mechanism to drive the linear motion of the carrier **416**, **516**. A pinion gear may

be attached to the drive shaft of the motor **412**, **512**, **522** and the rack may be attached to and/or may be an integral portion of the carrier **416**, **516**.

(61) The endoscopic deployment device **500** may include one or more actuation buttons **530**, similar to the one or more actuation buttons **430** of the endoscopic deployment device **400**, for controlling movement of the carrier **516** via the control board **510** and the motor **512**, **522**. The control board **510** may direct the motor **512**, **522** to rotate and/or to change its angular position based on signals from the one or more actuation buttons **530**. The endoscopic deployment device **500** preferably has at least two actuation buttons **530**. For example, a first button may be depressed to advance the carrier in the distal direction and stop when the button is released. A second button may be depressed to advance the carrier in the proximal direction and stop when the button is released. A double tap of either button (e.g., the first button or the second button) may bring the carrier to its most distal or most proximal position, respectively. Other button depression configurations may, for example, increase or decrease a speed of the carrier motion. In some embodiments, the endoscopic deployment device **500** may include at least one vibration motor **531** configured to generate vibrations as an angular position of the motor **512**, **522** changes to provide haptic feedback to the user. When using a powered accessory and/or device, tactile feedback normally associated with manual operations may not be available or felt by the user. Haptic feedback provided in accordance with the disclosure addresses the loss of tactile feedback associated with using powered accessories and/or devices, thereby restoring feedback to the user. The at least one vibration motor **531** may be positioned in proximity to (e.g., attached to, disposed under, etc.) the one or more actuation buttons **530** such that the user can feel the vibrations generated by the vibration motor **531** with the user's finger contacting the associated actuation button **530**. In at least one embodiment, each of the one or more actuation buttons **530** may have one corresponding and/or adjacent vibration motor **531**. In other embodiments, the vibration motor(s) **531** may be positioned at a different location of the endoscopic deployment device **500**, if desired. In some instances, the user can detect an audible change in tone/sound resonating from the vibration motor(s) **531** to provide feedback. In some embodiments, the endoscopic deployment device **500** may include a vibration motor control board **511** configured to control the at least one vibration motor **531** in response to signals from the one or more actuation buttons **530** and/or the position of the carrier **516**. In some embodiments, the control board **510** may also control the at least one vibration motor **531**.

(62) In some embodiments, an intensity of the vibrations corresponds to the angular position of the motor **512**, **522** and/or the linear position of the carrier **516**. Thus, the intensity of the vibrations may correspond with the degree that the end effector is open or closed. In some embodiments, the intensity of the vibrations is non-linear relative to the angular position of the motor **512**, **522**, as illustrated in FIG. **15** for example. In some embodiments, the intensity of the vibrations is linear relative to the angular position of the motor **512**, **522**, as illustrated in FIG. **16** for example.

(63) Placement of the one or more actuation buttons **530** adjacent to the grip area **118** and/or deflection knob **116** of the endoscopic device **100** (e.g., when the endoscopic deployment device **500** is attached, coupled, and/or mounted to the handle **102** of the endoscopic device **100**) provides ergonomic benefits to the user of the devices. For example, a typical user may have difficulty operating an endoscopic deployment device and a distal tip deflection mechanism simultaneously, especially when the thumb is extended on the deflection knob **116** at full deflection, and especially if the user has a small hand. The spatial configuration of the endoscopic device **100** and the endoscopic deployment device **500** allow for ease of use due to the proximity of the one or more actuation buttons **530**, the deflection knob **116**, and/or the grip area **118**.

(64) FIG. **6** shows an exemplary handle **600** that may be fitted to any of the aforementioned elongated end effector devices. In some embodiments, the handle **600** may be either of a Segura™ or a Dakota™ handle, depending on the elongated end effector device to which it is fitted, or may be a similar device for actuating an end effector device. Other configurations are also

contemplated.

(65) The handle **600** has a body **602** over which a slide **604** may slide. A male luer **610** is attached to a distal end of the slide **604**, while a shaft, i.e. pull wire of the elongated end effector device is held by a jaw vise including a plurality of jaws **606** at a proximal end **605** of the body **602**. A cap **608** forces the plurality of jaws **606** closed around the shaft of the end effector device as the cap **608** is screwed onto the body **602**. The body **602** has a through-lumen (not pictured) for the shaft of the elongated end effector device. Thus, it may be seen that the slide **604** may move relative to the body **602** and the shaft of the elongated end effector device. An outer sheath of the end effector device is connected vis a female luer to the male luer **610** and extends to cover the end effector at the distal end of the end effector device. When the slide **604** is moved distally it in turn moves the outer sheath distally over the end effector to close the end effector, and when the slide **604** is moved proximally it in turn moves the outer sheath proximally to uncover the distal end of the end effector, causing the self-opening, memory set end effector to open. A stroke-limiter in the handle **600** may govern the travel of the slide **604** relative to the end effector size.

(66) As discussed previously, the carriers **416**, **516** of the endoscopic deployment devices **400**, **500** are, in these embodiments, sized and shaped for compatibility with the slide **604** of the handle **600**. Thus, when the endoscopic deployment device **400**, **500** is actuated to move the carrier **416**, **516** in a proximal or distal direction, the slide **604** is correspondingly moved with respect to the body **602** and the end effector of the end effector device is moved towards the extended open position or moved towards the retracted closed position.

