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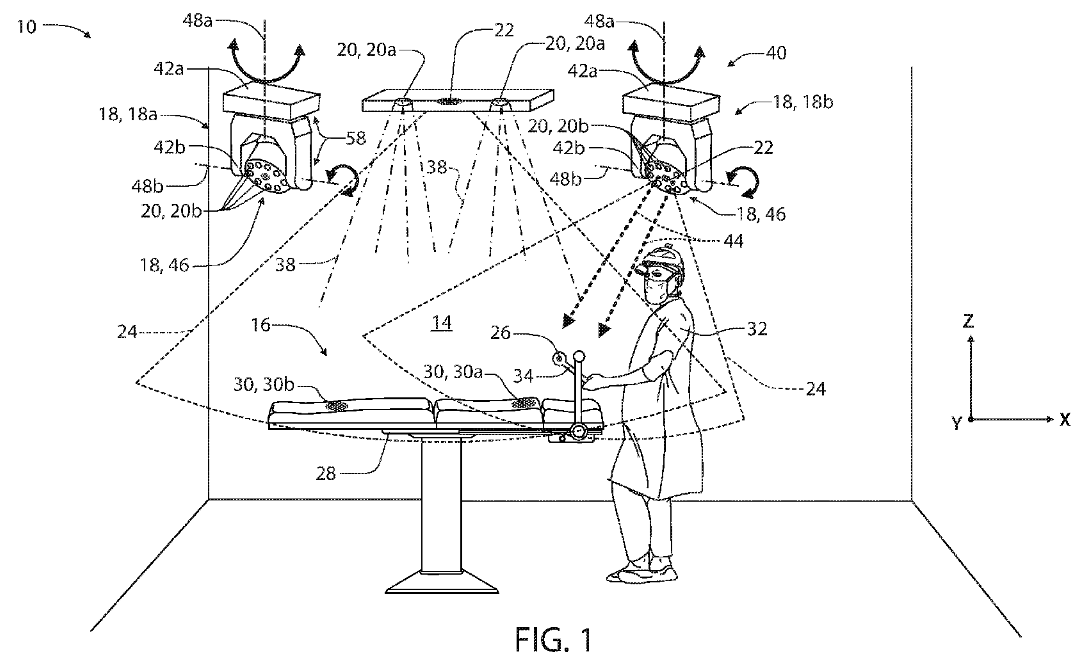

FIG. 1

(57) **Abstract:** A control instrument for an illumination system comprises a first end portion and a second end portion and an elongated handle interconnecting the first end portion and the second end portion. At least one marker is disposed proximate the first end portion. The at least one marker comprises a first symbol that may be detected by the illumination system to control at least one operating function of the illumination system. The illumination system is configured to selectively illuminate a location in an operating region.

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CONTROL APPARATUS AND METHODS FOR ADAPTIVE LIGHTING ARRAY

FIELD OF THE DISCLOSURE

[0001] The present disclosure generally relates to illumination systems, and more particularly, to surgical theater and surgical suite illumination systems.

BACKGROUND OF THE DISCLOSURE

[0002] Artificial lighting provided in surgical theaters and surgical suites may present a number of issues with regard to positioning, shadows, luminosity, and glare. Often, medical professionals are not stationary and the lighting needs to be dynamic due to the shifting of personnel and instruments throughout the surgical procedure. Further, differences in the physical dimensions of personnel may make positioning light sources challenging. Accordingly, new illumination systems for surgical suites may be advantageous.

SUMMARY OF THE PRESENT DISCLOSURE

[0003] According to one aspect of this disclosure, a control instrument for an illumination system is disclosed. The illumination system is configured to selectively illuminate a location in an operating region. The control instrument comprises a first end portion and a second end portion and an elongated handle interconnecting the first end portion and the second end portion. At least one marker is disposed proximate the first end portion. The at least one marker comprises a first symbol that may be detected by the illumination system to control at least one operating function.

[0004] According to another aspect of this disclosure, a method for controlling a light assembly is disclosed. The method comprises at least one illumination source. The method further comprises capturing image data in a field of view. The method further comprises identifying a first symbol positioned on a first portion of a control instrument in the image data. In response to identifying the first symbol, the method comprises controlling a controlling a first function of the light assembly. The method further comprises identifying a second symbol positioned on a second portion of the control instrument in the image data. In response to identifying the second symbol, the method comprises controlling a second function of the light assembly.

[0005] According to yet another aspect of this disclosure, an illumination system for a room is disclosed. The system comprises a light assembly comprising at least one illumination source configured to selectively direct at least one light emission in an operating region of the room. The system further comprises an imager configured to capture image data in a field of view in the room. A controller is in communication with the light assembly and the imager. The control is configured to control the light assembly to direct the at least one emission illuminating a lighting region of the operating region. The controller is further configured to identify a first symbol positioned on a first portion of a control instrument in the image data and control a first function of the light assembly in response to identifying the first symbol. The controller is further configured to identify a second symbol positioned on a second portion of the control instrument in the image data and control a second function of the light assembly in response to identifying the second symbol.

[0006] These and other aspects, objects, and features of the present disclosure will be understood and appreciated by those skilled in the art upon studying the following specification, claims, and appended drawings. It will also be understood that features of each example disclosed herein may be used in conjunction with, or as a replacement for, features of the other examples.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The following is a description of the figures in the accompanying drawings. The figures are not necessarily to scale, and certain features and certain views of the figures may be shown exaggerated in scale or in schematic in the interest of clarity and conciseness.

[0008] In the drawings:

[0009] FIG. 1 is a schematic view of a surgical suite comprising an illumination system;

[0010] FIG. 2 is a schematic view lighting module of an illumination system;

[0011] FIG. 3 is a schematic view of an illumination system comprising an articulating head assembly including an array of lighting modules;

[0012] FIG. 4 is a flowchart demonstrating a method for controlling an illumination system;

[0013] FIG. 5 is a diagram of an instrument comprising a marker configured to be detected to control of an illumination system;

[0014] FIG. 6 is an illustrative diagram demonstrating a control of the illumination system via an offset tracking method;

[0015] FIG. 7 is an illustrative diagram demonstrating a control of the illumination system via one or more gestures or movements;

[0016] FIG. 8 is an illustrative diagram demonstrating a control of the illumination system by outlining an illumination region; and

[0017] FIG. 9 is a block diagram demonstrating the illumination system in accordance with the disclosure.

DETAILED DESCRIPTION

[0018] Additional features and advantages of the invention will be set forth in the detailed description which follows and will be apparent to those skilled in the art from the description or recognized by practicing the invention as described in the following description together with the claims and appended drawings.

[0019] As used herein, the term “and/or,” when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items can be employed. For example, if a composition is described as containing components A, B, and/or C, the composition can contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination.

[0020] In this document, relational terms, such as first and second, top and bottom, and the like, are used solely to distinguish one entity or action from another entity or action, without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms “comprises,” “comprising,” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element proceeded by “comprises . . . a” does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

[0021] Referring generally to FIGS. 1-4, the disclosure provides for an illumination system 10. The illumination system 10 may comprise a controller 12 and various accessories that may be utilized in a medical suite 14 to selectively illuminate a location or operating region 16. The illumination system 10 may comprise one or more light assemblies 18, which may include one or more light sources 20. Additionally, the system 10 may comprise at least one imager 22 operable to capture image data in a field of view 24 comprising the operating region 16. In an exemplary embodiment, the controller 12 of the system 10 may be configured to scan the operating region 16 to identify a location of a marker 26. Based on the location of the marker 26, the controller 12 may control a lighting emission from the one or more light sources 20 to illuminate the location corresponding to the position of the marker 26 identified in the image data. In this way, the system 10 may provide for a computer-assisted control of a direction of lighting emissions directed from the one or more light sources to conveniently illuminate various locations within the operating region 16.

[0022] In some examples, the system 10 may be configured to track the motion of the marker 26 to adjust the position of one or more target positions 30 in response to controls instructed by a user 32. Such tracking may be at least partially determined by the controller 12 of the system 10 by detecting a motion and/or rate of motion of a control instrument 34 comprising the marker 26 identified in the field of view 24. In some examples, the marker 26 may comprise a plurality of markers, user inputs, and various features that may be configured to control the illumination system 10. The control instrument may comprise a handheld device that may be robust and configured to be sanitized with various surgical instruments via conventional sterilization processes (e.g. autoclave sterilization). In some examples, the instrument 34 may be passive in operation and rely on the imager 22 of the system to identify a user input in response to identifying an interaction by the user with a user input or feature of the control instrument 34. Various examples of such operations are discussed in reference to FIGS. 5-7.

[0023] Referring now to FIG. 1, reference numeral 10 generally designates an illumination system 10. The illumination system 10 is depicted in a medical suite 14 and includes one or more light assemblies 18. The light assemblies 18 may include one or more light sources 20. The illumination system 10 may include one or more imagers 22 depicted to aid in the use of the illumination system 10. The imagers 22 may be positioned within or coupled to the light assemblies 18 (e.g., in handles or bodies), a table 28, and/or around the medical suite 14. The imager 22 may be a charge-coupled device (CCD) imager, a complementary metal-oxide-semiconductor (CMOS) imager, other types of imagers, and/or combinations thereof. According to various examples, the imager 22 may include one or more lenses to collimate and/or focus the light reflected by the patient, the table 28, or other features of the medical suite 14.

[0024] The table 28 may at least partially define the operating region 16. For purposes of this disclosure, the operating region 16 may be an operating field which is an isolated area where surgery is performed and may include all furniture and equipment covered with sterile drapes and all personnel being properly attired. Although described in connection with the medical suite 14, it will be understood that the illumination system 10 of the present disclosure may be utilized in a variety of environments. For example, the illumination system 10 may be utilized in automobile repair areas, doctor's offices, dentistry, photography studios, manufacturing settings, as well as other areas where dynamic lighting solutions may be advantageous.

[0025] The table 28 is configured to support a patient during a surgical procedure. According to various examples, the table 28 may have a square, rectangular and/or oval configuration. The table 28 may be composed of a metal (e.g., stainless steel), a polymer and/or combinations thereof. According to various examples, a sterile covering (e.g., a cloth or paper) may be positioned across a surface of the table 28. The table 28 may be configured to tilt, rotate and/or be raised or lowered. In examples where the table 28 is configured to tilt, the table 28 may tilt an angle from about 1° to about 10° about a long or a short axis of the table 28. The tilting of the table 28 may be performed in conjunction with illumination provided from the illumination system 10 and/or the light assemblies 18. For example, the table 28 may be configured to tilt toward and/or away from the light assemblies 18 to increase illumination, decrease illumination and/or to eliminate glare reflecting off of the patient and/or table 28. Further, tilting of the table 28 may be advantageous in allowing users (e.g., medical personnel) positioned around the table 28 to more easily access the patient and/or surgical field. In addition to tilting, it will be understood that the table 28 may be configured to raise or lower, rotate and/or slide about an X-Y plane.

