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CATHETER WITH LIGHT SOURCE FOR IDENTIFYING POSITION OF OPENING OF CATHETER

Abstract

A catheter having an opening for introducing a fluid substance into a body, or for sucking the fluid substance in the body, wherein the catheter is provided with one or more light sources for identifying a position of the opening of the catheter. The light sources are arranged in a vicinity of the opening, and a conducting wire is provided to supply electric power to the light sources.

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Background/Summary

TECHNICAL FIELD

[0001] The present invention relates to a catheter, a guide wire, an opening position identification device, an opening position identification method, an internal object presence determination assistance device, a diagnostic assistance device, and a treatment assistance device.

BACKGROUND ART

[0002] As methods of identifying the position of a catheter, the method of providing an electrode on the catheter, and identifying the position with the impedance of the electrode, the method of performing position identification by a magnetic position sensor, and the like have been proposed (refer to Patent Literature 1).

CITATION LIST

Patent Literature

[0003] Patent Literature 1: Japanese Translation of PCT International Application Publication No. 2018-519046

SUMMARY OF INVENTION

Technical Problem

[0004] An object of the present invention is to provide a catheter, a guide wire, an opening position identification device, an opening position identification method, an internal object presence determination assistance device, a diagnostic assistance device, and a treatment assistance device that can easily identify the position of an opening of the catheter in a body.

Solution to Problem

[0005] Although conventionally, it has not even recognized as a problem to identify the position of an opening of a catheter, the present inventors have found out that various problems can be solved by identifying the position of the opening of the catheter.

[0006] Also, the present inventors have found out the invention that can make it easy to grasp the position of an opening of a catheter. Specifically, while there was no idea of identifying the position of a light source provided in a catheter in a body by a photographing unit such as a camera, the present inventors have found out to grasp the position of the light source by the photographing unit, and have also found out that the position of the opening of the catheter can be identified through the position of the light source.

[0007] Further, the present inventors have found out that, when light is introduced through a catheter or an optical fiber from a light source outside the body, light loss is large, light diffusivity is low, and the amount of light is insufficient.

[0008] One aspect of a guide wire of the present invention is a guide wire to be inserted into a catheter having an opening for introducing a fluid substance into a body, or for sucking the fluid substance in the body, wherein the guide wire is provided with one or more light sources for identifying a position of the opening of the catheter.

[0009] One aspect of a catheter of the present invention is a catheter into which the guide wire of the present invention is inserted.

[0010] One aspect of the catheter of the present invention is a catheter having an opening for introducing a fluid substance into a body, or for sucking the fluid substance in the body, wherein the catheter is provided with one or more light sources for identifying a position of the opening of the catheter.

[0011] One aspect of the catheter of the present invention is a catheter, wherein when an end face

of a tip of the catheter is opened, light is not emitted from the end face of the opened tip.
[0012] One aspect of an opening position identification device of the present invention can include the catheter of the present invention, and a photographing unit for photographing a light source of the catheter when the catheter is in a body.
[0013] One aspect of the opening position identification device of the present invention can include a display device that displays information based on image information or video information photographed by the photographing unit.
[0014] One aspect of the opening position identification device of the present invention can include a light receiving unit that receives light of the light sources of the catheter, when the catheter is in the body.
[0015] One aspect of the opening position identification device of the present invention includes a first information processing unit, wherein the first information processing unit can have a function of identifying whether or not a predetermined opening of the catheter is in a lung.
[0016] One aspect of the opening position identification device of the present invention includes a second information processing unit, wherein the second information processing unit can identify whether or not a predetermined opening of the catheter is below a diaphragm.
[0017] One aspect of the opening position identification device of the present invention includes a third information processing unit, wherein the third information processing unit can have a function of identifying whether or not a predetermined opening of the catheter is in a predetermined position or region of an alimentary canal.
[0018] One aspect of the opening position identification device of the present invention includes a fourth information processing unit, wherein the fourth information processing unit can have a function of identifying whether or not a predetermined opening of the catheter is in a predetermined position or region from a ureter to a bladder.
[0019] One aspect of a method of identifying a position of an opening of a catheter of the present invention can include a step of inserting the catheter described in the present invention into a body, a step of causing the light sources of the catheter to emit light, and a step of photographing light of the light sources by a photographing unit.
[0020] As one aspect of the method of identifying the position of the opening of the catheter of the present invention, a step of inserting the catheter described in the present invention into a body, a step of causing the light sources of the catheter to emit light, and a step of receiving light of the light sources by a light receiving unit can be included.
[0021] An object presence determination assistance device of the present invention is for assisting determination of whether or not an object exists in a predetermined portion or organ in a body, and includes the opening position identification device described in the present invention.
[0022] A diagnostic assistance device of the present invention includes the opening position identification device described in the present invention.
[0023] A treatment assistance device of the present invention includes the opening position identification device described in the present invention.
[0024] Here, the fluid substance is one that is fluid, and is a concept that includes a liquid, and a mixture of a liquid and a solid. It is assumed that in the body means in the body of a human being or an animal.