(67) FIGS. **7**A-F show examples of elongated end effector devices compatible with the handle **600**, including a stone/particle retrieval basket. FIGS. **7**A-**7**F show: a retrieval basket or device **702** for capturing objects at a distal end of the endoscopic shaft, a laser fiber device **704** for fragmenting and/or cauterizing objects at the distal end of the endoscopic shaft, a therapy needle **706** for puncturing and/or supplying medicament to a treatment site, a snare **708** for capturing objects at the distal end of the endoscopic shaft, a forceps **710** for capturing and/or grasping objects at the distal end of the endoscopic shaft, and a band ligation device **712**, respectively. Each of the elongated end effector devices may be fitted with the handle **600** and may be operated by the endoscopic deployment device **400** and/or the endoscopic deployment device **500**.

(68) The motors **412**, **512**, **522** described with respect to the endoscopic deployment devices **400** and **500** may be, e.g., a DC motor, a servo motor, a stepper motor, or the like. The preferred embodiment for the motor **412**, **512**, **522** is the stepper motor. A stepper motor is a brushless electromechanical device that converts the train of electric pulses applied at their excitation windings into precisely defined step-by-step mechanical shaft rotation. The shaft of the motor rotates through a fixed angle for each discrete pulse, which may be translated to linear motion in any of the aforementioned ways. Each pulse provides one step of motion, i.e., the angle through which the stepper motor shaft turns for each pulse is referred to as the step angle, generally expressed in degrees. The position of the motor shaft is controlled by controlling the number of pulses. This feature makes the stepper motor to be well suited for an open-loop control system wherein the precise position of the shaft is maintained with an exact number of pulses without using a feedback sensor. If the step angle is smaller, the greater will be the number of steps per revolution and the higher will be the accuracy of the position obtained. The step angles can be as large as 90 degrees and as small as 0.72 degrees, however, the commonly used step angles are 1.8 degrees, 2.5 degrees, 7.5 degrees and 15 degrees. The direction of the shaft rotation depends on the sequence of pulses applied to the stator. The speed of the shaft or the average motor speed is directly proportional to the frequency (the rate of input pulses) of input pulses being applied at excitation windings. Therefore, if the frequency is low, the stepper motor rotates in steps and for high frequency, it continuously rotates like a DC motor due to inertia. Stepper motors continue to generate holding torque even at standstill. This means that the motor can be held at a stopped position without using a mechanical brake. The built-in pulse generation function (controller)

allows the stepper motor to be driven via a directly connected personal computer, programmable controller or console. The stepper motor may achieve precise positioning via digital control, such control to be explained in further detail below.

(69) FIG. **8** shows an example stepper motor control board **800**. The stepper motor control board **800** comprises a USB port **804** for connecting a USB cable and motor terminals **802** for connecting a stepper motor. The stepper motor control board **800** may be used in either of the endoscopic deployment devices **400**, **500** as the control board **410** for the motor **412** or the control board **510** for the motor **512**, **522**, when those motors are stepper motors. However, if a stepper motor is not used, the corresponding control board is configured to drive whichever motor type is used. For example, if the motor **412** is a servo motor, the control board **410** is a servo motor control board. The motor control board may be custom built. The motor may be powered via the USB port **804**, however, in another embodiment, the motor may be powered by batteries. Other configurations are also contemplated.

(70) Different elongated end effector devices may be implemented in the endoscopic deployment device **400** or **500**, each one having a distinct data set for controlling the end effector. For example, each end effector device may have different stop limits or stroke lengths for the carrier **416**, **516**. However, through the “plug-and-play” functionality of the endoscopic device **100**, the data sets may be automatically loaded to the controller. Alternately, a type of elongated end effector device may be selected through a drop-down menu on the console. To assemble the handle **600** to the endoscopic deployment device **400**, **500**, the carrier **416**, **516** is moved to its most proximal position, (e.g., by depressing one of the one or more actuation buttons **430**, **530**, by depressing the actuation button **1203** of FIG. **12**, by depressing the second actuation button **1212** of FIG. **12**A, etc.), and the slide of the handle **600** is also moved to the most proximal position. This would match the contours of the slide and carrier such that the handle **600** is aligned and can be snapped into the endoscopic deployment device **400**, **500**. Actuation button **1204** of FIG. **12** or the first actuation button **1210** of FIG. **12**A, for example, is depressed to close or retract the end effector before the end effector is inserted into the working channel of the endoscopic device **100**. To remove the elongated end effector device, the end effector is closed by depressing e.g. the actuation button **1204** or the first actuation button **1210**. The end effector shaft of the elongated end effector device is withdrawn and the handle **600** can be unclipped from the endoscopic deployment device **400**, **500** and put aside for later use. Another elongated end effector device can be quickly exchanged for the previous elongated end effector device to perform its function.

(71) In an alternate embodiment, the endoscopic device **100** and the endoscopic deployment device **400**, **500** may be implemented in a single monolithic unit. In such an embodiment, instead of using mount holes and mount pins to connect the respective devices, the endoscopic deployment device is built into the handle **102** of the endoscopic device **100** and all associated wiring is within the endoscopic device **100**.