[0026] The light assemblies 18 may take a variety of configurations. The light assemblies may include one or more light sources 20. In a first example, the light assemblies 18 may be modular and interconnected and supported on a track system. For example, the light assemblies 18 may have a circular, oval, oblong, triangular, square, rectangular, pentagonal or higher order polygon shape. It will be understood that different light assemblies 18 may be provided in different forms and that the illumination system 10 may include a variety of light assemblies 18.

[0027] The operating region 16 may be illuminated by a detection emission 38, shown projected in a field of view 24 of the imager 22. The detection emission 38 may be emitted from one or more of the light sources 20 in a substantially non-visible wavelength of light. In an exemplary embodiment, the detection emission 38 may be emitted from a detection emitter 20a as infrared light (e.g., near-infrared, infrared, and/or far-infrared). In this configuration, the operating region 16 may be illuminated by the detection emission 38 illuminating various objects that enter the field of view 24 of the imager 22. Accordingly, the marker 26 may be illuminated by the detection emission 38 from the emitter 20a such that the reflected light from the detection emission 38 is captured in the image data of the imager 22. To improve an intensity of the detection emission 38 reflected back to the imager 22, in some embodiments, the marker 26 may comprise a reflective surface finish configured to reflect the detection emission 38.

[0028] In various examples, the light assemblies 18 may be positioned or suspended from one or more positioning assemblies 40, which may adjust a projection direction of the light sources 20 by controlling one or more actuators 42. Accordingly, the positioning assemblies may be configured to rotate and/or translate independently or in any combination. As shown, the system 10 may comprise a first positioning mechanism and a second positioning mechanism, which may be referred to as a first actuator 42a and a second actuator 42b. In general, the positioning assemblies 40 as discussed herein may be configured to control a direction of one or more lighting emissions 44 emitted from the one or more visible light sources 20b. As demonstrated and further discussed further herein, each of the light sources 20 as well as the positioning assemblies 40 may be in communication with the controller 12, which may be configured to control a direction of the one or more lighting emissions 44 to illuminate the location of the marker 26 with visible light. In this way, the system 10 may be operable to control one or more of the visible light sources 20b to illuminate the marker 26 or various portions of the operating region 16.

[0029] In various embodiments, the one or more positioning assemblies 40 may comprise one or more gimbaled arms, which may be maneuvered or adjusted in response to a movement (e.g., rotational actuation) of one or more actuators 42a and 42b. In this configuration, the controller 12 may be configured to control each of the actuators 42a and 42b to manipulate the orientation of a lighting module 46 comprising one or more of the visible light sources 20b and/or the detection emitters 20a. In this way, the positioning assembly 40 may control the rotation of the lighting module 46 about a first axis 48a and a second axis 48b. Such manipulation of the lighting module 46 may enable the controller 12 to direct the light sources 20b to selectively illuminate the operating region 16 or various portions of the medical suite 14 in response to the detected location of the marker 26.

[0030] The positioning assemblies 40 and actuators 42a and 42b, as discussed herein, may correspond to one or more electrical motors (e.g., servo motors, stepper motors, etc.). Accordingly, each of the positioning assemblies 40 (e.g., the actuators 42) may be configured to rotate the lighting module 360 degrees or within the boundary constraints of lighting modules 46 or other support structures that may support the lighting modules 46. The controller 12 may control the motors or actuators 42 of the lighting modules 46 to direct the lighting emissions 44 of the visible light sources 20b to target a desired location in the medical suite 14. In order to accurately direct the lighting module 46 to target the desired location, the controller 12 may be calibrated to control the position of the lighting module 46 to target locations in a grid or work envelope of the medical suite 14. The calibration of such a system may require maintenance in the form of calibration updates or compensation due to variations in operation of the positioning assemblies 40 and actuators 42 that may occur over time.

[0031] Still referring to FIG. 1, in operation, the marker 26 may be illuminated by the detection emission 38 in field of view 24 such that the imager 22 may capture the reflection of the marker 26 in image data. In some embodiments, the imager 22 may comprise one or more filters that may limit the transmission of wavelengths of light that are not included in the detection emission 38 such that the reflection of the detection emission 38 may be readily identifiable. Once the image data comprising the reflection of the marker 26 is captured, the image data may be communicated to the controller 12 such that the location of the marker 26 may be identified in the field of view 24. Based on the location of the marker 26, the controller 12 may control a lighting emission 44 from the one or more light sources 20 to illuminate the location corresponding to the position of the marker 26. The light sources 20 configured to emit the lighting emission 44 may be referred to as visible light sources 20b. In this way, the system 10 may provide for a computer-assisted control of a direction of lighting emissions directed from the one or more light sources to conveniently illuminate various locations within the operating region 16.

[0032] In some embodiments, the illumination system 10 may comprise a plurality of imagers 22 which capture image data from the medical suite 14 and/or from the operating region 16. The imagers 22 may be configured to relay image data to the controller 12 of the illumination system 10. The controller 12 may include a memory and a processor. The memory may store computer executable commands (e.g., routines) which are controlled by the processor. According to various examples, the memory may include a light control routine and/or an image analyzing routine. The image analyzing routine is configured to process data from the imager 22. For example, the image analyzing routine may be configured to identify shadows and luminosity of the operating region 16, the light from the guidance system, location of points of interest (e.g., users around the table 28) and/or gestures from the users.

[0033] According to various examples, the image analyzing routine may also be configured to identify the location of the marker 26 in the image data. The marker 26 may include one or more symbols, computer readable codes and/or patterns which designate a point of interest in the image data. For example, the marker 26 can be positioned around the operating region 16 such that the image analyzing routine may identify the location of the marker 26 in the operating region 16. The marker 26 may be disposed on one or more instruments, points of interest in the medical suite 14, and/or the patient.

[0034] Once the image analyzing routine has processed the data from the imager 22, the light control routine may control how the positioning assemblies 40 are operated. For example, the light control routine may be configured to move, steer, activate or otherwise influence the light assemblies 18 to emit light at the location of the marker 26.

Such a location may correspond to an area of interest where the user is looking or working (e.g., as measured from the guidance system). In this way, the light control routine may steer or otherwise move the one or more visible light sources 20b to emit the lighting emission 44 to illuminate various areas where the user is looking and/or where hands and instruments may be positioned.

[0035] As discussed herein, the illumination system 10 and/or the disclosure provided above are configured to operate in conjunction with a number of other features present in the medical suite 14. For example, the illumination system 10 may be configured to track the location and use of the marker 26, which may be coupled to one or more instruments. The instruments may be coded based on type (e.g., consumable tool vs. non-consumable) and/or by the operator using or placing them. The instruments may be tracked as they enter and exit the operating region 16 in response to a detection of the marker 26 in image data captured by the imager 22. In yet other examples, one or more of the instruments may include a radio frequency identification tracking device.

[0036] Referring now to FIG. 2, a schematic view of the illumination system 10 is shown comprising an exemplary implementation of the positioning assembly 40 referred to as an articulating head assembly 50. Each of the articulating head assemblies 50 or articulating assemblies 50 may comprise a lighting module array 52 of the lighting modules 46. Each of the articulating head assembly 50 may serve as an exemplary embodiment of the one or more positioning assemblies 40 in accordance with the disclosure. In the exemplary embodiment shown, the articulating head assembly 50 comprises five of the lighting modules 46. The lighting modules 46 may be suspended from a central control arm 54 comprising a plurality of support arms 56. Extending from each of the support arms 56, a lateral support beam 58 or wing may extend laterally outward from each of the arms 56 in opposing directions. In this configuration, the lighting modules 46 are supported by the central control arm 54 in a distributed arrangement.

[0037] The central control arm 54 may be suspended from a support housing 60 along a first axis 62a (e.g., Y-axis). The support housing 60 may comprise the controller 12 and a first actuator 64a configured to rotate the central control arm 54 about the first axis. A first lighting module 46a may be suspended along a second axis 62b (e.g., X-axis) extending between the support arms 56. A second actuator 64b may be in connection with the support arms 56 and the first lighting module 46a. The second actuator 64b may be configured to rotate the first lighting module 46a about the second axis 62b. In this configuration, the controller 12 may control the emission direction of the first lighting module 46a to rotate approximately 360 degrees about the first axis 62a and the second axis 62b.

[0038] Each of the lateral support beams 58 may support a pair of the lighting modules 46. That is, a first support beam 58a may support a second lighting module 46b on a first side 66 and a third lighting module 46c on a second side 68. The first side 66 and the second side 68 of the first support beam 58a may extend in opposing directions from the first support beam 58a along a third axis 62c. A second support beam 58b may support a fourth lighting module 46d on the first side 66 and a fifth lighting module 46e on the second side 68. The first side 66 and the second side 68 of the second support beam 58b may extend in opposing directions from the first support beam 58a along a fourth axis 62d. The third axis 62c and the fourth axis 62d may extend perpendicular to the second axis 62b.

[0039] Each of the first support beam 58a and the second support beam 58b may connect to each of the support arms 56 and rotate about the second axis 62b with the first lighting module 46a. Additionally, each of the lateral support beams may comprise at least one actuator configured to rotate the lighting modules 46b, 46c, 46d, and 46e about the third axis 62c and the fourth axis 62d. For example, the first support beam 58a may comprise a third actuator 64c in connection with the second lighting module 46b and the third lighting module 46c along the third axis 62c. The second support beam 58b may comprise a fourth actuator 64d in connection with the fourth lighting module 46d and the fifth lighting module 46e along the fourth axis 62d. In this configuration, the controller 12 may control the second actuator 64b to rotate each of the lighting modules 46b, 46c, 46d, and 46e about the second axis 62b. Additionally, the controller 12 may control the third actuator 64c to rotate the second and third lighting modules 46b and 46c about the third axis 62c. Finally, the controller 12 may control the fourth actuator 64d to rotate the fourth and fifth lighting modules 46d and 46e about the fourth axis 62d.

[0040] As previously discussed, each of the light modules 46 may comprise an imager 22. In some embodiments, the articulating head assembly 50 may comprise a single imager

22 or an imager array. For example, the imager array may be formed as follows: the first lighting module 46a may comprise a first imager 22a, the second lighting module 46b may comprise a second imager 22b, the third lighting module 46c may comprise a third imager 22c, the fourth lighting module 46d may comprise a fourth imager 22d, and/or the fifth lighting module 46e may comprise a fifth imager 22e. Each of the imagers 22 may be configured to capture the image data in corresponding fields of view 24a, 24b, 24c, 24d, and 24e (not shown for clarity). The controller 12 may process the image data from each of the imagers 22 to identify a region of interest. Accordingly, the controller 12 may scan the image data from each of the imagers 22 and adjust the orientation of each of the lighting modules 46 to dynamically control the light in the surgical suite 14.

