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(54) **IMAGING DEVICE FOR ANIMALS**

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(57) **ABSTRACT**

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An imaging device for animals of the present invention comprises: a darkroom box having an opening part through which a portion of a subject to be examined protrudes to the outside or an external stimulator can be inputted or outputted in order to apply stimulation; a subject-to-be-examined supporter for mounting the subject to be examined thereon so as to facilitate the protruding of the portion of the subject to be examined to the outside or the application of an external stimulus; an image capturing device for photographing the subject to be examined before, after or during the application of the external stimulus while applying the external stimulus to the portion of the subject to be examined mounted on the subject-to-be-examined supporter; and an image processing system for processing the image captured through the image capturing device.

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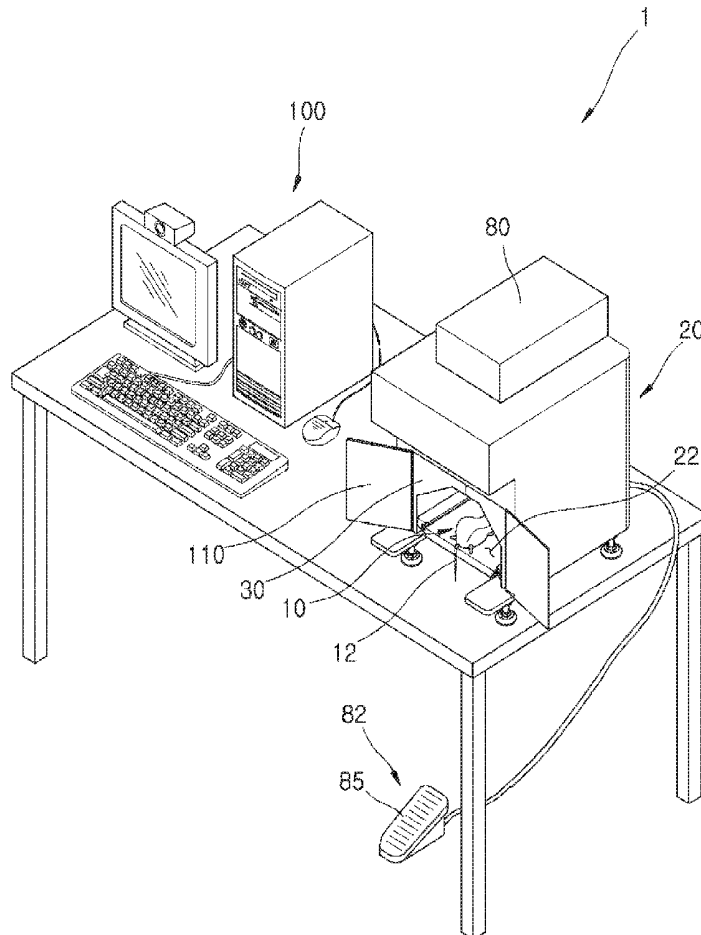