(72) In at least some embodiments, deflection of the distal tip **106** of the endoscopic device **100** may be motorized/wired using the same control board, such as the control board **800**, as the endoscopic deployment device **400**, **500**. In such an embodiment, a second driver and a second motor would be implemented in the handle **102** for controlling deflection of the distal tip **106**.

(73) FIG. **9** shows a handle **900** of the endoscopic device **100** with a motor **902** for controlling deflection of the distal tip **106**. The endoscopic device **100** in this embodiment may have two pull wires (not shown) for deflecting the distal tip **106** in either of two opposing directions (e.g., up and down, left and right, etc.). A pull wire wheel **904** has a first pull wire attachment **906** and a second pull wire attachment **908**. The motor **902** is mounted in the handle **900** with its drive shaft mounted in the center of the pull wire wheel **904**. In at least some embodiments, the motor **902** may be a stepper motor. A lever **910** may be coupled to the handle **900**, and may be keyed to the rotation of the pull wire wheel **904** via a controller/driver and wiring (not shown). The lever **910** may be and/or correspond to the deflection knob **116** of the endoscopic device **100**. Thus, the lever **910**

may operate as a switch and rotate independently from the pull wire wheel **904**. When pressure is applied on the lever **910** in a first direction, the motor **902** will rotate the pull wire wheel **904** such that one of the two pull wires, e.g. the pull wire attached to the first pull wire attachment **906**, pulls the distal tip **106** of the endoscopic device **100** in one of the two directions. Similarly, when pressure is applied on the lever **910** in the second direction, the motor **902** will rotate the pull wire wheel **904** such that the second of the two pull wires, e.g., the pull wire attached to the second pull wire attachment **908**, pulls the distal tip **106** of the endoscopic device **100** in the second of the two directions. Release of the lever **910** may stop the motor **902**, allowing the then-current position of the distal tip **106** to be maintained. The maximum angular travel of the motor **902** will be set to the limitations of the distal tip deflection. In some embodiments, the distal tip **106** may be deflectable 270 degrees in either (or both) of the two opposing directions. In some embodiments, a first vibration motor **911** may be disposed within the handle **900** proximate the lever **910** such that the user can feel the vibrations generated by the vibration motor **911** with the user's finger contacting the associated lever **910**. For example, the first vibration motor **911** may be coupled to the lever **910**, may be disposed under the lever **910**, may be disposed within the lever **910**, etc. The first vibration motor **911** may be configured to generate vibrations within the lever **910** as an angular position of the motor **902** within the handle **900** changes. In other embodiments, the vibration motor **911** may be positioned at a different location of the endoscopic deployment device **900**, if desired. In some instances, the user can detect an audible change in tone/sound resonating from the vibration motor **911** to provide feedback.

(74) In some embodiments, an intensity of the vibrations corresponds to the angular position of the motor **902**. Thus, the intensity of the vibrations may correspond with the degree of angulation of the distal tip **106** away from a central longitudinal axis of the endoscopic shaft **104**. In some embodiments, the intensity of the vibrations is non-linear relative to the angular position of the motor **902**, as illustrated in FIG. **15** for example. In some embodiments, the intensity of the vibrations is linear relative to the angular position of the motor **902**, as illustrated in FIG. **16** for example. For example, the intensity of the vibrations within the lever **910** may change (e.g., increase or decrease) as deflection of the distal tip **106** away from a central longitudinal axis of the endoscopic shaft **104** changes (e.g., increases or decreases). For instance the intensity of the vibrations may increase as the degree of angulation of the distal tip **106** increases. Thus, the intensity of the vibrations may provide the user with hepatic feedback regarding the degree of angulation of the distal tip **106**.

(75) In some embodiments, a gear train may be used in the handle **900** between the motor **902** and the pull wire wheel **904**, instead of the motor **902** driving the pull wire wheel **904** directly. FIGS. **10**A-C show a simple two-gear train **1000** where a smaller gear **1002** drives a larger gear **1004** that rotates the pull wire wheel **904**. The larger gear **1004** and the pull wire wheel **904** may be fashioned as a single part where the gear teeth extend from the circumference/perimeter of the pull wire wheel **904**, as shown in FIG. **10**D. FIG. **11** shows a two-gear train **1100** with a smaller gear **1102** and a larger gear **1104** comprising a pulley belt **1106**. The mechanical advantage of the aforementioned embodiments is to use a less powerful and/or less expensive motor **902**. In some embodiments of the endoscopic device **100** and/or the handle **900**, driving the pull wire wheel **904** directly will require a higher torque specification for the motor **902** than would be needed using the gear train **1000**, **1100** shown in FIGS. **10-11**.

(76) The aforementioned aspects of the present disclosure may be combined in various ways. In some embodiments, both the distal tip **106** of the endoscopic device **100** and the endoscopic deployment device **400**, **500** are motorized.