[0041] Though the imagers 22 are discussed as being incorporated on each of the lighting modules 46, the system 10 may be configured to capture image data from any location in the surgical suite 14. As further discussed in reference to FIG. 3, a plurality of the articulating head assemblies 50 may be controlled by a central controller in communication with each of the controllers 12. In such embodiments, the central controller may be configured to process the image data from the one or more imagers 22 and communicate control signals for each of the plurality of lighting modules 46 and the actuators 64 of the articulating head assemblies 50. Accordingly, the system 10 may be implemented in a variety of beneficial embodiments without departing from the spirit of the disclosure.

[0042] FIG. 3 is a schematic view of the illumination system 10 comprising a head assembly array 70 formed of the articulating head assemblies 50. Each of the articulating head assemblies 50 may comprise the lighting module array 52. As demonstrated, the head assembly array 70 comprises a first head assembly 50a, a second head assembly 50b, a third assembly 50c, and a fourth head assembly 50d. Each of the head assemblies 50 comprises a corresponding lighting module array 52. For example, the first head assembly 50a comprises the first lighting module array 52a, the second head assembly 50b comprises the second lighting module array 52b, the third head assembly 50c comprises the third lighting module array 52c, and the fourth head assembly 50d comprises the fourth lighting module array 52d.

[0043] Each of the head assemblies 50 of the head assembly array 70 may comprise a controller 12 (e.g., a first controller 12a, a second controller 12b, a third controller 12c, and a fourth controller 12d). The controllers 12 may be configured to independently control each of the actuators 64 as discussed in reference to FIG. 5. Additionally, the controllers 12 may be in communication via a central control system or a distributed control system incorporated in each of the controllers 12. In this configuration, each of the controllers 12 may be configured to identify an orientation of the actuators 64 and the corresponding positions of the lighting modules 46. Based on this information, the system 10 may be configured to map a combined illumination pattern or illumination coverage of each of the emissions that may be emitted from the light sources 20 of the lighting modules 46. As previously discussed, the map of the combined illumination or emission coverage of the combined lighting modules 46 may be programmed into the controllers 12 of the system 10 by one or more calibration methods. In this way, the system 10 may control each lighting module 46 of the head assemblies 50 in concert to provide a scalable, dynamic-lighting system operable to emit the various emissions of light as discussed herein.

[0044] As previously discussed, the system 10 may comprise one or more imagers 22. In the exemplary embodiment, the controllers 12a, 12b, 12c, and 12d are in communication with a central controller 74. The central controller 74 may comprise or be in communication with one or more of the imagers 22. In such embodiments, the imager 22 of the central controller 74 may be configured to identify one or more obstructions in a region of interest 72. The region of interest 72 may be identified by a location of the marker 26, gesture, input via a user interface, identified by a radio frequency identification tracking device, or programmed into the central controller 74 in relation to a specific procedure. Though discussed in reference to the central controller 74, each of the controllers 12 of the head assemblies 50 may alternatively have a single imager or multiple imagers. In such embodiments, the controllers 12 of each of the head assemblies 50 may be configured to detect the obstructions and communicate among one another to identify the best response to adjust the lighting modules 46 to illuminate the region of interest 72.

[0045] The identification of one or more obstructions 76 may be based on a detection of an object in the image data. The obstructions 76 may be identified in response to detecting one or more pulsed infrared emissions emitted from the lighting modules 46. For example, the central controller 74 may be calibrated such that the location of each of a plurality of the detection emitters 20a is indicated in programming. Accordingly, by cycling through the detection emitters 20a of each of the lighting modules (46a, 46b, 46c... 46m), the controller may identify a location of the obstructions 76 based on a timed detection of each of the infrared emissions 77. In this way, the central controller 74 may detect a location of the obstructions 76 in relation to a projection trajectory of each of the detection emitters 20a to identify a clear or unobstructed trajectory 78. Once the unobstructed trajectory 78 is identified, the central controller 74 may control one or more of the light sources to illuminate the region of interest 72.

[0046] In some embodiments, the controllers 12 may communicate within the system 10 to identify the region of interest 72 between two or more of the imagers 22, which may be incorporated in two or more or the lighting modules 46. That is, the two or more of the lighting modules 46 from which the image data is processed to identify the region of interest 72 may be incorporated in a single head assembly 50 or captured by imagers 22 in two or more of the head assemblies 50 (e.g., 50a and 50b). In this way, the system 10 may operate as a distributed scanning and illumination system formed by the head assemblies 50 and controlled to operate as a unified system via communication among the controllers 12 and/or a central controller.

[0047] In general, the central controller 74 or the controllers 12 may be configured to identify one or more light sources 20 of the lighting modules 46 with a line of sight or projection trajectory 78 aligned with the region of interest 72 without interference by one or more obstructions 76. Upon identifying at least one lighting module 46 in one or more of the head assemblies 50 with the clear projection trajectory 78, the central controller 74 may respond by controlling one or more of the controllers 12 to position the at least one lighting module 46 to direct an emission to the region of interest 72. In this configuration, the head assembly array 70 may provide for effective lighting even when tasked with illuminating obstructed regions that change over time.

[0048] As an example of a control sequence of the system 10, the system 10 may initially illuminate the table 28 via a lighting module of the second head assembly 50b by emitting a second emission 80 of visible light. After the initial operation of the system 10, the imager 22 may detect the obstruction 76 in the field of view 24, which may result in one or more shadows 81 in the region of interest 72. In response to identifying the obstruction 76, the central controller 74 may control controllers 12a and 12b activating a lighting module of the first head assembly 50a that may have the clear projection trajectory 78 via activating a first emission 82 of visible light. Once the first emission 82 is activated, the system 10 may continue to monitor the image data to verify that the first emission 82 remains unobstructed. In this way, the head assembly array 70 may be configured to illuminate the region of interest 72 by controlling a plurality of the head assemblies 50 in combination.

[0049] Though specific reference is made to identifying a location of the obstruction 76 and the clear projection trajectory 78 from the image data, the system 10 may utilize one or more algorithms configured to identify and project light to the region of interest 72 via a predictive or experimental algorithm. Such algorithms may apply various inference as well as trial and error to gradually move one or more of the head assemblies 50 and gradually activating the light sources 20 to illuminate the region of interest 72. In these methods as well as others discussed herein, the system may consistently monitor the region or regions of interest 72 for changes or improvements in lighting. In this way, the system 10 may be configured to continue positioning operations that improve the projected trajectory of the light as indicated by the image data from the imagers 22. Such a routine may be applied alone or in combination with the location detection based control discussed herein.

[0050] Referring to FIG. 4, a flowchart for a method 90 for controlling the system 10 is demonstrated. In operation, the method 90 may begin by initializing a control routine of the illumination system 10 (92). Once initiated, the controller 12 may activate the emitter 20a to illuminate the operating region 16 in the detection emission 38 (94). In this way, the operating region 16 may be illuminated by the detection emission 38 illuminating various objects that enter the field of view 24 of the imager 22. The controller 12 may then control the imager 22 to capture image data in the field of view 24 (96). Once the image data is captured, the controller 12 may process or scan the image data for various objects including the marker 26 (98).

[0051] In step 100, the controller 12 may determine if the position of the marker 26 is identified in the image data. If the position of the marker is not identified, the method 90 may return to steps 96 and 98 to capture and scan the image data in the field of view 24. If the position of the marker 26 is identified in step 100, the controller 12 may control one or more of the positioning or head assemblies 50 to activate the lighting emission(s) 44 directed at the marker 26 (102). Once the position of the marker 26 is identified and illuminated by the lighting emission(s) 44, the controller 12 may continue to track the location of the marker 26 and reposition the head assemblies 50 to maintain a consistent illumination of the marker 26 and the corresponding location (104).

[0052] Referring now to FIG. 5, the control instrument 34 is shown demonstrating a plurality of the markers 26. In the example shown, the control instrument 34 comprises a first marker 26a and a second marker 26b. The markers 26a, 26b may be disposed at opposing ends of a connecting member 112, which may correspond to a narrow, elongated bar interconnecting a plurality to end portions 114. In operation, the controller 12 may be configured to identify and distinguish between the first marker 26a and the second marker 26b. In response to identifying one of the markers 26a, 26b in the field of view 24, the system 10 may control one or more of the positioning assemblies 40, head assemblies 50 and corresponding lighting modules 46 to illuminate the operating region 16 in different ways.

[0053] As shown in FIG. 5, the control instrument 34 may be configured such that the end portions 114 correspond to a first grip 116a and a second grip 116b. The first grip 116a may comprise the first marker 26a, and the second grip 116b may comprise the second marker 26b. In this configuration, the control instrument 34 may be configured such that the user 32 may hold the second grip 116b to display the first marker 26a or hold the first grip 116a to display the second marker 26b. As shown, when the user 32 holds the second grip 116b, the second marker 26b may be substantially or completely covered/masked by the hand of the user 32.

[0054] Accordingly, in the illustrated example, when the user 32 holds the instrument 34 via the second grip 116b, the first marker 26a may be visible, while the second marker 26b is hidden from the field of view 24. Similarly, when the user 32 holds the instrument 34 via the first grip 116a, the second marker 26b may be visible, while the first marker 26a is hidden from the field of view 24. As provided herein, the instrument 34 may be configured to allow the user 32 to intuitively and selectively reveal the first marker 26a or the second marker 26b in the field of view 24 to control the system 10. In some implementations, the first marker 26a and the second marker 26b may be disposed on opposite sides (e.g. a top surface and bottom surface) of the instrument 34 such that the body of the instrument 34 conceals one of the markers 26a, 26b from the field of view.

[0055] As previously discussed, the operation of the illumination system may vary based on the detection of the first marker 26a or the second marker 26b. For example, in response to identifying the first marker 26a, the system 10 may be configured to load a first control configuration, which may comprise a variety of pre-configured or user-defined operation settings. Similarly, in response to identifying the second marker 26b, the system 10 may be configured to load a second control configuration that may comprise pre-configured or user-defined settings that differ from the first control configuration. Each of the control configurations may differ in a variety of ways, which may include, control sensitivity, control methods, control offsets, light intensity, light coverage or focus, light color, and a variety of configurable settings for the lighting system 10.

[0056] In some implementations, the instrument 34 may comprise a plurality of inputs 118, which may correspond to virtual inputs or symbols disposed on one or more of the surfaces of the instrument 34. As illustrated, the plurality of inputs 118 may be implemented as a plurality of symbols or details formed or printed on the instrument 34. For example, the inputs may comprise a first symbol 118a and a second symbol 118b positioned on a first surface 120a (e.g. top surface). Additionally, the instrument 34 may comprise a third symbol 118c and a fourth symbol 118d, which may be disposed on a second surface 120b (e.g. a bottom surface), opposite the first surface 120a. In this configuration, the controller 12 of the system 10 may be configured to detect each of the markers 26 and the symbols to control various operations, presets, and/or configurations of the system 10.