FIG. 1

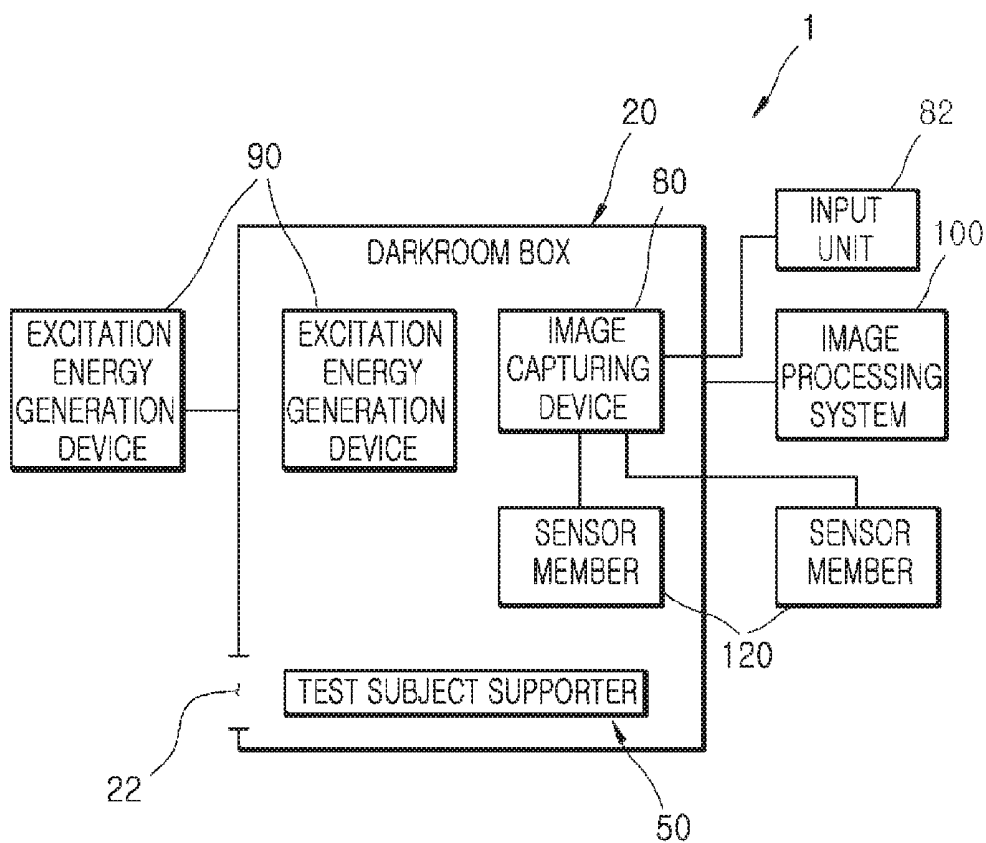


FIG. 2

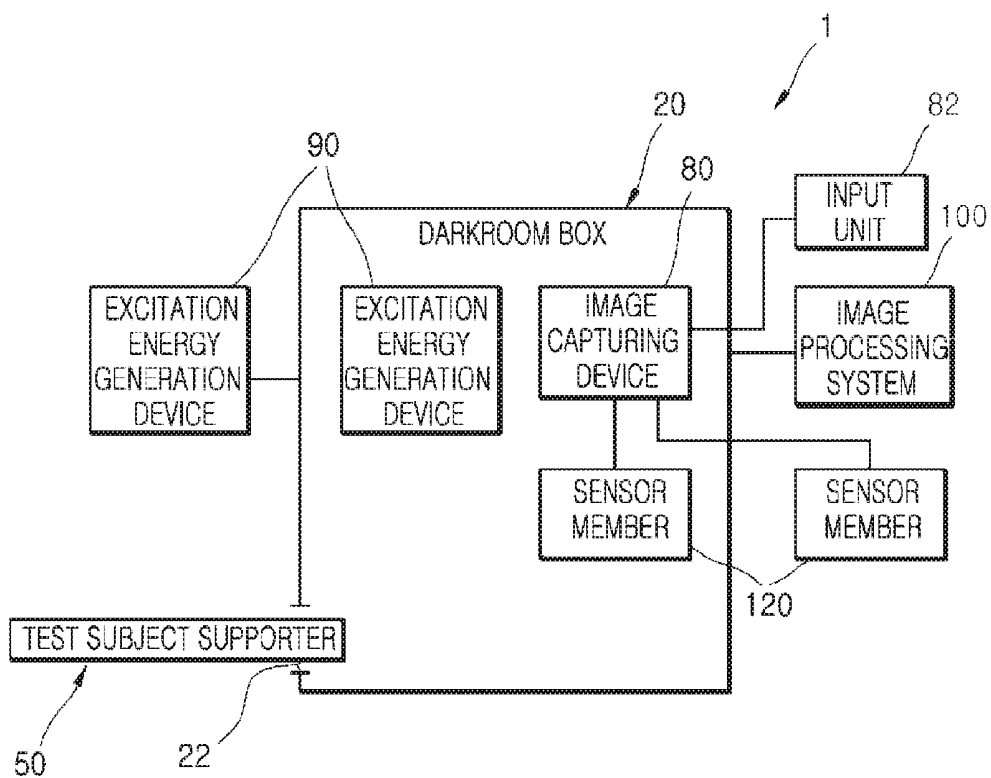


FIG. 3

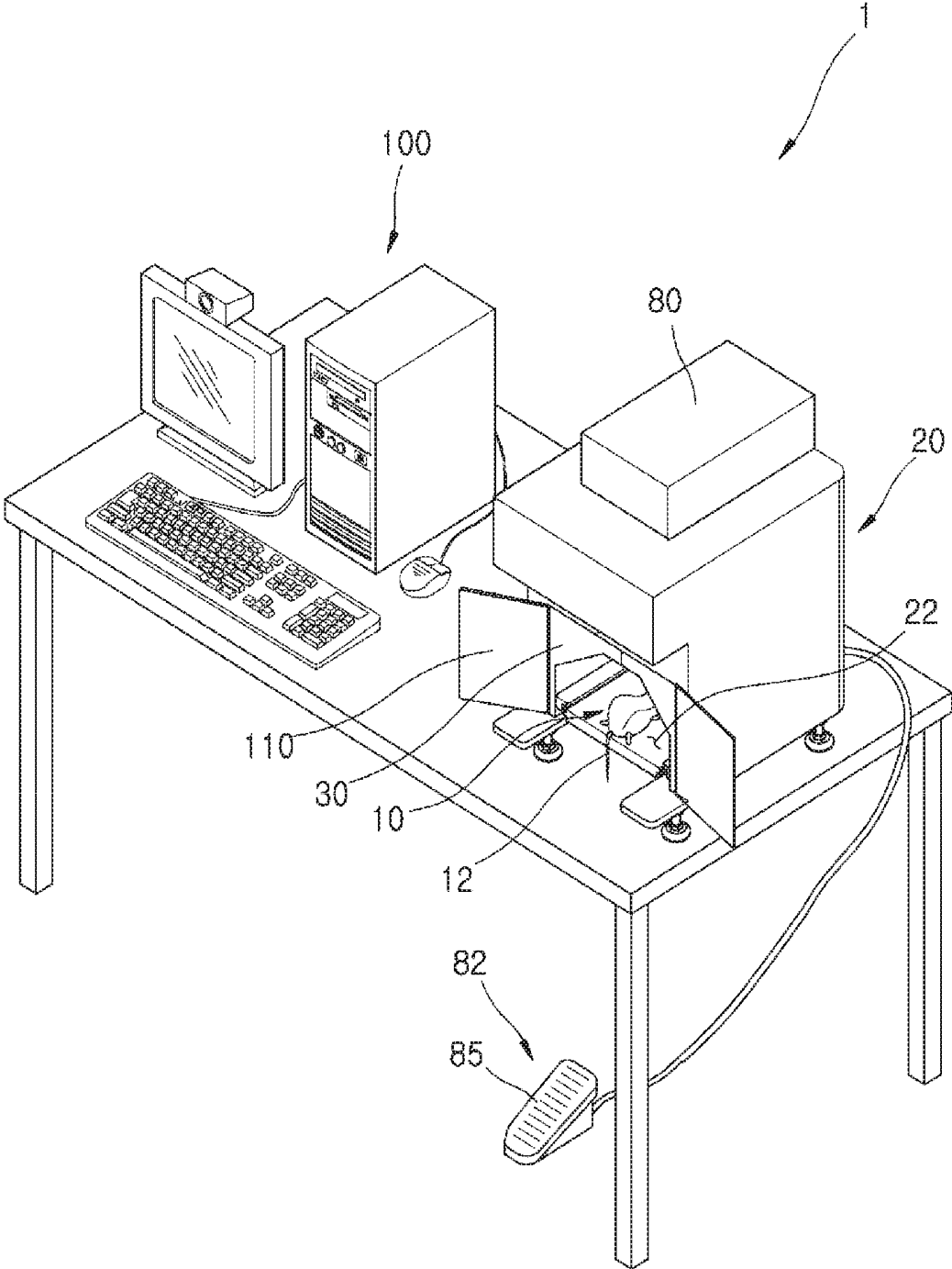


FIG. 4