(77) In some embodiments, the one or more actuation buttons described herein may be a button pad **1200** physically separate from the body of the endoscopic deployment device **400**, **500** and in operable communication with the motor **412**, **512**, **522**. FIG. **12** illustrates an ergonomic button pad **1200** for controlling the distal tip **106** of the endoscopic device **100** and the endoscopic deployment

device **400**, **500**. The button pad **1200** has a first actuation button **1201**, a second actuation button **1202**, a third actuation button **1203** and a fourth actuation button **1204**. The button pad **1200** is also adjacent to a shortened deflection knob **1205**, which may be and/or may function as the deflection knob **116** and/or the lever **910**. The deflection knob **1205** is shortened to allow the placement of the button pad **1200** adjacent to the deflection knob **1205**. In other embodiments, the deflection knob **1205** may be eliminated completely, with deflection of the distal tip **106** of the endoscopic device **100** being controlled by the button pad **1200**. In another embodiment, the shortened deflection knob **1205** may be used as a safety/bailout feature in case of e.g. power failure, considering the deflected distal tip **106** has to be straightened before it can be removed from the body without injuries.

(78) The button pad **1200** is connected to a controller programmed for all aspects of the intervention. The button pad **1200** is located on and/or adjacent to the bottom side of the handle **102** and may be operated, for example, by the thumb of the scope handle grip hand. For example, the first actuation button **1201** and the second actuation button **1202** (opposite one another; e.g., distal button and proximal button, respectively, in FIG. **12**) may be used to deflect the distal tip **106** in either of the two opposing directions. For example, the first actuation button **1201** may be configured to deflect the distal tip **106** downward relative to the central longitudinal axis of the endoscopic shaft **104**, and the second actuation button **1202** may be configured to deflect the distal tip **106** upward relative to the central longitudinal axis of the endoscopic shaft **104**. Other configurations are also contemplated, including the first and second actuation buttons **1201**, **1202** being configured to operate the distal tip **106** in directions opposite those described above. In some embodiments, the third actuation button **1203** and the fourth actuation button **1204** (opposite one another; e.g., upper button and lower button, respectively, in FIG. **12**) may be used to move the carrier **416**, **516** proximally and distally, respectively, to thereby control opening and closing, respectively, of the elongated end effector device. In some embodiments, a fifth actuation button may be implemented, such that when the fifth button is “on,” the third actuation button **1203** and the fourth actuation button **1204** are used to turn on and off a fluid management system to flush the imaged cavity. Alternatively, the fifth actuation button alone may actuate and/or engage and disengage the fluid management system. In some embodiments, the button pad **1200** may be programmed such that the microprocessor is executing the direction of movement of the motor **412**, **512**, **522** and/or the motor **902** via a program, when a conditional statement in the program is true.

(79) In at least some embodiments, the button pad **1200** may include a first vibration motor **1201**A associated with the first actuation button **1201**, a second vibration motor **1202**A associated with the second actuation button **1202**, a third vibration motor **1203**A associated with the third actuation button **1203**, and a fourth vibration motor **1204**A associated with the fourth actuation button **1204**. More or fewer vibration motors may also be used in some configuration. For example, only one vibration motor may be used with each related pair of actuation buttons (e.g., buttons **1201**/**1202**, buttons **1203**/**1204**). Similarly, at least one vibration motor **1205**A may be associated with the deflection knob **1205** as described herein with respect to the deflection knob **116** and/or the lever **910**.

(80) In another embodiment, the handle **102** of the endoscopic device **100** and the body of the endoscopic deployment device **400**, **500** may be arranged and/or constructed such that all controls are disposed in and/or on the handle **102**. For example, the endoscopic deployment device **400** may be mounted on the handle **102** of the endoscopic device **100**. In another example, the endoscopic deployment device **400** may be monolithically formed with the handle **102**. In one example shown in FIG. **12**A, rotation of the drive shaft slides the carrier in the carrier channel and actuates the end effector of the elongated end effector device in response to a signal from one or more actuation buttons on the handle **102**. The description relative to the endoscopic deployment device **400** may be equally applied with respect to the endoscopic deployment device **500**. Similar to other embodiments described herein, the handle **102** of the endoscopic device **100** may include a

deflection knob **1205** (e.g., deflection knob **116** and/or lever **910**). A first vibration motor **1205**A may be configured to generate vibrations within the deflection knob **1205** (and/or the deflection knob **116**, and/or the lever **910**, where so equipped) as an angular position of the motor (not shown) within the handle **102** changes such that the user can feel the vibrations generated by the vibration motor **1205**A with the user's finger contacting the associated deflection know **1205** (and/or the deflection knob **116** and/or the lever **910**, where so equipped). In other embodiments, the vibration motor **1205**A may be positioned at a different location of the endoscopic **100**, if desired. In some instances, the user can detect an audible change in tone/sound resonating from the vibration motor **1205**A to provide feedback. Similar to above and/or other embodiments herein, an intensity of the vibrations within the deflection knob **1205** (and/or the deflection knob **116**, and/or the lever **910**, where so equipped) increases as deflection of the distal tip **106** away from the central longitudinal axis of the endoscopic shaft **104** increases and/or approaches its deflection limit (e.g., its most deflected position). Thus, the intensity of the vibrations may correspond with the degree of angulation of the distal tip **106** away from a central longitudinal axis of the endoscopic shaft **104**.