[0057] For example, in operation, the user 32 may selectively conceal one or more of the symbols 118a, 118b, 118c, 118d with a hand 32a, digit 32b (finger, thumb), etc. In response to identifying that one or more of the inputs 118 is hidden from the field of view 24, the controller may be configured to change one or more settings or adjust various configurations of the system 10 as discussed here. For example, in response to detecting one or more of the symbols 118a, 118b, 118c, 118d disguised from the field of view 24, alone or in combination with the identification of the first marker 26a and/or the second marker 26b in the field of view 24, the controller may adjust a variety of settings of the system 10. For example, in response to a combination of the portions (e.g. markers 26, symbols 118a-118d, etc.) of the instrument 34 displayed in the image data captured by the imager 22, the controller 12 may be configured to adjust a variety of settings or activate various preconfigured settings of the system 10. Such settings may include but are not limited to: a control sensitivity, light intensity, light coverage or focus, light color, lighting priority, tracking function, and a variety of configurable settings for the lighting system 10.

[0058] As discussed herein, the control instrument 34 may comprise a handheld device that may be robust and configured to be sanitized with various surgical instruments via conventional sterilization processes (e.g. autoclave sterilization). The exemplary instrument 34 demonstrated in FIG. 5 may be configured to communicate a variety of visual cues to the system 10 to control various settings and operations. In this way, the instrument 34 may be free of complex mechanical and/or electrical parts that may be damaged due to sterilization techniques that may be necessary to ensure sanitation for use in the surgical suite 14.

[0059] Referring now to FIG. 6, the system 10 may be configured to control the location of the target positions 30 in the field of view 24 via an offset control method. For example, in various examples, the user 32 may desire to change the location of the target position 30 without reaching into a region 130 where the target position 30 is located. Avoiding reaching into such the region 130 may prevent the user 32 from interfering with a working area or blocking one or more of the visible light emissions 80 and/or 82, which may be directed at the region 130. Accordingly, the user 32 may activate the offset control method such that the location the target position 30 may be adjusted relative the location of the marker 26 in the field of view 24 over a configurable offset 132. In this way, the user may adjust the location of the target position without interfering with the region 130. The controller 12 may be configured to activate the offset control method in response to the user 32 revealing the first marker 26a, the second marker 26b, and/or one or more of the symbols 118a, 118b, 118c, 118d to the imager 22 in the field of view 24.

[0060] The configurable offset 132 may comprise an X-axis offset 132a, a Y-axis offset 132b such that the relative location of the marker 26 is defined relative to the target position 30. During operation via the offset control method, the offset 132 may be set or selected by hiding and revealing the marker 26 in the field of view 24. Once revealed, the controller 12 may set the configurable offset 132 and adjust the location of the target position 30 relative to a movement of the marker 26. In this way, the system 10 may be configured to adjust the location of the target position 30 without interfering with the region 130.

[0061] Referring now to FIG. 7, in some implementations, the controller 12 may be configured to detect one or more, motions, gestures, and/or visual cues identified in the image data captured in the field of view 24 to control the system. As depicted in FIG. 7, exemplary gestures 140 that may be identified by the controller 12 may include a rotation 140a, a lateral motion 140b, and/or an outline or character gesture 140c. In response to detecting each of the gestures 140, the controller 12 may selectively control one or more settings of the illumination system 10. The detection of the gestures 140 may be in connection with a movement of the instrument 34, which may be detected by the controller 12 based on a position, orientation, and/or appearance or presence of the markers 26 or symbols 118a-118d identified in the image data. Such settings may include, but are not limited to, a control sensitivity, light intensity, light coverage or focus, light color, a lighting priority, tracking function, panning and/or control of positioning assemblies 40, and a variety of configurable settings for the lighting system 10.

[0062] For example, in some embodiments, the system 10 may be configured to control a focus or intensity of one or more of the lighting emissions 80, 82 in response to a rotation gesture. In operation, the controller 12 may be configured to detect a rotation of the instrument in connection with the hand 32a of the user 32. In response to a detection of a clockwise rotation or counterclockwise rotation, the controller 12 may increase or decrease an intensity of one or more of the lighting emissions 80, 82. Similarly, the controller 12 may be configured to increase a proportion or size of an illumination range or region, adjust a color or color temperature, and/or control various operational characteristics of the illumination system 10 in response to detecting each of the gestures 140.

[0063] In some embodiments, the controller 12 may also be configured to identify the lateral motion 140b of the marker 26 and/or the instrument 34 in connection with the hand 32a. In response to the detection, the controller 12 may be configured to control various characteristics (e.g. intensity, focus, hue, etc.). Similarly, the controller 12 may be configured to identify rapid lateral movements, which may exceed a predetermined rate of movement. For example, the controller 12 may be configured to identify a swiping gesture, and, in response, the controller 12 may selectively control various operations and/or characteristics of the system 10. In some embodiments, the controller 12 may even be configured to identify characters in the form or sign language and/or traced characters that may be demonstrated by the hand 32a in the field of view 24.

[0064] The controller 12 may further be configured to identify one or more gestures completed by the user 32 with a first hand 32a and a second hand. For example, the user 32 may merge a plurality of illumination regions corresponding to the first lighting emission 80 and the second lighting emission 82 in response to detecting the user 32 moving the first hand and the second hand from a separated configuration to a close proximity. Accordingly, the controller 12 may selectively control the illumination system 10 in response to a variety of gestures 140 and or movements identified in the image data in the field of view 24.

[0065] Referring now to FIGS. 6 and 7, in some embodiments, the controller 12 may be configured to set a primary lighting region 142a and a second region 142b illuminated by the light sources 20 of the positioning assemblies 40. For example, in response to detecting one of the gestures 140 and/or one or more of the inputs 118, within a first portion 144a of the field of view 24, the controller 12 may designate the first portion 144a to be the primary lighting region 142a. Similarly, in response to detecting one of the gestures 140 and/or one or more of the inputs 118, within a second portion 144b of the field of view 24, the controller 12 may designate the second portion 144b to be the secondary lighting region 142b. In this way, the controller 12 may be configured to identify and/or determine that the first portion 144a and the second portion 144b are to be illuminated by the light sources 20. Additionally, the controller 12 may prioritize the lighting of each of the first portion 144a and the second portion 144b based on the indication of the primary light region 142a and the secondary lighting region 142b.

[0066] For example, the controller 12 may control the positioning assemblies 40 to direct the light sources 20 to prioritize the illumination of the first portion 144a in response to the designation of the primary lighting region 142a. The controller 12 may assign each the light sources 20 of the positioning assemblies 40 to mitigate shadowing, as previously discussed herein, in the first portion 144a. The controller 12 may additionally assign a greater number of the lighting modules 46 to illuminate the first portion 144a relative to the second portion 144b in response to the designation as the primary lighting region 142a. Though the primary lighting region 142a and the secondary lighting region 142b are discussed herein, the number and/or scale of the lighting regions may vary depending on the application and desired operation of the system 10. Accordingly, the disclosure may provide for a flexible solution that may provide for illumination in a variety of applications.

[0067] Referring now to FIG. 8, a diagram is shown demonstrating a method for defining an illumination region 150. As shown, the system 10 may be configured to identify a path 152 of at least one of the hand 32a of the user 32 and/or the instrument 34 in the field of view 24. The path 152 may be tracked by the controller 12 of the system to define an outline 154 of the lighting region 150 in the operating region 16. Similar to the identification of the gestures 140, the controller 12 may be configured to detect the movement of the instrument 34, which may be detected by the controller 12 based on a position, orientation, and/or appearance or presence of the markers 26 or symbols 118a-118d identified in the image data. The controller 12 may similarly be configured to detect the path 152 in response to the lateral motion 140b of the marker 26 and/or the instrument 34 in connection with the hand 32a forming a closed path. In this way, the system 10 may identify the lighting region 150 based on the path 152.

[0068] In response to the identification of the outline, the controller 12 may be configured to control the positioning assemblies 40 to direct one or more of the light sources 20 to illuminate the illumination region 150. As shown, the illumination region may be illuminated by a plurality of the light sources 20 as represented by the plurality of illuminated regions 156 shown in FIG. 8. In order to accurately illuminate the region 150 defined by the outline 154, the controller 12 may be configured to control a light intensity, light coverage or focus, emission direction, lighting priority, panning of one or more of the positioning assemblies 40, etc. Accordingly, the system 10 may be configured to selectively illuminate the illumination region 150 based on the outline 154 drawn or gestured by the user 32 within the field of view 24.

[0069] Referring to FIG. 9, a block diagram of an illumination system 10 is shown. As discussed herein, the illumination system 10 may include one or more imagers 22 configured to capture image data from the medical suite 14 and/or from the operating region 16. The imagers 22 may be configured to relay visual information to the controller

12 of the illumination system 10. The controller 12 may include a memory 160 and a processor 162. The memory 160 may store computer executable commands (e.g., routines) which are controlled by the processor 162. According to various examples, the memory 160 may include a light control routine and/or an image analyzing routine. In exemplary embodiments, the memory 160 may include the lighting control method 90.

[0070] Once the image analyzing routine has processed the image data from the imager 22, the controller 12 may communicate one or more control instructions to a motor or actuator controller 164. In response to the control signals, the motor controller 164 may control the actuators 42, 64 or the positioning assemblies 40 to move, steer, or otherwise adjust an orientation of the light assemblies 18. In this way, the controller 12 may direct the lighting assemblies 18 to emit the lighting emission 44 and/or direct the field of view 24 to a desired location, which may correspond to the location of the marker 26. The system 10 may additionally comprise one or more power supplies 166. The power supplies 166 may provide for one or more power supplies or ballasts for various components of the lighting assembly 18 as well as the actuators 42, 64 or positioning assemblies 40.

[0071] In some embodiments, the system 10 may further comprise one or more communication circuits 168, which may be in communication with the processor 162. The communication circuit 168 may be configured to communicate data and control information to a display or user interface 170 for operating the system 10. The interface 170 may comprise one or more input or operational elements configured to control the system 10 and communicate data. The communication circuit 168 may further be in communication with additional lighting assemblies 18, which may operate in combination as an array of lighting assemblies. The communication circuit 168 may be configured to communicate via various communication protocols. For example, communication protocols may correspond to process automation protocols, industrial system protocols, vehicle protocol buses, consumer communication protocols, etc. Additional protocols may include, MODBUS, PROFIBUS, CAN bus, DATA HIGHWAY, DeviceNet, Digital multiplexing (DMX512), or various forms of communication standards.

[0072] In various embodiments, the system 10 may comprise a variety of additional circuits, peripheral devices, and/or accessories, which may be incorporated into the system 10 to provide various functions. For example, in some embodiments, the system

10 may comprise a wireless transceiver 172 configured to communicate with a mobile device 174. In such embodiments, the wireless transceiver 172 may operate similar to the communication circuit 168 and communicate data and control information for operating the system 10 to a display or user interface of the mobile device 174. The wireless transceiver 172 may communicate with the mobile device 174 via one or more wireless protocols (e.g. Bluetooth®; Wi-Fi (802.11a, b, g, n, etc.); ZigBee®; and Z-Wave®; etc.). In such embodiments, the mobile device 174 may correspond to a smartphone, tablet, personal data assistant (PDA), laptop, etc.