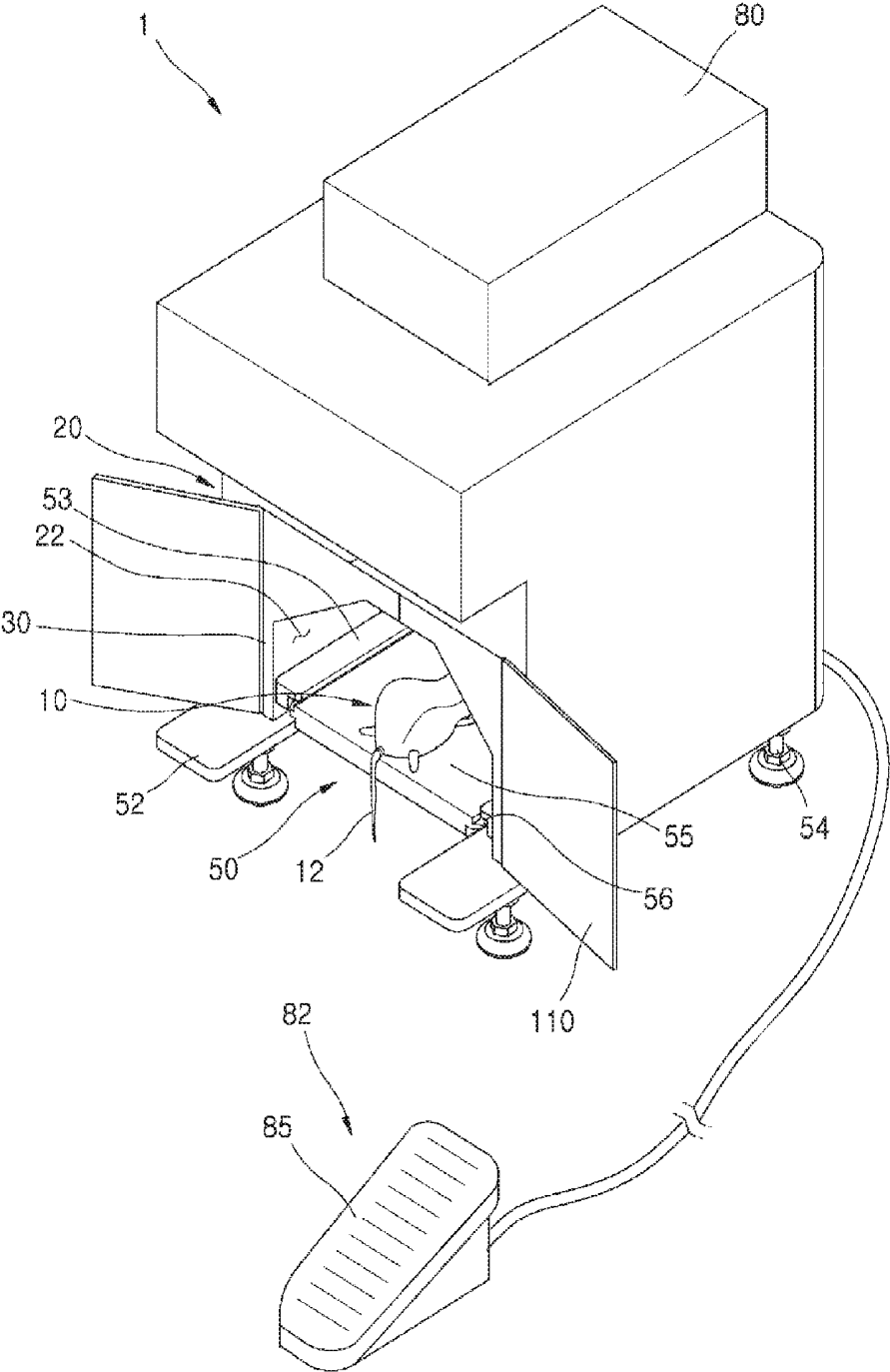


FIG. 6

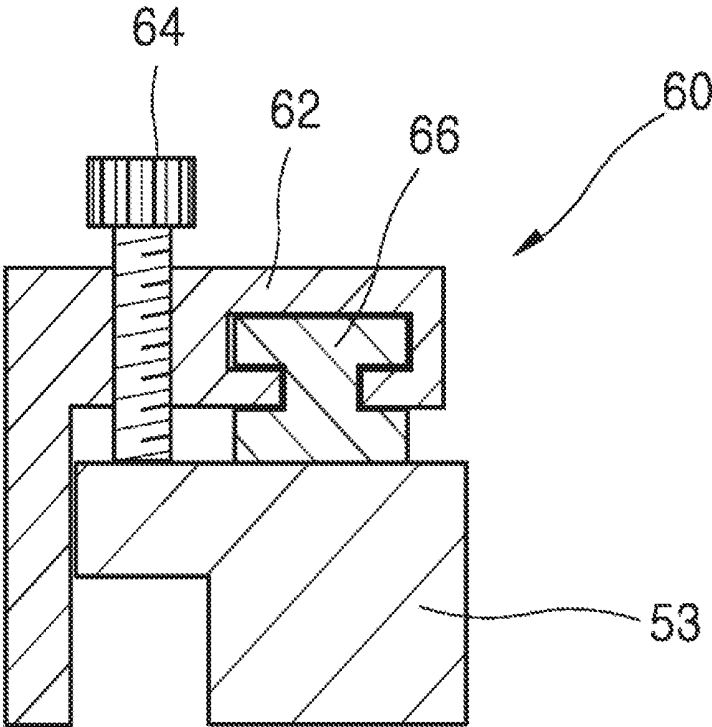


FIG. 7

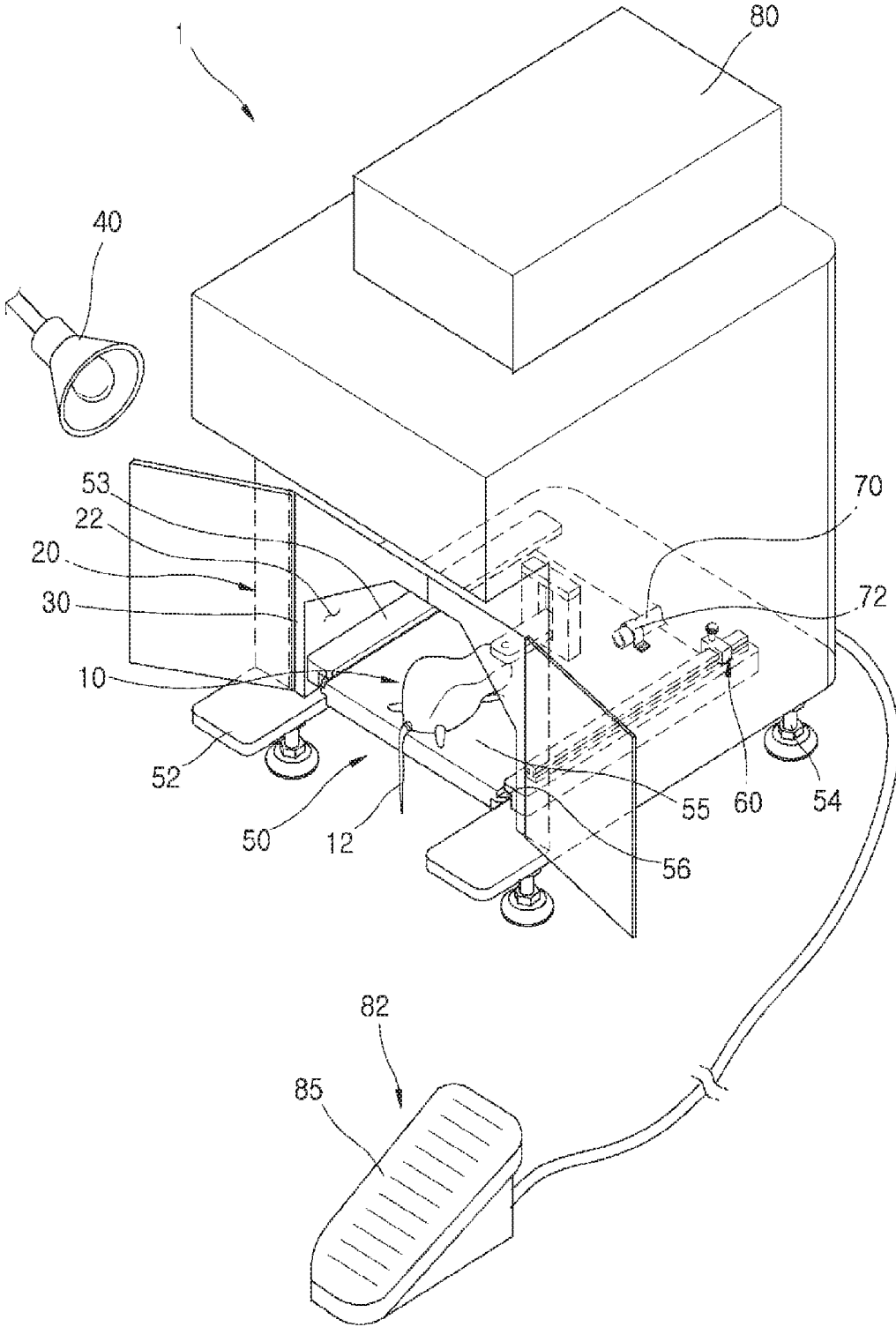
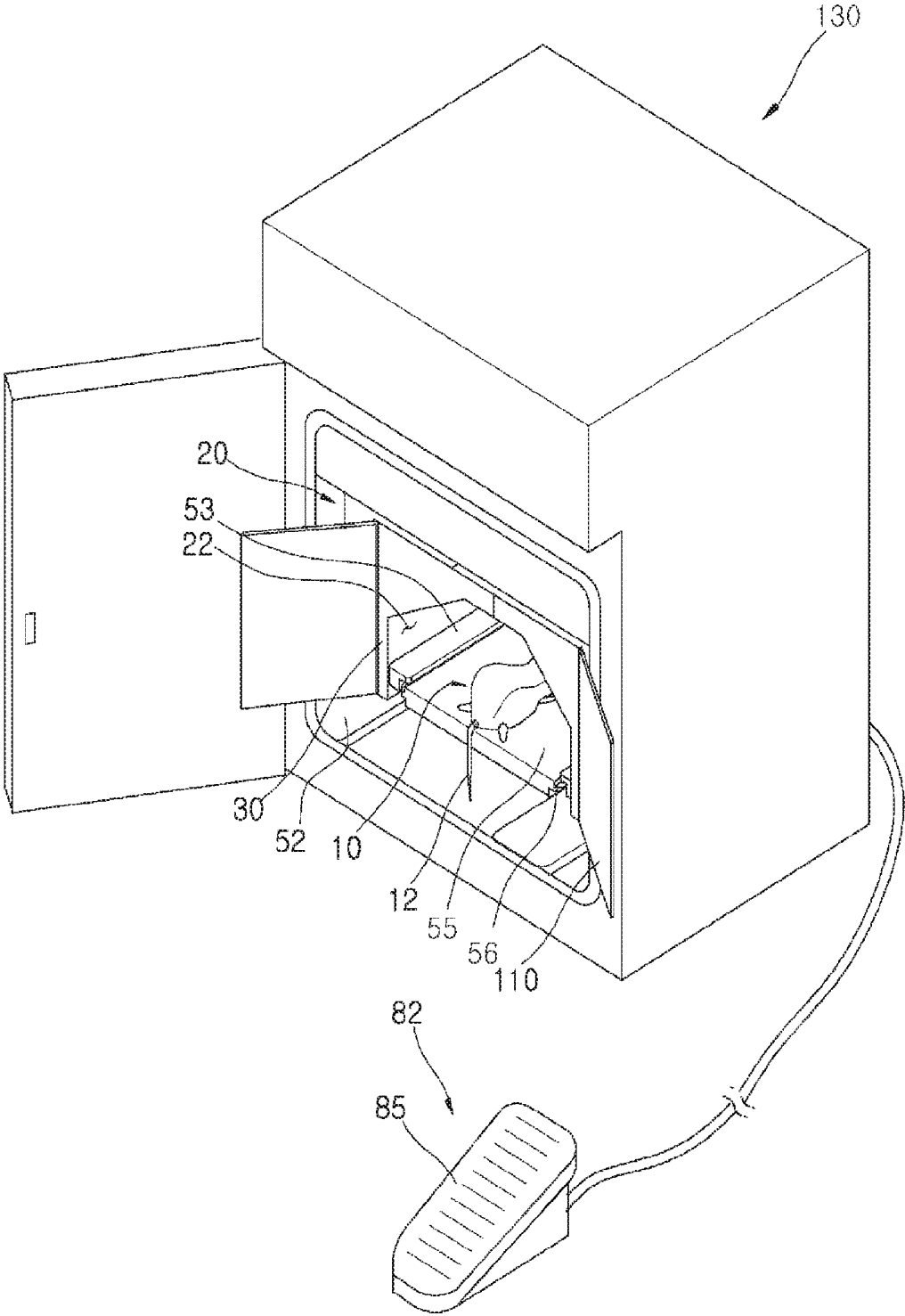