(81) In the example shown in FIG. **12**A, the handle **102** may further include at least one vibration motor configured to generate vibrations within the one or more actuation buttons as an angular position of the motor **412** (not visible) within the body of the endoscopic deployment device **400** changes. In some embodiments, the at least one vibration motor may include a second vibration motor **1210**A associated with (e.g., coupled to, disposed under, etc.) a first actuation button **1210** of the one or more actuation buttons and a third vibration motor **1212**A associated with (e.g., coupled to, disposed under, etc.) a second actuation button **1212** of the one or more actuation buttons. In some embodiments, the second vibration motor **1210**A may be configured to generate vibrations within the first actuation button **1210** when the end effector is actuated toward the retracted closed position (e.g., when the carrier is translated distally). In some embodiments, the third vibration motor **1212**A may be configured to generate vibrations within the second actuation button **1212** when the end effector is actuated toward the extended open position (e.g., when the carrier is translated proximally). In some embodiments, an intensity of the vibrations within the first actuation button **1210** increases as the end effector approaches the retracted closed position (and/or as the carrier approaches its most distal position). In some embodiments, an intensity of the vibrations within the second actuation button **1212** increases as the end effector approaches the extended open position (and/or as the carrier approaches its most proximal position.

(82) In another embodiment, the button pad **1200** and/or the actuation buttons **1210**, **1212** are implemented on a console, tablet (e.g., iPad) or the like and controlled remotely. Thus, the endoscopic device may be fashioned without control features implemented directly thereon, and may instead be controlled via Bluetooth, infrared remote, etc.

(83) FIG. **13** illustrates an example vibration motor **1300** that may be used with the current disclosure. The vibration motor **1300** may include a housing **1302** and connection wires **1304**, **1306**. In at least some embodiments, the vibration motor **1300** may be shaftless. In some embodiments, the vibration motor may include a flat coreless coil and/or a commutator disposed within the housing **1302**. All moving parts may be contained within the housing **1302**. In one example, the vibration motor **1300** may operate between 2 volts and 3.6 volts and may operate at about 13,000+/−3000 rpm. Other configurations and/or arrangements are also contemplated. None, any, and/or all of the vibration motors described herein may be the vibration motor **1300**.

(84) FIG. **14** illustrates an example vibration motor control board **1400** for use with the vibration motor **1300**. In some embodiments, the vibration motor control board **1400** may be a haptic motor driver configured to control the vibration motor **1300**. In the illustrated example, the vibration motor control board **1400** includes six pins to provide power and communication to the vibration motor control board **1400**. The vibration motor control board **1400** may include built-in firmware for driving the vibration motor **1300**. In one example, the vibration motor control board **1400** may operate between 2 volts and 5.2 volts. Other configurations are also contemplated. In some

embodiments, none, any, and/or all of the vibration motor control boards **411**, **511** may be the vibration motor control board **1400**. Additionally, in some embodiments, control of the vibration motor **1300** may be built into the motor control boards **410**, **510** and thus a dedicated vibration motor control board **1400** is not needed.

(85) FIG. **15** illustrates a graph showing vibration intensity of the vibrations produced by the vibration motor **1300** (and/or any of the vibration motors described herein) relative to degrees of rotation of the associated motor (e.g., any one or more of the motors **412**, **512**, **522**, **902**). As shown, in some embodiments, the intensity of the vibrations is non-linear relative to the angular position of the motor. For example, a map of the intensity of the vibrations may lie along a parabolic curve and/or may be exponential in nature. In FIG. **15**, a horizontal axis **1504** shows degrees of rotation (e.g., angular position) of the motor relative to a central starting position (e.g., 0 degrees). In accordance with selected embodiments described herein, the motor may be actuatable and/or movable between −270 degrees and +270 degrees relative to the central starting position. In FIG. **15**, a vertical axis **1502** shows relative intensity of the vibrations as a percentage of the intensity the vibration motor **1300** is capable of producing. The intensity of the vibrations may increase as the angular position of the motor away from a neutral position (e.g., 0 degrees) increases. The values illustrated are merely exemplary, and other configurations are also contemplated. As shown, as the angular position of the motor moves further away from the central starting position (in either direction), the intensity of the vibrations increases.

(86) FIG. **16** illustrates a graph showing vibration intensity of the vibrations produced by the vibration motor **1300** (and/or any of the vibration motors described herein) relative to degrees of rotation of the associated motor (e.g., any one or more of the motors **412**, **512**, **522**, **902**). As shown, in some embodiments, the intensity of the vibrations is linear relative to the angular position of the motor. For example, a map of the intensity of the vibrations may lie along a straight line angled up from a horizontal axis and away (left and right) from a vertical axis. In FIG. **16**, the horizontal axis **1604** shows degrees of rotation (e.g., angular position) of the motor relative to a central starting position (e.g., 0 degrees). In accordance with selected embodiments described herein, the motor may be actuatable and/or movable between −270 degrees and +270 degrees relative to the central starting position. In FIG. **16**, a vertical axis **1602** shows relative intensity of the vibrations as a percentage of the intensity the vibration motor **1300** is capable of producing. The intensity of the vibrations may increase as the angular position of the motor away from a neutral position (e.g., 0 degrees) increases. The values illustrated are merely exemplary, and other configurations are also contemplated. As shown, as the angular position of the motor moves further away from the central starting position (in either direction), the intensity of the vibrations increases.