[0073] In various embodiments, the light sources 20 may be configured to produce un-polarized and/or polarized light of one handedness including, but not limited to, certain liquid crystal displays (LCDs), laser diodes, light-emitting diodes (LEDs), incandescent light sources, gas discharge lamps (e.g., xenon, neon, mercury), halogen light sources, and/or organic light-emitting diodes (OLEDs). In polarized light examples of the light sources 20, the light sources 20 are configured to emit a first handedness polarization of light. According to various examples, the first handedness polarization of light may have a circular polarization and/or an elliptical polarization. In electrodynamics, circular polarization of light is a polarization state in which, at each point, the electric field of the light wave has a constant magnitude, but its direction rotates with time at a steady rate in a plane perpendicular to the direction of the wave.

[0074] As discussed, the light assemblies 18 may include one or more of the light sources 20. In examples including a plurality of light sources 20, the light sources 20 may be arranged in an array. For example, an array of the light sources 20 may include an array of from about 1x2 to about 100x100 and all variations therebetween. As such, the light assemblies 18 including an array of the light sources 20 may be known as pixelated light assemblies 18. The light sources 20 of any of the light assemblies 18 may be fixed or individually articulated. The light sources 20 may all be articulated, a portion may be articulated, or none may be articulated. The light sources 20 may be articulated electromechanically (e.g., a motor) and/or manually (e.g., by a user). In static, or fixed, examples of the light sources 20, the light sources 20 may be assigned to focus on various predefined points (e.g., on a patient and/or on the table 28).

[0075] Modifications of the disclosure will occur to those skilled in the art and to those who make or use the disclosure. Therefore, it is understood that the embodiments shown in the drawings and described above are merely for illustrative purposes and not intended to limit the scope of the disclosure, which is defined by the following claims as interpreted according to the principles of patent law, including the Doctrine of Equivalents.

[0076] It will be understood by one having ordinary skill in the art that construction of the described disclosure, and other components, is not limited to any specific material. Other exemplary embodiments of the disclosure disclosed herein may be formed from a wide variety of materials unless described otherwise herein.

[0077] For purposes of this disclosure, the term "coupled" (in all of its forms: couple, coupling, coupled, etc.) generally means the joining of two components (electrical or mechanical) directly or indirectly to one another. Such joining may be stationary in nature or movable in nature. Such joining may be achieved with the two components (electrical or mechanical) and any additional intermediate members being integrally formed as a single unitary body with one another or with the two components. Such joining may be permanent in nature or may be removable or releasable in nature unless otherwise stated.

[0078] It is also important to note that the construction and arrangement of the elements of the disclosure, as shown in the exemplary embodiments, is illustrative only. Although only a few embodiments of the present innovations have been described in detail in this disclosure, those skilled in the art who review this disclosure will readily appreciate that many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter recited. For example, elements shown as integrally formed may be constructed of multiple parts or elements shown as multiple parts may be integrally formed, the operation of the interfaces may be reversed or otherwise varied, the length or width of the structures and/or members or connector or other elements of the system 10 may be varied, and the nature or numeral of adjustment positions provided between the elements may be varied. It should be noted that the elements and/or assemblies of the system 10 may be constructed from any of a wide variety of materials that provide sufficient strength or durability, in any of a wide variety of colors, textures, and combinations. Accordingly, all such modifications are intended to be included within the scope of the present innovations. Other substitutions, modifications, changes, and omissions may be made in the design, operating conditions, and arrangement of the desired and other exemplary embodiments without departing from the spirit of the present innovations.

[0079] It will be understood that any described processes, or steps within described processes, may be combined with other disclosed processes or steps to form structures within the scope of the present disclosure. The exemplary structures and processes disclosed herein are for illustrative purposes and are not to be construed as limiting.

[0080] It is also to be understood that variations and modifications can be made on the aforementioned structures and methods without departing from the concepts of the present disclosure, and further, it is to be understood that such concepts are intended to be covered by the following claims, unless these claims, by their language, expressly state otherwise. Further, the claims, as set forth below, are incorporated into and constitute part of this Detailed Description.

[0081] As used herein, the term “about” means that amounts, sizes, formulations, parameters, and other quantities and characteristics are not and need not be exact, but may be approximate and/or larger or smaller, as desired, reflecting tolerances, conversion factors, rounding off, measurement error and the like, and other factors known to those of skill in the art. When the term “about” is used in describing a value or an end-point of a range, the disclosure should be understood to include the specific value or end-point referred to. Whether or not a numerical value or end-point of a range in the specification recites “about,” the numerical value or end-point of a range is intended to include two embodiments: one modified by “about,” and one not modified by “about.” It will be further understood that the end-points of each of the ranges are significant both in relation to the other end-point and independently of the other end-point.

[0082] The terms “substantial,” “substantially,” and variations thereof as used herein are intended to note that a described feature is equal or approximately equal to a value or description. For example, a “substantially planar” surface is intended to denote a surface that is planar or approximately planar. Moreover, “substantially” is intended to denote that two values are equal or approximately equal. In some embodiments, “substantially” may denote values within about 10% of each other, such as within about 5% of each other, or within about 2% of each other.

What is claimed is

1. A control instrument for an illumination system, the illumination system configured to selectively illuminate a location in an operating region, the control instrument comprising:

a first end portion and a second end portion;

an elongated handle interconnecting the first end portion and the second end portion; and

at least one marker disposed proximate the first end portion, wherein the at least one marker comprises a first symbol.

2. The control instrument according to claim 1, wherein the at least one marker comprises a first marker and a second marker, wherein the first marker is disposed on the first end portion and the second marker is disposed on the second end portion.

3. The control instrument according to any one of claims 1-2, wherein the at least one marker comprises a first marker and a second marker, wherein the first marker is disposed on a first side of the control instrument and the second marker is disposed on a second side of the control instrument.

4. The control instrument according to claim 3, wherein the second side is substantially opposite the first side such that one of the first marker and the second marker is hidden from the field of view of the imager by a body of the control instrument.

5. The control instrument according to any one of claims 1-4, further comprising at least one user input disposed on the handle portion between the first end portion and the second end portion.

6. The control instrument according to any one of claims 1-5, wherein the at least one user input comprises at least one symbol configured to define a user function identifiable by the illumination system.

7. The control instrument according to any one of claims 1-6, wherein the illumination system comprising at least one image sensor configured to identify a location of the at least one marker in a field of view.

8. The control instrument according to claim 7, wherein the control instrument is configured to control the illumination system by selectively displaying at least one of the marker and the symbol in the field of view.

9. The control instrument according to any one of claims 1-8, wherein the control instrument is configured to control the illumination system via visual cues.

10. A method for controlling a light assembly comprising at least one illumination source, the method comprising:

capturing image data in a field of view;

identifying a first symbol positioned on a first portion of a control instrument in the image data;

controlling a first function of the light assembly in response to identifying the first symbol;

identifying a second symbol positioned on a second portion of the control instrument in the image data; and

controlling a second function of the light assembly in response to identifying the second symbol.

11. The method according to claim 10, wherein the first function comprises controlling a position of a lighting region illuminated by at least one emission output from the at least one illumination source.

12. The method according to any one of claims 10-11, further comprising:

adjusting a target location of the lighting region in response to identifying the marker proximate to the first lighting region for a predetermined period of time.

13. The method according to claim 12, further comprising:

in response to identifying a change in a position of the first symbol in the image data at a rate of motion within a predetermined velocity range in the field of view, tracking the motion of the first symbol within an operating region of the light assembly.

14. The method according to any one of claims 10-13, wherein the second function comprises controlling at least one of an intensity, a focus, and a hue of the at least one emission.

15. The method according to any one of claims 10-14, further comprising:

selectively concealing one of the first symbol and the second symbol in the image data thereby activating one of the first function and the second function.

16. The method according to claim 15, further comprising:

controlling a third function of the light assembly in response to identifying the first symbol and the second symbol in the image data.

17. The method according to any one of claims 10-16, further comprising:

detecting a movement of at least one of the first symbol and the second symbol in the image data; and

identifying a gesture of the control instrument based on the movement.

18. The method according to claim 17, further comprising:

adjusting at least one of an intensity, a focus, and a hue of the at least one emission in response to the gesture.

19. An illumination system for a room, comprising:

a light assembly comprising at least one illumination source configured to selectively direct at least one light emission in an operating region of the room;

an imager configured to capture image data in a field of view in the room;

a controller in communication with the light assembly and the imager, wherein the controller is configured to:

control the light assembly to direct the at least one emission illuminating a lighting region of the operating region;

identify a first symbol positioned on a first portion of a control instrument in the image data;

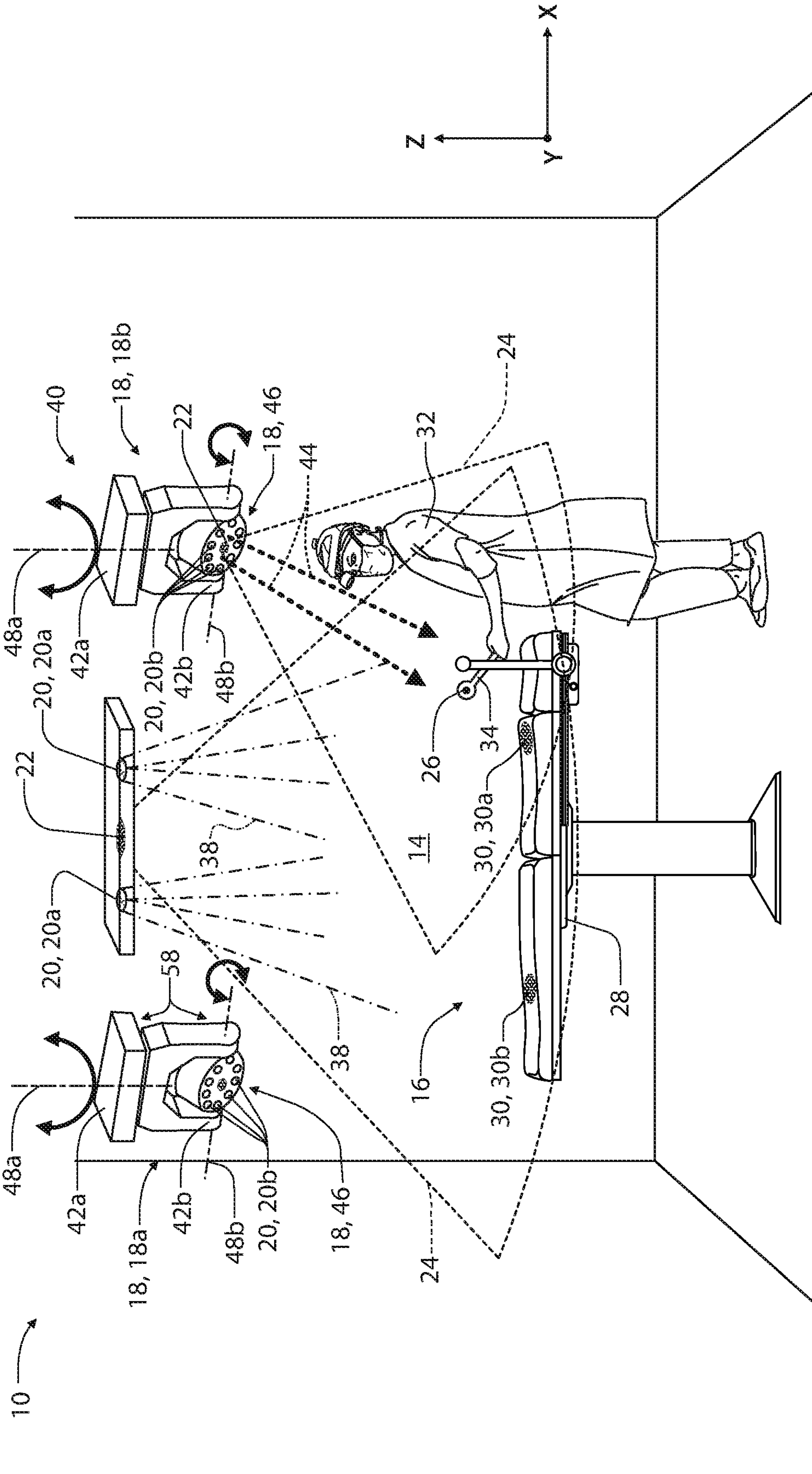
control a first function of the light assembly in response to identifying the first symbol;