Advantageous Effects of Invention

[0025] According to the present invention, the absolute position of an opening of a catheter can be easily identified.
[0026] When discharging or sucking a fluid substance from the opening of the catheter, it is important whether or not the opening is in a predetermined position. When the opening of the catheter is not in an appropriate position, for example, when the opening of the catheter enters a lung, and a nutrient or a liquid material flows into the lung via the opening, although a problem

occurs such as aspiration pneumonia, such a problem can be solved according to the present invention.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0027] FIG. **1** is a diagram schematically showing a guide wire according to an embodiment.

[0028] FIG. **2**A is a diagram schematically showing an example of a catheter into which the guide wire is to be inserted. FIG. **2**B is a diagram schematically showing a state at the time when the guide wire is inserted into the catheter.

[0029] FIG. **3**A is a diagram schematically showing an example of a catheter. FIG. **3**B is a diagram schematically showing a state at the time when a guide wire is inserted into the catheter.

[0030] FIGS. **4**A and **4**B schematically show examples of a catheter.

[0031] FIG. **5** is a diagram schematically showing a catheter according to the embodiment.

[0032] FIG. **6**A is a diagram schematically showing an example of implementing light sources to a catheter. FIG. **6**B is a diagram schematically showing a cross section along A**1**-A**1** line in FIG. **6**A.

[0033] FIGS. **7**A and **7**B are diagrams schematically showing examples of implementing light sources to a catheter.

[0034] FIG. **8**A is a diagram schematically showing an example in which light sources are implemented in an insertion facilitating member of a catheter. FIG. **8**B is a diagram schematically showing a cross section along A**2**-A**2** line in FIG. **8**A.

[0035] FIG. **9** is a diagram for describing the light emission directions of a light source.

[0036] FIG. **10** is a diagram schematically showing an opening position identification device for identifying the positions of openings of a catheter.

[0037] FIG. **11** is a diagram schematically showing a photographed image of light sources in a case where the light sources are photographed by a photographing unit of the opening position identification device for identifying the positions of the openings of the catheter.

[0038] FIG. **12** is a diagram schematically showing the opening position identification device for identifying the positions of the openings of the catheter.

[0039] FIG. **13** is a diagram for describing the significance for identifying the positions of the openings of the catheter.

[0040] FIG. **14** is a diagram for describing the significance for identifying the positions of the openings of the catheter.

DESCRIPTION OF EMBODIMENTS

[0041] Hereinafter, a preferred embodiment of the present invention is described in detail.

1. Guide Wire

[0042] A guide wire **20** according to an embodiment is inserted into a catheter **30**, and is provided with light sources **10** as shown in FIG. **1**.

[0043] The catheter **30** can be the form as shown in FIG. **2**A, FIG. **3**A, or FIG. **4**. The catheter **30** is provided with at least one opening **32** for introducing a fluid substance into a body, or for sucking the fluid substance in the body. As the fluid substance to be introduced into the body, for example, a nutrient, a medicine, and the like can be listed. As the fluid substance to be sucked from the body, for example, a gastric fluid and the like can be listed. The opening **32** of the catheter **30** may be provided in a side surface, and a tip may be provided to be an open end.

[0044] One or more light sources **10** can be provided in the guide wire **20**. The light sources **10** are provided so as to correspond to the positions of the openings **32**, when the guide wire **20** is inserted into the catheter **30** and the distal end of the guide wire **20** reaches the distal end of the catheter **30**. Accordingly, each of the light sources is configured to emit the light through the corresponding opening **32**. The interval between the openings **32** may be the same as the interval between the light

sources. That is, the light sources **10** are set to the guide wire **20** in the positions where the light of the light sources **10** is emitted to the outside through the openings **32**. Wiring (conducting wire) **36** can be provided to be bundled with the guide wire **20**. Electricity can be supplied to the light sources **10** through the wiring **36**.