FIG. 8



IMAGING DEVICE FOR ANIMALS

TECHNICAL FIELD

[0001] The present invention relates to an imaging device for animals, and more particularly, to an imaging device for animals capable of taking images of changes in a test subject while applying an external stimulus to the test subject.

BACKGROUND ART

[0002] Generally, imaging devices for animals are devices used when conducting an experiment on an animal or an organ and a cell thereof for developing a drug or researching a function of a protein. As experimental animals used in the imaging device for animals, the experiment is mainly conducted on a mouse, rat, or the like. After injecting a fluorescence conjugated antibody or a vascular-contrast-medium with respect to a research protein, a fluorescent substance (5-ALA) responding to a cancer tissue, or the like into an experimental animal and taking images thereof, various types of research on a position of the research protein in a body, a shape of blood vessel, a degree of blood flow, a size of cancer tissue or a function of a blood vessel in the cancer tissue, and the like may be conducted.

[0003] Image capturing devices for taking images of experimental animals using X-rays, computerized tomography (CT), magnetic resonance imaging (MRI), and the like have been developed. The image capturing is conducted in a state in which an experimental animal is mounted in a darkroom box or a separate space for imaging.

[0004] The background art of the present invention is disclosed in Korean Patent Laid-Open Publication No. 2011-0058496 (published on Jun. 1, 2011, and entitled X-ray Radiographic Apparatus for Radiography of Small-Sized Laboratory Animal).

DISCLOSURE

Technical Problem

[0005] Conventionally, there has been a problem of not being able to obtain an accurate measurement value for influence on and changes in a test subject while treating or applying external stimulus on the test subject such as a part of an animal body, a tissue or a cell extracted from an animal body, molecules in a cell including a deoxyribonucleic acid (DNA), a ribonucleic acid (RNA), and a protein which are research objects in molecular biology because taking images of the influence and changes in a quick manner is not feasible. Thus, a need for improving the problem has been demanded.

[0006] The present invention is directed to providing an imaging device for animals capable of taking images of influence on and changes in a test subject while treating the test subject serving as an imaging subject.

Technical Solution

[0007] One aspect of the present invention provides an imaging device for animals which includes a darkroom box provided with an opening through which a part of a test subject protrudes outward therefrom or an external stimulator moves in and out thereof, a test subject supporter on which the test subject is mounted so that the part of the test subject protrudes outward therefrom or an application of an external stimulus is facilitated, an image capturing device

which takes images of the test subject before, after, or while the external stimulus is applied while applying the external stimulus to the part of the test subject mounted on the test subject supporter, and an image processing system which processes the images taken by the image capturing device.

[0008] In addition, the test subject may include an animal body or a tissue or cell and molecules in the cell extracted from the animal body, and it may be preferable that the external stimulus include at least one of a physical stimulus, a chemical stimulus, a temperature change, an injection of an external substance into the animal body, and an extraction of an internal substance of the animal body.

[0009] In addition, it may be preferable that the test subject supporter be installed to be movable in and out of the darkroom box.

[0010] In addition, it may be preferable that the test subject supporter move in a sliding manner.

[0011] In addition, it may be preferable that the test subject supporter include a fastening device which fastens or supports a part of an animal body in the test subjects to restrict unexpected motion of the animal.

[0012] In addition, it may be preferable that a position of the fastening device be attachable by moving a position thereof, and the fastening device be detachable.

[0013] In addition, it may be preferable that the image capturing device include a combination of at least one of an optical image capturing device, X-rays, computerized tomography (CT), and magnetic resonance imaging (MRI).

[0014] In addition, it may be preferable that the invention further include an excitation energy generation device which emits energy for the image capturing device to acquire an image and is installed at least at one place of an inside or outside of the darkroom box.

[0015] In addition, it may be preferable that the invention further include a blackout device which manually or automatically adjusts a size of the opening through which external light is incident into the darkroom box.

[0016] In addition, it may be preferable that the invention further include an outer door which shields the opening to block external light from being incident into the darkroom box.

[0017] In addition, it may be preferable that the invention further include an input unit which receives operational signals for operating the image capturing device.

[0018] In addition, it may be preferable that the invention further include a sensor member which senses the external stimulus applied to the test subject or a specific behavior pattern of an operator for taking images and induce an implementation of the image capturing device.

[0019] In addition, it may be preferable that the invention further include a stopper which constantly maintains a position selected for the test subject supporter to be fixed in the darkroom box when the test subject supporter moves in and out of the darkroom box.

[0020] In addition, it may be preferable that the invention further include a lighting device which supplies light when applying the external stimulus to the test subject.

[0021] In addition, it may be preferable that the image processing system perform at least one function of image processing, display, storage, and analysis for the images taken, and the analysis analyzes the images by parameterization, digitization, and two dimensional or three dimensional maps.

Advantageous Effects

[0022] The imaging device for animals according to the embodiment of the present invention can take real time images of influence on and changes in an animal while applying an external stimulus in a state in which a part of the animal body protrudes from the darkroom box or changes in the animal due to the external stimulus can be imaged because images before and after the external stimulus is applied are obtainable, and all of which can be statistically analyzed, thus an accuracy of imaging measurement can be improved.

DESCRIPTION OF DRAWINGS

[0023] FIG. 1 is a block diagram schematically illustrating a structure of an imaging device for animals according to one embodiment of the present invention.

[0024] FIG. 2 is a block diagram schematically illustrating a state in which a test subject supporter protrudes outward from a darkroom box according to one embodiment of the present invention.

[0025] FIG. 3 is a perspective view schematically illustrating the imaging device for animals according to one embodiment of the present invention.

[0026] FIG. 4 is an enlarged perspective view illustrating a darkroom box according to one embodiment of the present invention.

[0027] FIG. 5 is a perspective view schematically illustrating the test subject supporter according to one embodiment of the present invention.

[0028] FIG. 6 is a cross-sectional view schematically illustrating a state in which a stopper is installed according to one embodiment of the present invention.