identify a second symbol positioned on a second portion of the control instrument in the image data; and

control a second function of the light assembly in response to identifying the second symbol.

20. The illumination system according to claim 19, wherein the controller is further configured to:

control a third function of the light assembly in response to identifying the first symbol and the second symbol in the image data.


X
Z
Y
10
14
16
18, 18a
18, 18b
18, 46
20, 20a
20, 20b
22
24
26
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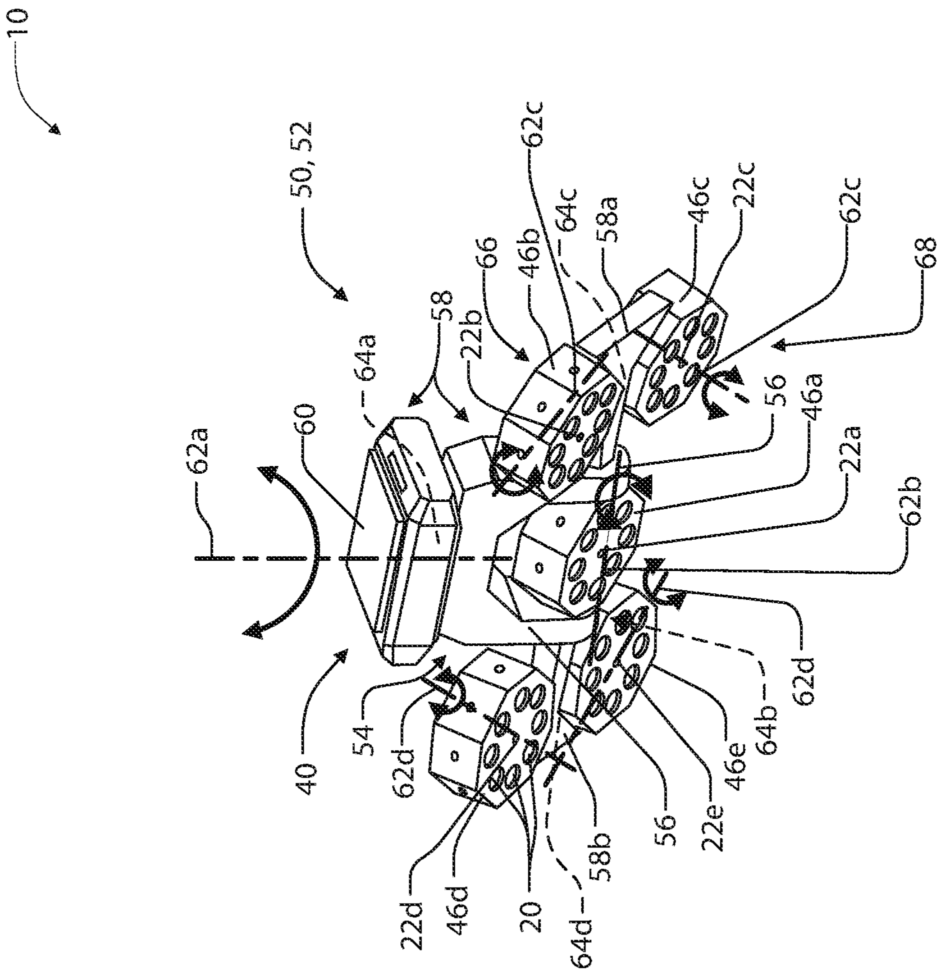
40
42a
42b
44
48a
48b
58

FIG. 1


10
50, 52
62a
60
64a
58
66
46b
22b
62c
64c
58a
46c
22c
62c
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56
46a
22a
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58b
64d
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46d
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54
40

FIG. 2

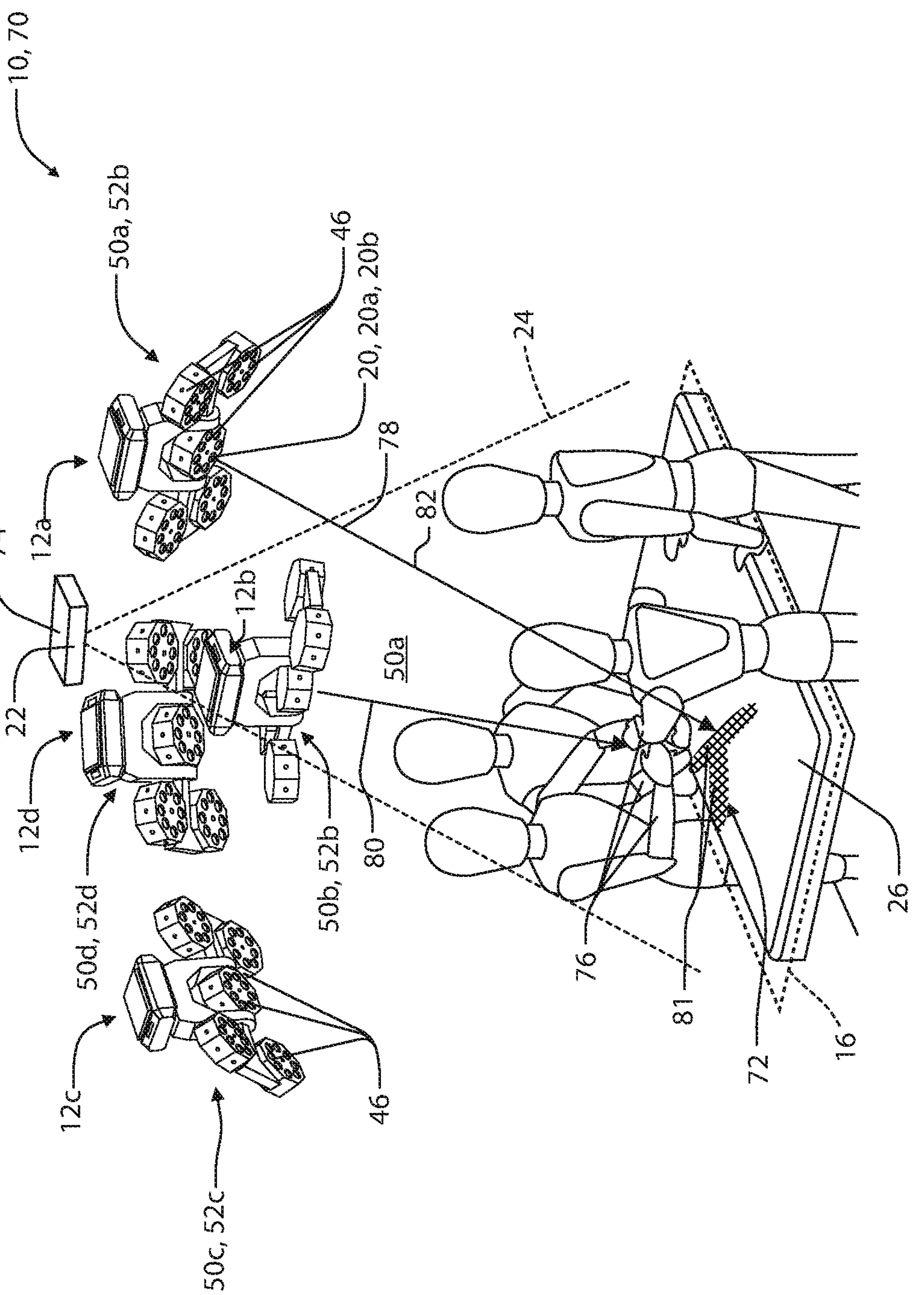
10, 70
50a, 52b
46
20, 20a, 20b
24
78
82
74
12a
12b
22
50a
12d
80
50b, 52b
50d, 52d
76
81
26
72
16
12c
46
50c, 52c