(87) In some embodiments, the present disclosure relates to an endoscopic deployment device which includes a body mountable on an endoscopic device, the body having a movable carrier couplable to an elongated end effector device, the elongated end effector device having an end effector shaft covered by an outer sheath and an end effector extending from a distal end of the end effector shaft, the outer sheath being sized and shaped for insertion through a working channel of an endoscopic shaft of the endoscopic device, the body having a carrier channel sized for the carrier to slide therein, wherein the end effecter is actuatable between an extended open position and a retracted closed position by sliding the carrier in the carrier channel which in turn slides the outer sheath over the end effector shaft to uncover or cover the end effector; a communication interface extending from the body and configured to be mated with a corresponding communication interface on the endoscopic device on which the body is mounted to receive power therefrom and exchange data therewith; and a motor having a drive shaft coupled to the carrier, rotation of the drive shaft sliding the carrier in the carrier channel and actuating the end effector in response to a signal.

(88) In an embodiment, the signal is generated based on actuation of an actuator on the endoscopic device.

(89) In an embodiment, the actuator is a button pad controlling the motor via the mated communication interfaces of the endoscopic deployment device and the endoscopic device.
(90) In an embodiment, the signal is generated in response to an endoscopic sensor reading.
(91) In an embodiment, the motor is a stepper motor.
(92) In an embodiment, the drive shaft has an arm extending orthogonally therefrom coupled to a slot in the carrier and the arm has a pin at an end of the arm opposite the drive shaft, the pin being coupled to the slot so that, when the drive shaft rotates, the pin slides in the slot in a direction orthogonal to the carrier channel and the carrier slides in the carrier channel.
(93) In an embodiment, the drive shaft is a lead screw coupled to a threaded through-hole extending through a portion of the carrier parallel to the carrier channel so that, when the drive shaft rotates, the carrier slides in the carrier channel.
(94) In an embodiment, a pinion gear is coupled to the drive shaft and to a rack that is an integral portion of the carrier so that, when the drive shaft rotates, the pinion gear drives the rack and the carrier slides in the carrier channel.
(95) In an embodiment, the end effector device is a retrieval device for capturing objects at a distal end of the endoscopic shaft.
(96) In an embodiment, the end effector device is a laser fiber or energy fiber for fragmenting or cauterizing objects at a distal end of the endoscopic shaft.
(97) In an embodiment, the end effector device has a handle for coupling to the carrier of the endoscopic deployment device, wherein the carrier and a slide of the handle are positioned fully proximally prior to attaching the handle to the endoscopic deployment device.
(98) In an embodiment, the endoscopic device has a proximal communication interface and a distal communication interface and the communication interface of the endoscopic deployment device is compatible with the proximal communication interface of the endoscopic device.
(99) In addition, in some embodiments, the present disclosure relates to an endoscopic device which includes an elongated flexible endoscopic shaft including a working channel and a deflectable distal tip, the flexible endoscopic shaft being sized and shaped for insertion to a target site within a living body, the distal tip including a camera; a handle from which the endoscopic shaft extends distally, the handle including a pull wire wheel comprising pull wire attachments from which first and second pull wires extend distally through the endoscopic shaft to the distal tip, rotation of the pull wire wheel deflecting the distal tip by tensioning a first one of the first and second pull wires and slacking a second one of the first and second pull wires, the handle including an actuator, a proximal end of the handle including a communication interface for connecting an accessory device; and a motor including a rotatable drive shaft coupled to and configured to rotate the pull wire wheel in response to a signal.
(100) In an embodiment, the deflection knob operates as a switch so that deflecting the deflection knob in a first direction rotates the pull wire wheel a predefined angular extent to apply tension to the first one of the first and second pull wires and deflecting the deflection knob in a second direction rotates the pull wire wheel a predefined angular extent to apply tension to the second one of the first and second pull wires.
(101) In an embodiment, the signal is generated by a button pad on an exterior of the handle.
(102) Furthermore, in some embodiments, the present invention relates to a method which includes attaching an endoscopic deployment device to an endoscopic device, the endoscopic deployment device comprising a body mountable on the endoscopic device, the body having a movable carrier couplable to an elongated end effector device, the elongated end effector device having an end effector shaft covered by an outer sheath and an end effector extending from a distal end of the end effector shaft, the outer sheath being sized and shaped for insertion through a working channel of an endoscopic shaft of the endoscopic device, the body having a carrier channel sized for the carrier to slide therein, wherein the end effecter is actuatable between an extended open position and a retracted closed position by sliding the carrier in the carrier channel which in turn slides the