[0029] FIG. 7 is a perspective view schematically illustrating an imaging device for animals according to another embodiment of the present invention.

[0030] FIG. 8 is a perspective view schematically illustrating an imaging device for animals according to still another embodiment of the present invention.

MODES OF THE INVENTION

[0031] Hereinafter, an imaging device for animals according to one embodiment of the present invention will be described in detail with reference to the accompanying drawings. An animal serving as a test subject will be taken as an example for convenience of description. Thicknesses of lines and sizes of components may be somewhat exaggerated in the drawing for the sake of clarity and convenience of descriptions.

[0032] In addition, terms described below are defined considering functions of the present invention, but the terms may be changed by an intention or a practice of users and operators. Thus, definitions of these terms may have to be made on the basis of the content throughout the specification.

[0033] FIG. 1 is a block diagram schematically illustrating a structure of an imaging device for animals according to one embodiment of the present invention, FIG. 2 is a block diagram schematically illustrating a state in which a test subject supporter protrudes outward from a darkroom box according to one embodiment of the present invention, FIG. 3 is a perspective view schematically illustrating the imaging device for animals according to one embodiment of the present invention, FIG. 4 is an enlarged perspective view

illustrating a darkroom box according to one embodiment of the present invention, FIG. 5 is a perspective view schematically illustrating the test subject supporter according to one embodiment of the present invention, FIG. 6 is a cross-sectional view schematically illustrating a state in which a stopper is installed according to one embodiment of the present invention, FIG. 7 is a perspective view schematically illustrating an imaging device for animals according to another embodiment of the present invention, and FIG. 8 is a perspective view schematically illustrating an imaging device for animals according to still another embodiment of the present invention.

[0034] As illustrated in FIGS. 1 to 6, an imaging device for animals 1 according to one embodiment of the present invention includes a darkroom box 20 having an opening 22 through which a part of a test subject 5 to be stimulated protrudes to the outside or through which an external stimulator may enter and exit, a test subject supporter 50 provided to mount the test subject 5 so that a part of the test subject 5 protrudes to the outside or applying an external stimulus to the test subject 5 is facilitated, an image capturing device 80 which takes images of the test subject 5 before, after, or while an external stimulus is activated while the external stimulus is applied to a part of the test subject 5 mounted on the test subject supporter 50, and an image processing system 100 for processing the images taken by the image capturing device 80.

[0035] The test subject 5 includes a body of an animal 10 or a tissue or cell and molecules in the cell extracted from the body of an animal 10. Cells and molecules in the cells may be prepared in a state of an object to be observed by being positioned on various types of well dishes, membranes, biochips or the like to facilitate the observation.

[0036] The imaging device for animals 1 according to one embodiment of the present invention is a device used when taking images of a living animal 10 in an anesthetized or non-anesthetized state for the purpose of imaging a shape, a structure, a function, etc. of the animal 10.

[0037] Besides a mouse, a rat, and a rabbit which are mainly used for research, a mammal such as a dog, a cat, a pig, etc., an amphibian, and the like are included as the animal 10 among test subjects 5 to be put into the imaging device for animals 1 for obtaining images.

[0038] When an external stimulus is directly or indirectly applied to a part of a body of the animal 10, the imaging device for animals 1 according to one embodiment of the present invention is used to image responses at the part to which the stimulus is applied and another part to which the stimulus is not applied.

[0039] The darkroom box 20 may be formed in various shapes which block external light within the inventive concept and is provided with the opening 22 so that a part of the test subject 5 protrudes to the outside. The darkroom box 20 according to one embodiment of the present invention includes the test subject supporter 50 therein and is formed in a box shape. Through the opening 22, the test subject 5 may move in and out of the darkroom box 20, and the test subject supporter 50 on which the test subject 5 is mounted may move in and out of the darkroom box 20.

[0040] After the animal 10 is positioned in the darkroom box 20, a blackout device 30 which manually or automatically adjusts a size of the opening 22 through which external light is incident into the darkroom box 20 is installed.

[0041] The blackout device 30 is installed at the darkroom box 20 before or after completing movement of the test subject supporter 50 on which the test subject 5 is mounted into the darkroom box 20. The blackout device 30 is sufficiently open to a size for applying an external stimulus to the animal 10 serving as the test subject 5 mounted on the test subject supporter 50, and the opened size may be adjusted depending on a size of the body of the animal 10 which protrudes outward from the darkroom box 20.

[0042] The blackout device 30 is manually operated or automatically operates to adjust a quantity of incident light into the darkroom box 20, and when a tail 12 of the animal 10 used as the test subject 5 protrudes outward from the darkroom box 20, the blackout device 30 may block the incident light into the darkroom box 20 by shielding all other portions besides the tail 12 of the animal 10.

[0043] The blackout device 30 is formed in a curtain shape and may perform a manual or automatic operation which laterally opens the opening 22 or closes the opening 22 toward the center. In the case in which the blackout device 30 automatically operates, the blackout device 30 may be laterally moved by receiving power of a motor in a gear engagement method. Alternatively, various modified implementations are possible for moving the blackout device 30 such as broadening or narrowing the size of the opening 22 by vertically moving the blackout device 30 in a curtain shape, and the like.

[0044] Alternatively, the blackout device 30 may be formed in a sheet shape to manually or automatically perform an operation of laterally opening or closing toward the center. In the case in which the blackout device 30 automatically operates, the blackout device 30 may be laterally moved by receiving power of a motor via an engagement method of a rack and pinion gear. Alternatively, various modified implementations are possible for broadening or narrowing the size of the opening 22 by vertically moving the blackout device 30 in a sheet shape, and the like.

[0045] The driving force to automatically move the blackout device 30 may employ various types of drive sources such as a cylinder, a linear driving device, a motor, or the like, and power of these drive sources may be transferred to the blackout device 30 via gear engagement, etc.

[0046] To block the light from being incident into the darkroom box 20 via the opening 22, at least one of the blackout device 30 and an outer door 110 may be used as needed. That is, the blackout device 30 or the outer door 110 may be installed at the opening 22, or both of the blackout device 30 and the outer door 110 may be installed.

[0047] The outer door 110 shields the opening 22 to block external light from being incident into the darkroom box 20. As illustrated in FIGS. 4 and 8, the outer door 110 is rotatably installed at the darkroom box 20 or an extension box 130 which surrounds the darkroom box 20, and is rotated by an operation of an operator to shield a front surface of the opening 22 or minimize an extent to which the opening 22 is open. The outer door 110 is manually opened and closed, but, according to need, the opening and the closing may also automatically perform by transferring power of a motor to the rotation shaft of the outer door 110. In addition, the outer door 110 may be moved in a rotating method, and may be installed to be slidable in a horizontal direction at an outer side of the darkroom box 20.

[0048] As illustrated in FIG. 8, the extension box 130 may be additionally installed in a shape of surrounding an outer

side of the darkroom box 20, and the outer door 110 may be installed at each of the darkroom box 20 and the extension box 130. Alternatively, various modified implementations are possible such as the outer door 110 being installed at only one of the darkroom box 20 or the extension box 130, etc. as needed.

[0049] As illustrated in FIG. 7, in another embodiment of the present invention, a lighting device 40 may be installed outside the darkroom box 20. The lighting device 40 may supply light to facilitate work when applying an external stimulus to the body of the animal 10 serving as the test subject 5 which protrudes outward from the darkroom box 20. In addition, it is preferable that an image-taking software of the image capturing device 80 and the image processing system 100 be interlocked with power control of the lighting device 40 to control the power of the lighting device 40 to be turned off during the image-taking of the image capturing device 80 to prevent light from being incident into the darkroom box 20 via the opening 22. Meanwhile, the lighting device 40 may provide a bright work environment for easier work visually when applying an external stimulus to the animal 10.