FIG. 3

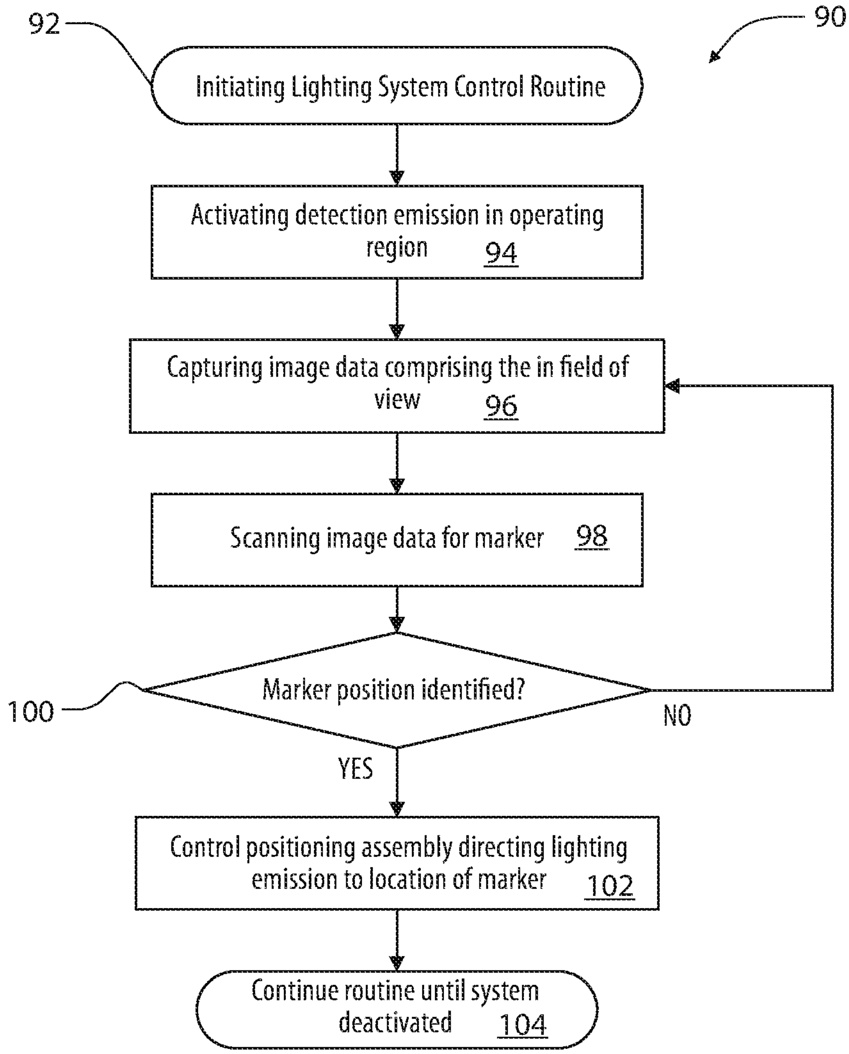
92
90
Initiating Lighting System Control Routine
Activating detection emission in operating region 94
Capturing image data comprising the in field of view 96
Scanning image data for marker 98
Marker position identified?
100
NO
YES
Control positioning assembly directing lighting emission to location of marker 102
Continue routine until system deactivated 104

FIG. 4

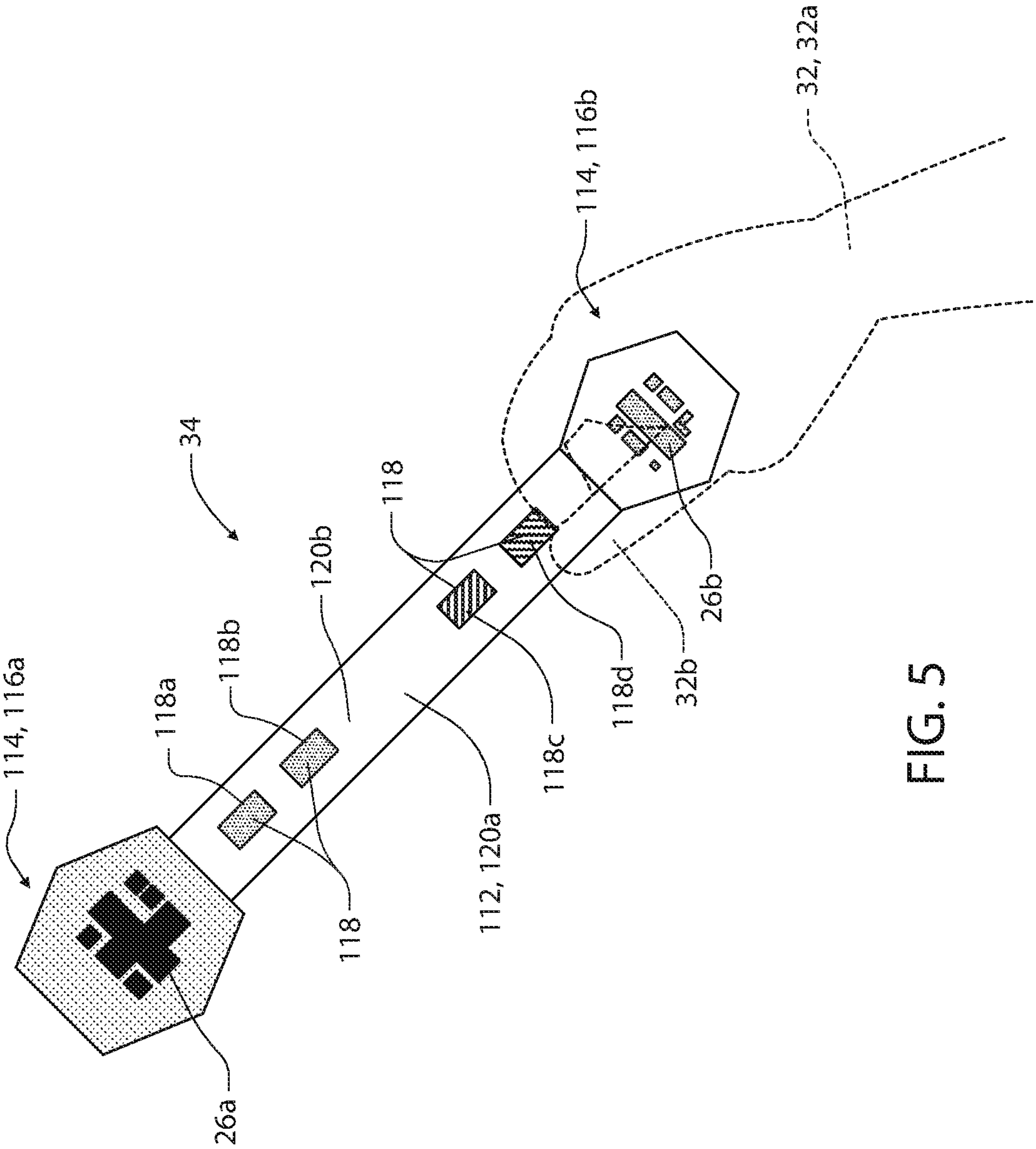
114, 116a
118a
118b
120b
34
118
114, 116b
32, 32a
26a
118
112, 120a
118c
118d
32b
26b