outer sheath over the end effector shaft to uncover or cover the end effector, the endoscopic deployment device further comprising a communication interface extending from the body and configured to be mated with a corresponding communication interface on the endoscopic device on which the body is mounted to receive power therefrom and exchange data therewith, the endoscopic deployment device further comprising a motor having a drive shaft coupled to the carrier; and actuating the motor in response to a signal, the actuation of the motor rotating the drive shaft and sliding the carrier in the carrier channel to actuate the end effector.
(103) In an embodiment, the actuator is a button pad on the endoscopic device, the button pad being operated with a thumb of a grip hand of a user.
(104) In an embodiment, the button pad further actuates a deflection of a distal end of the endoscopic shaft.
(105) In an embodiment, the motor is a stepper motor.
(106) In an embodiment, the end effector device is a retrieval device for capturing objects at a distal end of the endoscopic shaft.
(107) The materials that can be used for the various components of the endoscopic device, the endoscopic deployment device, the end effector device, and the various elements thereof disclosed herein may include those commonly associated with medical devices. For simplicity purposes, the following discussion makes reference to the endoscopic device and/or the endoscopic deployment device. However, this is not intended to limit the devices and methods described herein, as the discussion may be applied to other elements, members, components, or devices disclosed herein, such as, but not limited to, the expandable framework, the endoscopic shaft, the distal tip, the handle, the body, the carrier, motor, the drive shaft, the vibration motor(s), the actuation button(s), the button pad, the end effector shaft, the end effector, the outer sheath, etc. and/or elements or components thereof.
(108) In some embodiments, the endoscopic device and/or the endoscopic deployment device, and/or components thereof, may be made from a metal, metal alloy, polymer (some examples of which are disclosed below), a metal-polymer composite, ceramics, combinations thereof, and the like, or other suitable material.
(109) Some examples of suitable polymers may include polytetrafluoroethylene (PTFE), ethylene tetrafluoroethylene (ETFE), fluorinated ethylene propylene (FEP), polyoxymethylene (POM, for example, DELRIN® available from DuPont), polyether block ester, polyurethane (for example, Polyurethane 85A), polypropylene (PP), polyvinylchloride (PVC), polyether-ester (for example, ARNITEL® available from DSM Engineering Plastics), ether or ester based copolymers (for example, butylene/poly(alkylene ether) phthalate and/or other polyester elastomers such as HYTREL® available from DuPont), polyamide (for example, DURETHAN® available from Bayer or CRISTAMID® available from Elf Atochem), elastomeric polyamides, block polyamide/ethers, polyether block amide (PEBA, for example available under the trade name PEBAX®), ethylene vinyl acetate copolymers (EVA), silicones, polyethylene (PE), MARLEX® high-density polyethylene, MARLEX® low-density polyethylene, linear low density polyethylene (for example REXELL®), polyester, polybutylene terephthalate (PBT), polyethylene terephthalate (PET), polytrimethylene terephthalate, polyethylene naphthalate (PEN), polyetheretherketone (PEEK), polyimide (PI), polyetherimide (PEI), polyphenylene sulfide (PPS), polyphenylene oxide (PPO), poly paraphenylene terephthalamide (for example, KEVLAR®), polysulfone, nylon, nylon-12 (such as GRILAMID® available from EMS American Grilon), perfluoro(propyl vinyl ether) (PFA), ethylene vinyl alcohol, polyolefin, polystyrene, epoxy, polyvinylidene chloride (PVdC), poly(styrene-b-isobutylene-b-styrene) (for example, SIBS and/or SIBS 50A), polycarbonates, polyurethane silicone copolymers (for example, ElastEon® from Aortech Biomaterials or ChronoSil® from AdvanSource Biomaterials), biocompatible polymers, other suitable materials, or mixtures, combinations, copolymers thereof, polymer/metal composites, and the like. In some embodiments the sheath can be blended with a liquid crystal polymer (LCP). For example, the

mixture can contain up to about 6 percent LCP.
(110) Some examples of suitable metals and metal alloys include stainless steel, such as 304V, 304L, and 316LV stainless steel; mild steel; nickel-titanium alloy such as linear-elastic and/or super-elastic nitinol; other nickel alloys such as nickel-chromium-molybdenum alloys (e.g., UNS: N06625 such as INCONEL® 625, UNS: N06022 such as HASTELLOY® C-22®, UNS: N10276 such as HASTELLOY® C276®, other HASTELLOY® alloys, and the like), nickel-copper alloys (e.g., UNS: N04400 such as MONEL® 400, NICKELVAC® 400, NICORROS® 400, and the like), nickel-cobalt-chromium-molybdenum alloys (e.g., UNS: R30035 such as MP35-N® and the like), nickel-molybdenum alloys (e.g., UNS: N10665 such as HASTELLOY® ALLOY B2®), other nickel-chromium alloys, other nickel-molybdenum alloys, other nickel-cobalt alloys, other nickel-iron alloys, other nickel-copper alloys, other nickel-tungsten or tungsten alloys, and the like; cobalt-chromium alloys; cobalt-chromium-molybdenum alloys (e.g., UNS: R30003 such as ELGILOY®, PHYNOX®, and the like); platinum enriched stainless steel; titanium; platinum; palladium; gold; combinations thereof; or any other suitable material.
(111) In at least some embodiments, portions or all of the endoscopic device and/or the endoscopic deployment device, and/or components thereof, may also be doped with, made of, or otherwise include a radiopaque material. Radiopaque materials are understood to be materials capable of producing a relatively bright image on a fluoroscopy screen or another imaging technique during a medical procedure. This relatively bright image aids the user of the endoscopic device and/or the endoscopic deployment device in determining its location. Some examples of radiopaque materials can include, but are not limited to, gold, platinum, palladium, tantalum, tungsten alloy, polymer material loaded with a radiopaque filler, and the like. Additionally, other radiopaque marker bands and/or coils may also be incorporated into the design of the endoscopic device and/or the endoscopic deployment device to achieve the same result.
(112) In some embodiments, a degree of Magnetic Resonance Imaging (MRI) compatibility is imparted into the endoscopic device and/or the endoscopic deployment device and/or other elements disclosed herein. For example, the endoscopic device and/or the endoscopic deployment device, and/or components or portions thereof, may be made of a material that does not substantially distort the image and create substantial artifacts (i.e., gaps in the image). Certain ferromagnetic materials, for example, may not be suitable because they may create artifacts in an MRI image. The endoscopic device and/or the endoscopic deployment device, or portions thereof, may also be made from a material that the MRI machine can image. Some materials that exhibit these characteristics include, for example, tungsten, cobalt-chromium-molybdenum alloys (e.g., UNS: R30003 such as ELGILOY®, PHYNOX®, and the like), nickel-cobalt-chromium-molybdenum alloys (e.g., UNS: R30035 such as MP35-N® and the like), nitinol, and the like, and others.
(113) It should be understood that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of steps without exceeding the scope of the invention. This may include, to the extent that it is appropriate, the use of any of the features of one example embodiment being used in other embodiments. The invention's scope is, of course, defined in the language in which the appended claims are expressed.