[0050] As illustrated in FIGS. 1 to 6, the test subject supporter 50 may be formed in various shapes in which an animal 10 is mounted on that a part of a body of the animal 10 serving as a test subject 5 protrudes outward from the darkroom box 20 within the inventive concept.

[0051] The test subject supporter 50 according to one embodiment allows the animal 10 to be mounted so as not to disturb motion of the animal 10 when taking images of motion of the animal 10. That is, when it is intended to observe motion of the test subject 5 by an external stimulus, tissues expected to move is mounted as not to be fastened by a fastening device 57 but to be freely moved. To this end, the test subject supporter 50 fastens only a part of a body of the animal 10 which needs to be fastened while permitted movement of other parts of the body of the animal 10 for taking images is not restricted.

[0052] The external stimulus includes at least one of a physical stimulus, a chemical stimulus, a temperature change, injecting an external substance into an animal body, and extracting an internal substance of an animal body. That is, the external stimulus may be a stimulus such as a temperature change, a physical or chemical stimulus, injecting a substance into a body, or extracting a substance from a body of the animal 10.

[0053] In addition, since the test subject supporter 50 is installed to be movable in and out of the darkroom box 20, various types of embodiments are possible such as moving the test subject supporter 50 to an outside of the darkroom box 20, applying a stimulus to a specific part of the animal 10, moving the test subject supporter 50 back into the darkroom box 20 to take images of the animal 10, and the like.

[0054] The animal 10 is mounted on the test subject supporter 50 so that a part of the body of the animal 10 to which the external stimulus is applied protrudes outward from the darkroom box 20. The test subject supporter 50 may or may not protrude outward from the darkroom box 20. In addition, the test subject supporter 50 may be moved in or out of the darkroom box 20 to mount the animal 10 thereon.

[0055] The test subject supporter 50 which moves in a sliding method may move in or out of the darkroom box 20,

and the animal **10** mounted on the test subject supporter **50** may also be moved in or out of the darkroom box **20** along with the test subject supporter **50**.

[0056] In addition, the animal **10** may be mounted on the test subject supporter **50** in the anesthetized or non-anesthetized state.

[0057] One embodiment describes the imaging device for animals **1** invented to be advantageous for taking images while injecting a contrast medium into a vein of the tail **12** of a mouse or rat employed as the imaging subject animal **10**.

[0058] The test subject supporter **50** according to one embodiment of the present invention includes a support member **52**, guide rails **53**, leg members **54**, a moving member **55**, and a fastening device **57**.

[0059] The support member **52** having a board shape is installed under the darkroom box **20**. An inner space in which the moving member **55** is slidable is provided at an inner side of the support member **52**, and guide rails **53** are installed on opposite sides in a width direction of the support member **52** (a lateral direction based on FIG. 5). Two guide rails **53** form a pair and are installed in parallel, and guide protrusions **56** which protrude on opposite sides of the moving member **55** are inserted between the guide rails **53** and the support member **52** to be slidable.

[0060] In addition, installation places and the number of the support member **52** and the guide rails **53** may be modified depending on the size of the moving member **55**. For instance, in the case in which the size of the moving member **55** is enlarged, the support member **52** and the guide rails **53** may be formed to be two or more and installed beneath the moving member **55**.

[0061] The leg members **54** installed under the support member **52** are adjustable in length. The leg members **54** may be installed under the darkroom box **20** or the support member **52**. Since the protrusion lengths of the leg members **54** are adjustable, a height of the darkroom box **20** and the test subject supporter **50** are adjustable.

[0062] When applying an external stimulus to the tail **12** of the animal **10** which protrudes outward from the darkroom box **20**, the lengths of the leg members **54** may be adjusted to provide a sufficient space between the tail **12** and a floor or between the tail **12** and a desk on which the darkroom box **20** is put for convenient hand motion of an operator.

[0063] A space suitable for applying an external stimulus is securable depending on a size of the animal **10** which protrudes outward from the darkroom box **20** since the space between the desk and the darkroom box **20** is adjustable by adjusting the lengths of the leg members **54**. The leg members **54** may be installed at an inner side or an outer side, or at the support member **52** of the test subject supporter **50**, but it is advantageous to be installed at the outer side of the darkroom box **20** or under the support member **52** for freely adjusting the height.

[0064] The moving member **55** is formed in a board shape on which the animal **10** is put, and guide protrusions **56** are provided on opposite sides of the moving member **55** to guide the moving member **55** in a horizontal direction through the guide rails **53**. The moving member **55** of the test subject supporter **50** is installed in a sliding method to be freely moved in and out of the darkroom box **20**, and is slid and pulled out of the darkroom box **20** when mounting the animal **10** such as a mouse on the moving member **55**.

[0065] The fastening device **57** may be formed in various shapes within the inventive concept which fasten or support a part of a body of the animal **10** to restrict unexpected motion of the animal **10**. In addition, the fastening device **57** may be moved and attached at a different position, and is detachable.

[0066] The fastening device **57** fastens only a part of a body of an animal to restrict motion of a region of the body to be imaged by the image capturing device **80**. In addition, an installation position of the fastening device **57** may be adjustable to match various sizes of animals **10** since the fastening device **57** may be moved and attached in the test subject supporter **50** and is detachable.

[0067] The fastening device **57** according to one embodiment includes a fastening body **58** fixed to the moving member **55** of the test subject supporter **50**, and a pressing member **59** which vertically moves along the fastening body **58** and grabs the animal **10**. The fastening body **58** is fitted and coupled to the moving member **55** or bolt-coupled thereto, and an installation position may be changed as needed. The fastening body **58** is perpendicularly installed on the moving member **55**.

[0068] The pressing member **59** may be manually operated or automatically operates along the fastening body **58** and presses the animal **10** at a predetermined force to restrict a movement of the animal **10**. The pressing member **59** moves vertically along the fastening body **58**, and, when the pressing member **59** is moved manually, an engaging bolt (not shown) which vertically passes through the fastening body **58** presses an upper side of the pressing member **59**. Therefore, the pressing member **59** which presses an animal is constrained from moving upward. An operator may constrain the pressing member **59** from moving upward by moving the pressing member **59** by hand to press the animal **10** and rotating the engaging bolt to press an upper side of the pressing member **59**.

[0069] In the case in which the pressing member **59** moves automatically, the pressing member **59** is installed to be vertically slidable along the fastening body **58**. Protrusions protrude on opposite sides of the pressing member **59** in a horizontal direction, the protrusions which protrude from the pressing member **59** are inserted into the fastening body **58**, and thus the pressing member **59** may vertically slide along the fastening body **58**. A pressing device such as a cylinder is installed between an upper side of the pressing member **59** and the fastening body **58** to move the pressing member **59** downward. A rack gear is additionally installed at the pressing member **59**, a pinion gear is installed at a rotating axis of a motor, and the rack gear and the pinion gear are engaged to each other to move the pressing member **59** to an extent of a predetermined length. Besides the above, the pressing member **59** may automatically move using various types of driving apparatuses.

[0070] Therefore, when the animal **10** is mounted on the test subject supporter **50**, the animal **10** may be assisted in being mounted to be immobile by a device which fastens a part of a body of the animal **10** such as the fastening device **57**.

[0071] When mounting the animal **10** such as a mouse on the test subject supporter **50**, the animal **10** is mounted so that more than one third of the tail **12** of the animal **10** protrudes from the moving member **55** of the test subject supporter **50**. Here, the animal **10** is fastened on the test subject supporter **50** to facilitate the mounting of the animal

10. For example, a part of the body of the animal **10** such as a head **14**, teeth, a leg, a torso, or the like may be fastened by the moving member **55** of the test subject supporter **50**. The fastening device **57** may be installed at the moving member **55** of the test subject supporter **50** so as to be easily moved to a position or be removed. When mounting the animal **10** by the fastening device **57** is completed, the moving member **55** of the test subject supporter **50** is moved into the darkroom box **20**.