FIG. 5

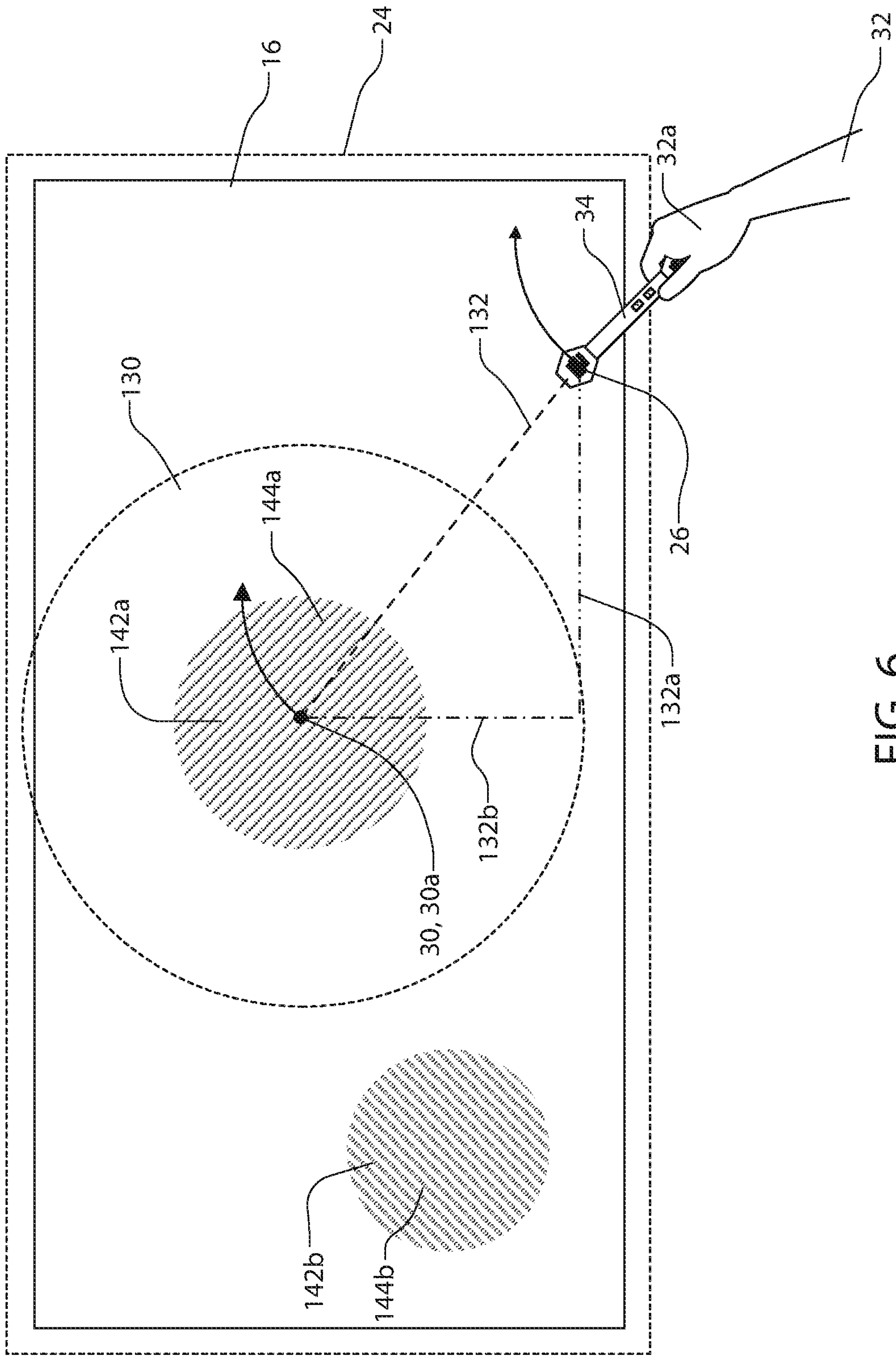

FIG. 6

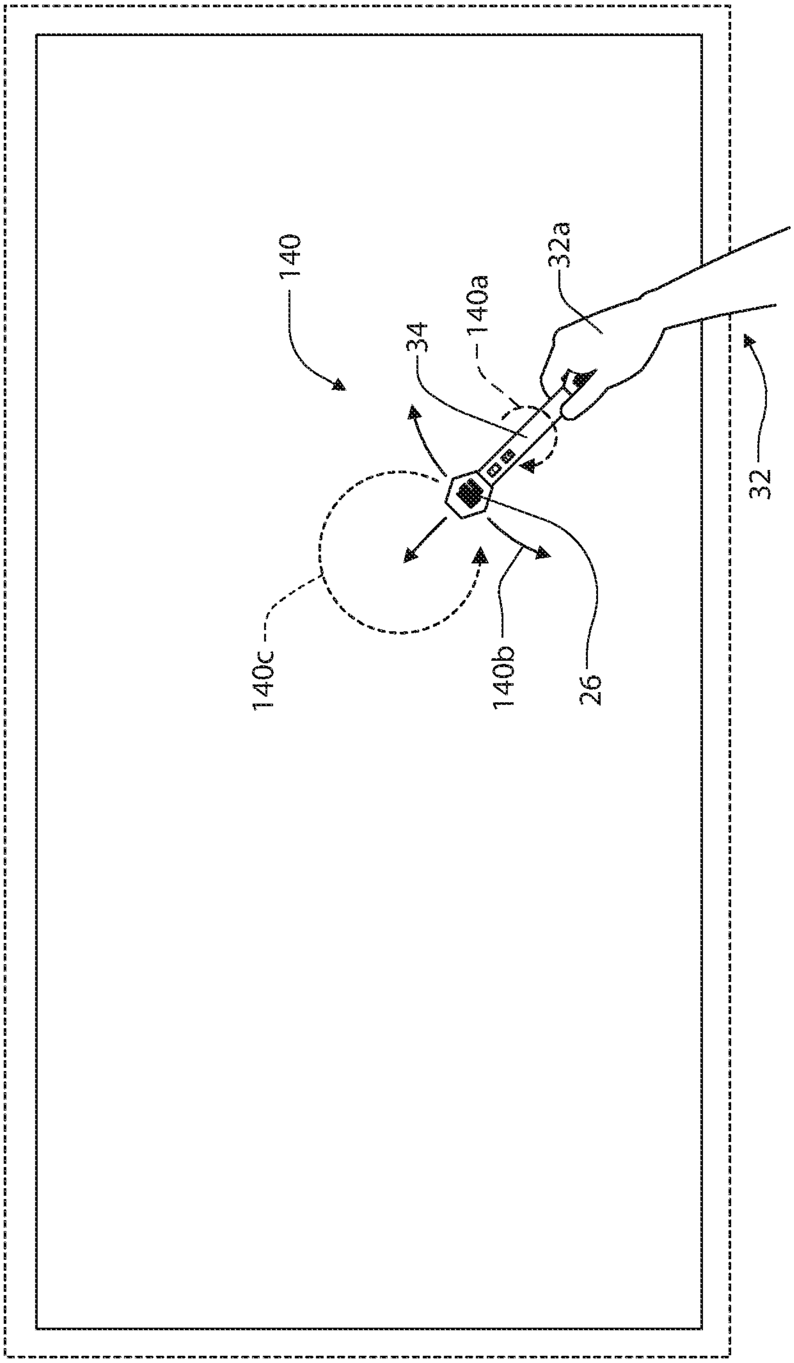

FIG. 7

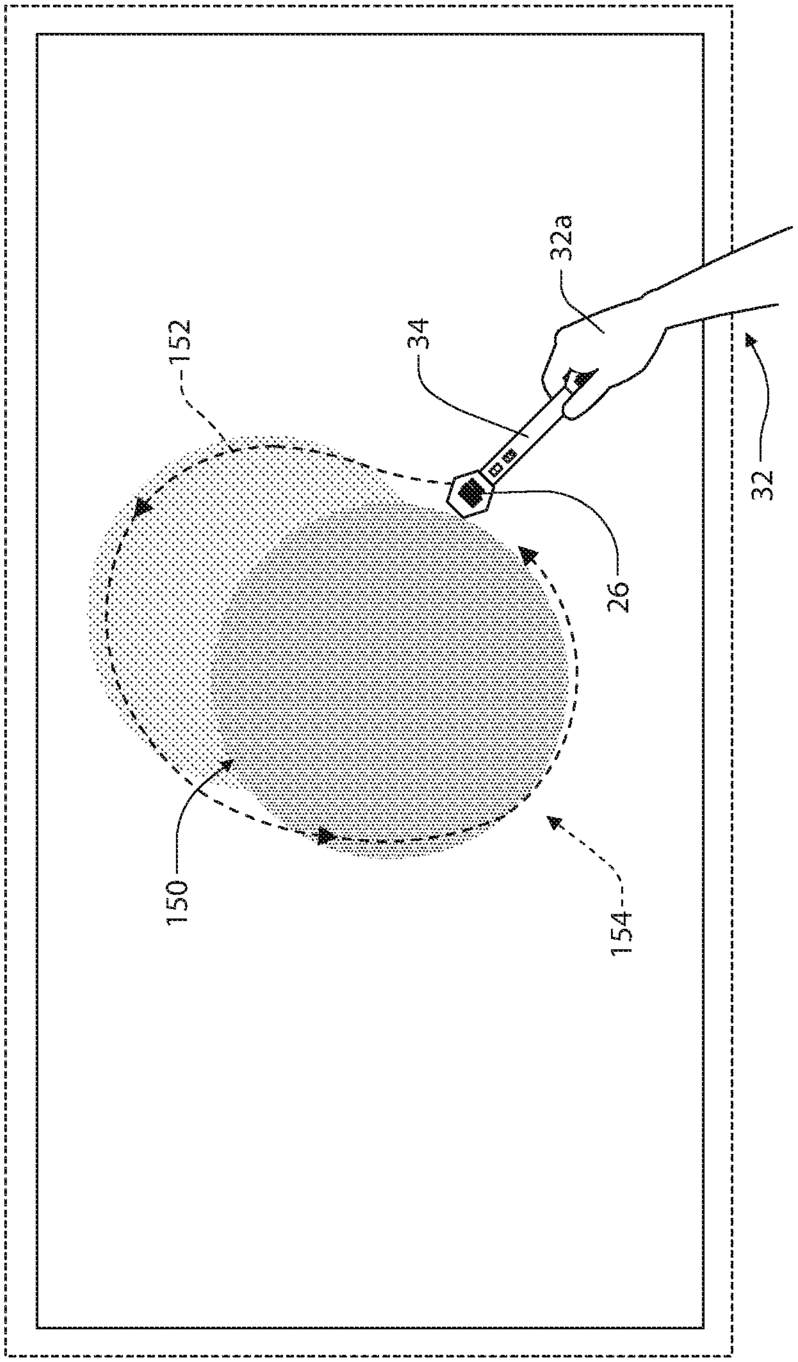

FIG. 8

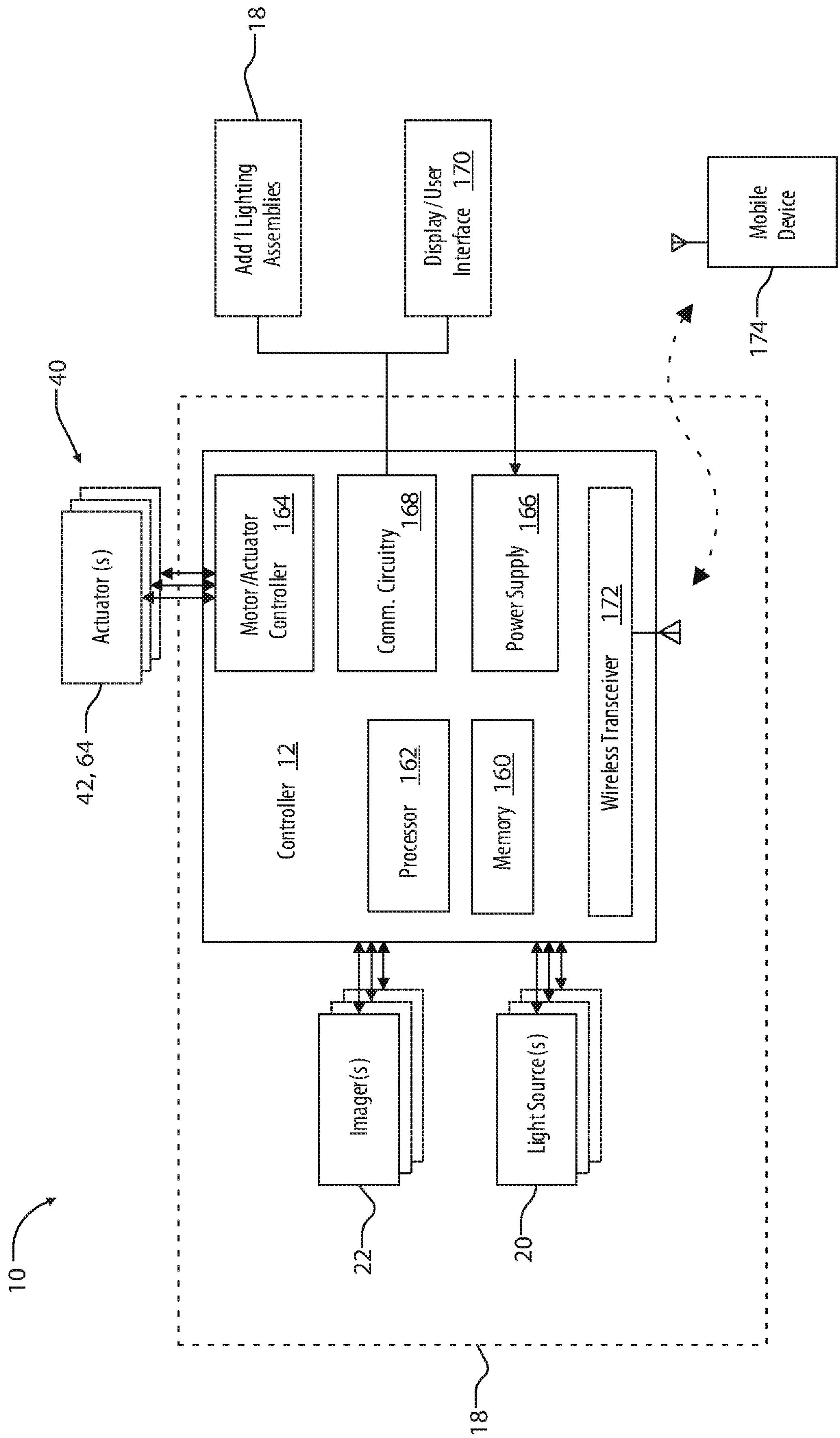
18
Add'l Lighting Assemblies
Display / User Interface 170
Mobile Device
174
40
Actuator (s)
42, 64
Motor /Actuator Controller 164
Comm. Circuitry 168
Power Supply 166
Wireless Transceiver 172
Controller 12
Processor 162
Memory 160
Imager(s)
Light Source (s)
22
20
10
18

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 2020/050018

A. CLASSIFICATION OF SUBJECT MATTER

H05B 47/10 *(2020.01)*

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F 3/00, 3/033, G06K 9/00, H05B 47/10, 47/125, 47/175

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

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

G06F 3/00, 3/033, G06K 9/00, H05B 47/10, 47/125, 47/175

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 8736548 B2 (PRYOR TIMOTHY R) 27.05.2014	1-4, 10-13, 19-20
A	US 8817085 B2 (ABRI OMID et al.) 26.08.2014.	1-4, 10-13, 19-20
A	US 6079862 A (MATSUSHITA ELECTRIC WORKS LTD) 27.06.2000	1-4, 10-13, 19-20

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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

“E” earlier document but published on or after the international filing date

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

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

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

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

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

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

“&” document member of the same patent family

Date of the actual completion of the international search

21 March 2020 (21.03.2020)

Date of mailing of the international search report

09 April 2020 (09.04.2020)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB 2020/050018

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

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 5-9, 14-18
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

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

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.