Claims

1. An endoscopic deployment device, comprising: a body couplable to a handle of an endoscope, the body having a channel and a carrier translatable within the channel; wherein the body is configured to receive an end effector device handle of an end effector device having an end effector device shaft extending from the end effector device handle and configured for insertion through a working channel of the endoscope; wherein the carrier is configured to engage with the end effector device handle; a powered motor coupled to the body, wherein rotation of the powered

motor is configured to translate the carrier within the channel to actuate the end effector device; and at least one vibration motor coupled to the body, the at least one vibration motor being configured to generate vibrations as an angular position of the powered motor changes.
2. The endoscopic deployment device of claim 1, wherein the powered motor is configured to rotate in response to signals from one or more actuation buttons.
3. The endoscopic deployment device of claim 2, wherein the one or more actuation buttons is a button pad physically separate from the body and in operable communication with the powered motor.
4. The endoscopic deployment device of claim 1, wherein an intensity of the vibrations corresponds to the angular position of the powered motor.
5. The endoscopic deployment device of claim 4, wherein the intensity of the vibrations is linear relative to the angular position of the powered motor.
6. The endoscopic deployment device of claim 4, wherein the intensity of the vibrations is non-linear relative to the angular position of the powered motor.
7. The endoscopic deployment device of claim 1, wherein the powered motor is a stepper motor.
8. The endoscopic deployment device of claim 1, wherein rotation of the powered motor is configured to translate the carrier within the channel to actuate the end effector device.
9. The endoscopic deployment device of claim 8, wherein an arm extends from the powered motor to the carrier and the arm has a pin at an end of the arm opposite the powered motor, the pin being disposed in a slot formed in the carrier such that rotation of the powered motor slides the pin in the slot in a direction orthogonal to the channel as the carrier translates within the channel.
10. The endoscopic deployment device of claim 8, wherein a lead screw extending from the powered motor is engaged with a threaded through-hole extending through a portion of the carrier parallel to the channel configured such that rotation of the powered motor translates the carrier within the channel.
11. The endoscopic deployment device of claim 8, wherein a pinion gear coupled to the powered motor is engaged with a rack coupled to the carrier such that rotation of the powered motor rotates the pinion gear to drive the rack and translate the carrier within the channel.
12. The endoscopic deployment device of claim 1, wherein the end effector device is a retrieval device for capturing objects at a distal end of the endoscope.
13. The endoscopic deployment device of claim 1, wherein the end effector device is a laser fiber for fragmenting or cauterizing objects at a distal end of the endoscope.
14. An endoscopic system, comprising: an endoscope comprising an endoscope handle and a flexible endoscope shaft extending distally from the endoscope handle to a deflectable distal tip; wherein the endoscope handle includes a first motor disposed therein, the first motor being configured to deflect the deflectable distal tip in response to a signal from a lever coupled to the endoscope handle; and an endoscopic deployment device comprising a body mounted on the endoscope handle, the body having a channel and a carrier translatable within the channel; wherein the body is configured to receive an end effector device handle of an end effector device having an end effector device shaft extending from the end effector device handle and configured for insertion through a working channel of the endoscope; wherein the carrier is configured to engage with the end effector device handle; a powered motor coupled to the body, wherein the powered motor is configured to rotate in response to signals from one or more actuation buttons; wherein rotation of the powered motor is configured to translate the carrier within the channel to actuate the end effector device; and at least one vibration motor coupled to the body, the at least one vibration motor being configured to generate vibrations as an angular position of the powered motor changes.
15. The endoscopic system of claim 14, wherein the endoscope handle includes a first vibration motor configured to generate vibrations within the lever as an angular position of the first motor changes.

16. The endoscopic system of claim 15, wherein an intensity of the vibrations within the lever increases as deflection of the deflectable distal tip away from a central longitudinal axis of the flexible endoscope shaft increases.
17. The endoscopic system of claim 16, wherein the intensity of the vibrations within the lever is linear relative to the angular position of the first motor.
18. The endoscopic system of claim 14, wherein an intensity of the vibrations within the one or more actuation buttons corresponds to the angular position of the powered motor.
19. The endoscopic system of claim 18, wherein the at least one vibration motor includes a second vibration motor coupled to a first actuation button of the one or more actuation buttons and a third vibration motor coupled to a second actuation button of the one or more actuation buttons.
20. The endoscopic system of claim 19, wherein the first actuation button and the second actuation button are disposed on the endoscope handle.