[0072] The imaging device for animals **1** includes a stopper **60** which constantly maintains a position selected for the test subject supporter **50** to be fixed in the darkroom box **20** when the test subject supporter **50** moves in and out of the darkroom box **20**.

[0073] Various types of stopper devices may be used within the inventive concept to select a position of the moving member **55** of the test subject supporter **50** so that the image capturing device **80** may take optimum images of a whole or a part of a body of the animal **10** and to restrict a movement of the moving member **55** of the test subject supporter **50** at a selected position.

[0074] The stopper **60** performs a function of stopping the moving member **55** at a desired or selected position while it is advancing into the darkroom box **20**. The stopper **60** is manually operated or automatically operates to restrict a movement of the moving member **55** so as to quickly take images of the animal **10** upon applying an external stimulus.

[0075] The stopper **60** according to one embodiment includes a stopper body **62**, an adjusting knob **64**, and a base member **66**. The base member **66** is fixedly installed to the guide rail **53**, and the stopper body **62** is slid along the base member **66** to stop at the position where the moving member **55** is supposed to be stopped. Thus, a movement of the moving member **55** is restricted as the moving member **55** is caught by the stopper body **62** while moving along the guide rail **53**.

[0076] The adjusting knob **64** is rotatably installed at the stopper body **62** and restricts a movement of the stopper body **62** since the adjusting knob **64** is rotated to come in contact with the guide rail **53**. Thus, a movement of the moving member **55** which moves along the guide rail **53** is restricted.

[0077] The base member **66** is fixed on the guide rail **53**, and stopper grooves are formed on opposite sides of the base member **66**. The stopper body **62** is provided with protrusions inserted into the stopper grooves provided on opposite sides of the base member **66**, and moves along the base member **66** in a rod shape. As the protrusions which extend downward from the stopper body **62** are positioned at the side surface of the guide rail **53**, the protrusions may restrict the moving member **55** which moves along the guide rail **53**.

[0078] An inhalation anesthesia apparatus for animals may be installed at the darkroom box **20** or the test subject supporter **50**. The inhalation anesthesia apparatus for animals according to one embodiment includes a tube **70** and a tube support member **72**.

[0079] The tube **70** through which an anesthetic gas is supplied for inhalation anesthesia for the animal **10** is installed at the test subject supporter **50**, and a movement of the tube **70** is restricted by the tube support member **72**. The tube **70** according to one embodiment is positioned at the moving member **55** of the test subject supporter **50**, and the tube support member **72** which surrounds an outer side of the tube **70** is fixed at the moving member **55**.

[0080] Various types of image capturing devices **80** may be used within the inventive concept to take images of the animal **10** mounted on the test subject supporter **50** while applying an external stimulus to a part of the animal immediately before, immediately after, or at the same time as the application of the external stimulus. In addition, the image capturing device **80** may facilitate acquisition of images even when external light is incident via the opening **22**.

[0081] The image capturing device **80** according to one embodiment is formed as a combination of at least one of an optical image capturing device, X-rays, computerized tomography (CT), and magnetic resonance imaging (MRI).

[0082] The above-described image capturing device **80** may acquire time-series images in real time or images which are not time-series at the same time as an external stimulus. The time-series images refer to images taken in a time sequence, and is also referred to as a video. The images which are not time-series images refer to various forms of photographic images including snapshot images.

[0083] In addition, the image capturing device **80** is capable of taking images before, after, or at the same time as the application of the external stimulus to the animal **10**. That is, the image capturing device **80** may take images of a time-series array or images which are not a time-series array at a desired time from before to after the application of the external stimulus.

[0084] In addition, the image capturing device **80** may increase measurement accuracy by providing an image for assuming that the test subject supporter **50** is put at a suitable position for imaging before main imaging.

[0085] Various types of input devices may be used as an input unit **82** which receives operational signals for operating the image capturing device **80**. The input unit **82** according to one embodiment uses a foot switch **85** which is operable by foot. The foot switch **85** operated by a foot of an operator includes a function of operating the image capturing device **80**. The image capturing device **80** may be operated by hands of the operator, and may be operated using the foot switch **85** operated by the foot of the operator when the operator works with his or her hands to apply an external stimulus to the animal **10**.

[0086] Various types of devices may be used as excitation energy generation devices **90** which emit energy for the image capturing device **80** to acquire images within the inventive concept.

[0087] The excitation energy generation devices **90** are preferably installed at least at one place of an inside or outside of the darkroom box **20**. In addition, the excitation energy generation devices **90** may generate a sufficient energy so that the image capturing device **80** is not hindered in acquiring images even when external light is incident to a part of the darkroom box **20**.

[0088] The excitation energy generation devices **90** are devices which generate various types of light or energy such as light energy, visible rays, X-rays, etc. within the inventive concept and emit energy for the image capturing device **80** to acquire images.

[0089] As a use example of the imaging device for animals **1** in the case of using a contrast medium as the external stimulus, a contrast medium for near-infrared rays is injected to a blood vessel of a tail of the animal **10** which protrudes outward from the darkroom box **20**, to which a light emitting diode (LED) of near-infrared rays among the excitation energy generation devices **90** installed in the darkroom box

20 is operated and responds to the contrast medium for near-infrared ray injected to the body of the animal 10.

[0090] In the image capturing device 80 which take images of fluorescent images of the contrast medium, the image capturing device 80 of the near-infrared rays may take images of the time-series images. As an advantage of the imaging device for animals 1, image taking may be started immediately before, immediately after, or simultaneously with an injection of the contrast medium, and thus a pattern with which the contrast medium spreads in the body is accurately grasped by taking time-series images.

[0091] Various types of image processing systems may be used as the image processing system 100 which processes images taken by the image capturing device 80 within the inventive concept. The image processing system 100 performs at least one function of image processing, display, storage, and analysis for the images taken by the image capturing device 80. The analysis of images includes analyzing images by parameterization, digitization, and two dimensional or three dimensional maps. In addition, functions of the image processing system 100 may be achieved in a single device or multiple devices.

[0092] In addition, it is preferable that image processing, display, storage and analysis of the image processing system 100 be performed by a single device or multiple devices, and the images taken by the image capturing device 80 are stored after being displayed at the image processing system 100. The image processing system 100 may analyze the images and perform functions such as parameterization, digitization, quantification, or mapping.

[0093] The imaging device for animals 1 includes a sensor member 120 which senses an external stimulus applied to the animal 10 or a specific behavior pattern of an operator for taking images, and induces implementation of the image capturing device 80. The sensor member 120 is installed at least at one place of an inner side and outer side of the darkroom box, and a plurality of sensors different from each other may be installed as needed.

[0094] Hereinafter, an operational state of the imaging device for animals 1 according to one embodiment will be described in detail with reference to the accompanying drawings.

[0095] The moving member 55 of the test subject supporter 50 is pulled out of the darkroom box 20. A mouse serving as a subject animal 10 is pre-anesthetized before being mounted on the test subject supporter 50, and is put on the test subject supporter 50. Alternatively, the animal 10 may be anesthetized by inhalation anesthesia in the darkroom box 20 when the tube 70 for inhalation anesthesia is connected to the darkroom box 20.

[0096] A head 14 of the animal 10 is fastened by the fastening device 57 so that the animal 10 is mounted to be immobile and comfortable. Here, the tube 70 for inhalation anesthesia may be positioned together with the fastening device 57.

[0097] Surgery on the mouse serving as the subject animal 10 may have been conducted in advance for imaging, and the mouse is mounted so that one third or more of a tail 12 protrudes outward from the test subject supporter 50 for injecting to a vein of the tail 12.

[0098] In addition, the moving member 55 of the test subject supporter 50 is moved into the darkroom box 20. At this point, a position to which the animal 10 is moved is selected to be a position in which a most interesting part to

be imaged in the body of the animal 10 is perpendicularly in line with the image capturing device 80. A position of the stopper body 62 is adjusted so that the moving member 55 is stopped at the selected position. The reason why the position at which the animal 10 is put is set by the stopper 60 is to start taking images upon pushing the moving member 55 of the test subject supporter 50 into the darkroom box 20 immediately after injecting at the outside of the darkroom box 20, when injecting into the vein of the tail 12 of the animal 10. When images are taken using the stopper 60, taking images may be achieved in a quick and accurate manner since the animal is quickly moved to the position which is preset for the taking images.

[0099] Depending on preference of an operator, an external stimulus may be applied after positioning the test subject supporter 50 on which the animal 10 is mounted to the position in the darkroom box 20 where the image taking is to be conducted. Alternatively, apart of the test subject supporter 50 on which the animal 10 is mounted is pulled out of the darkroom box 20 for applying the external stimulus, and then the moving member 55 of the test subject supporter 50 is pushed into the darkroom box 20 to start taking images immediately after the external stimulus or after a predetermined amount of time passes.

[0100] When taking images, the image capturing device 80 may be adjusted by the foot switch 85 for allowing hands of the operator to easily apply the external stimulus. Images may be taken in real time and time-series, or by each shot of images. Once the images are taken, the image processing system 100 may display or store the images during or after the image taking. An image analysis device in the image processing system 100 may be the same device which displays and stores the images, or may be installed in another apparatus. Accordingly, the images may be checked or analyzed after taking the images through the image processing system 100.

[0101] The imaging device for animals 1 according to one embodiment of the present invention may facilitate taking images when imaging a contrast medium or pharmacokinetics, particularly when taking time-series images, and when taking images immediately after injecting the contrast medium.

[0102] A conventional imaging device uses a darkroom box 20 sealed after putting an animal 10 therein and requires some time before taking images after injecting a contrast medium including such time as mounting the animal 10, closing an opening 22 of the darkroom box 20, implementing a start operation on a computer, and the like, and thus, in this case, images immediately after injecting a contrast medium may not be obtained. Particularly, when pharmacokinetics of a contrast medium is very dynamic or quickly flows, many images immediately after injecting a drug may be missed. The imaging device for animals 1 according to one embodiment of the present invention is capable of taking real time images without loss for an external stimulus which dynamically acts, and is a useful invention also in the case in which images on real time changes in a living body due to an external stimulus such as physical stimuli including touching, cooling, heating, etc. and a chemical stimulus are required.

[0103] As described above, according to the embodiment of the present invention, since real-time images of the influence on and changes in the animal 10 while applying an external stimulus in a state in which a part of a body of the

animal **10** protrudes outward from the darkroom box **20** are obtainable as well as the images before and after the external stimulus is applied, changes caused by the external stimulus may be imaged, statistically analyzed, and thereby accuracy of an imaging measurement can be improved.

[0104] While the present invention has been described in connection with limited embodiments illustrated in the drawings, the above-described embodiments should be considered in a descriptive sense only and not for purposes of limitation, and it should be obvious to those skilled in the art that various modifications and other equivalent embodiments may be made without departing from the principles and spirit of the invention. In addition, while an animal is taken as an example of the test subject, the example should be considered in a descriptive sense only, and a tissue, a cell, molecules in a cell which are extracted from an animal body may also be used as a test subject in the invention. Accordingly, the scope of the present invention should be determined only according to the technical spirit of the attached claims.

1. An imaging device for animals, comprising:
 - a darkroom box provided with an opening through which a part of a test subject protrudes outward therefrom or an external stimulator moves in and out thereof;
 - a test subject supporter on which the test subject is mounted so that the part of the test subject protrudes outward therefrom or an application of an external stimulus is facilitated;
 - an image capturing device which takes images of the test subject before, after, or while the external stimulus is applied while applying the external stimulus to the part of the test subject mounted on the test subject supporter; and
 - an image processing system which processes the images taken by the image capturing device.
2. The imaging device of claim **1**, wherein:
 - the test subject includes an animal body or a tissue or cell and molecules in the cell removed from the animal body; and
 - the external stimulus includes at least one of a physical stimulus, a chemical stimulus, a temperature change, an injection of an external substance into the animal body, and an extraction of an internal substance of the animal body.
3. The imaging device of claim **1**, wherein the test subject supporter is installed to be movable in and out of the darkroom box.

4. The imaging device of claim **3**, wherein the test subject supporter moves in a sliding manner.

5. The imaging device of claim **4**, wherein the test subject supporter includes a fastening device which fastens or supports a part of an animal body in the test subjects to restrict unexpected motion of the animal.

6. The imaging device of claim **5**, wherein the fastening device is attachable by moving a position thereof, and the fastening device is detachable.

7. The imaging device for claim **1**, wherein the image capturing device includes a combination of at least one of an optical image capturing device, X-rays, computerized tomography (CT), and magnetic resonance imaging (MRI).

8. The imaging device of claim **1**, further comprising an excitation energy generation device which emits energy for the image capturing device to acquire an image and is installed at least at one place of an inside or outside of the darkroom box.

9. The imaging device of claim **1**, further comprising a blackout device which manually or automatically adjusts a size of the opening through which external light is incident into the darkroom box.

10. The imaging device of claim **1**, further comprising an outer door which shields the opening to block external light from being incident into the darkroom box.

11. The imaging device of claim **1**, further comprising an input unit which receives operational signals for operating the image capturing device.

12. The imaging device of claim **1**, further comprising a sensor member which senses the external stimulus applied to the test subject or a specific behavior pattern of an operator for taking images and induces an implementation of the image capturing device.

13. The imaging device of claim **1**, further comprising a stopper which constantly maintains a position selected for the test subject supporter to be fixed in the darkroom box when the test subject supporter moves in and out of the darkroom box.

14. The imaging device of claim **1**, further comprising a lighting device which supplies light when applying the external stimulus to the test subject.

15. The imaging device of claim **1**, wherein the image processing system performs at least one function of image processing, display, storage, and analysis for the images taken, and the analysis analyzes the images by parameterization, digitization, and two dimensional or three dimensional maps.

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专利名称(译)	动物成像装置		
公开(公告)号	US20160324497A1	公开(公告)日	2016-11-10
申请号	US15/108069	申请日	2014-12-15
申请(专利权)人(译)	VIEWWORKS CO. , LTD.		
当前申请(专利权)人(译)	VIEWWORKS CO. , LTD.		
[标]发明人	KANG YOU JUNG SON KYUNG SU WON HO KEUN YANG HAN SU		
发明人	KANG, YOU JUNG SON, KYUNG SU WON, HO KEUN YANG, HAN SU		
IPC分类号	A61B6/00 A61D3/00 A61B6/03 A61B5/00 A61B5/055		
CPC分类号	A61B6/508 A61B5/0059 A61B5/055 A61B6/032 A61B2503/42 A61D3/00 A61B5/0035 A61B2503/40 A61B6/52 A01K1/031 A61B5/0071 A61B5/0555 A61B6/0421 A61B6/0457 A61B6/481 A61B6/486 A61B6/5247 A61B6/54 A61D7/04		
优先权	1020140180006 2014-12-15 KR 1020130164881 2013-12-27 KR		
外部链接	Espacenet USPTO		

摘要(译)

本发明的用于动物的成像装置包括：暗室盒，其具有开口部分，待检查对象的一部分通过该开口部分突出到外部，或者可以输入或输出外部刺激器以施加刺激；待检查对象的支架，用于在其上安装待检查对象，以便于将待检查对象的部分突出到外部或施加外部刺激；图像捕获装置，用于在施加外部刺激之前，之后或期间拍摄待检查对象，同时将外部刺激施加到安装在待检查对象支撑物上的待检查对象部分；以及图像处理系统，用于处理通过图像捕获装置捕获的图像。