[0045] The diameter of the guide wire **20** preferably ranges from 0.2 mm to 2.5 mm, for example. The guide wire **20** can be made of a bundle of, for example, two or three conductors that are spirally strung together. The conductors of the guide wire may be coated with an insulator or insulators. The insulators covering the conductors can be a single layer or multiple layers. The guide wires can be coaxial or parallel conductors. The outer skin of the guide wire may be coated (e.g. with a hydrophilic coating) to ensure sliding properties. The guide wire may be shielded to filter electromagnetic noise.

[0046] An insertion facilitating member (olive) **34** having a stopper function for the guide wire **20** is provided at a tip of the catheter **30** shown in FIG. **2**A. The opening **32** may be provided also in the insertion facilitating member **34**. The catheter **30** shown in FIG. **3**A is in a form without the insertion facilitating member **34** for the guide wire **20** at the tip. FIG. **3**B schematically shows a state where the guide wire **20** is inserted into the catheter **30** in FIG. **3**A. The catheter **30** shown in FIG. **4**A is in a form having a weight holding portion **38** that holds a weight on the tip side. Note that, as shown in FIG. **4**B, the number of the openings **32** may be one. The light sources **10** may be provided in the catheters **30** shown in FIG. **2** to FIG. **4**B. The insertion facilitating member **34** may be made of the same material as the catheter, or made of a different material from the material of the catheter. The material of the insertion facilitating member may be softer than the material of the catheter to lower a risk to damage the patient body.

2. Catheter

[0047] The catheter **30** according to the embodiment has the openings **32** for introducing the fluid substance into the body, or for sucking the fluid substance in the body. One or more light sources **10** for identifying the positions of the openings **32** of the catheter **30** are provided. Specifically, as shown in FIG. **5**, the light sources **10** are provided in the positions corresponding to the openings **32** of the catheter **30**. The light sources **10** may be provided in positions adjacent to each other in the axial direction in relation to the openings **32**, or may be provided in portions of the catheter **30** that are located in the horizontal direction of the openings **32** of the catheter **30** (or the radial direction which is perpendicular to the axial direction). The wiring (conducting wire) **36** is provided in the catheter **30**, and the light sources **10** are electrically connected to the wiring **36**. By providing the wiring **36**, the secondary effect is obtained that the catheter **30** can be easily inserted into a predetermined position by making the catheter **30** harder to break, while maintaining the elasticity of the catheter **30**.

[0048] The catheter **30** is a long, narrow, hollow tube. The outer diameter of the tube can be 3˜20 Fr. The inner diameter of the tube can be 2˜15 Fr. Herein, “Fr” is the unit of measurement for catheter size, where 3 Fr=1 mm. The opening(s) **32** in the catheter is a hole that penetrates from the outer surface to the inner surface of the tube, and its diameter can range from 1 mm˜10 mm. Various materials can be used for the tube. For example, PVC (Poly vinyl chloride),, silicone, and polyurethane are available. PVC has the advantage of low cost and a softness that makes it comfortable for patients to insert. Silicone is scientifically stable and flexible. Polyurethane has the advantage of low cost and stiffness make it easy for the doctor to insert into the patient's digestive tract.

3. Light Sources and Implementation of Light Sources

[0049] Known light sources can be applied to the light sources **10**, and the light sources **10** can be a LED light source such as a LED light bulb. The light of the light sources **10** is preferably the light that easily passes through the body, and can be, for example, near infrared ray.

[0050] The wavelength and the light intensity of the light source may be appropriately set depending on the patient's body shape, the purpose of use, or other factors. An example of the

wavelength is ranged from 650 to 1500 nm. It is desirable that the light intensity is strong enough that the presence of the light can be confirmed from outside the patient's body. However, when the light intensity is too large, the light will be diffused and it will be difficult to identify the exact location. Taking this into consideration, it is desirable that the light intensity be ranged from 1 mW/sr to predetermined amount. The wavelength and intensity of the light may be the same for all light sources or may be varied. For example, the wavelength may be longer or shorter towards the tip. The intensity of the light may be increased or decreased towards the tip. FIG. **7**A and **7**B shows multiple light sources that are arranged around the axis (or circumference),

[0051] The size of the light source is arbitrary. For example, when considering a square LED or light source, for example, one side of the square may be 0.5-10 mm, preferably 1-5 mm. When a light source is installed at the distal end (or leading tip) of the guide wire, the light source can be installed on one side of the substrate to emit the light from the one side. It is also possible to have the light source (or LEDs) installed on both sides of the substrate so that the light is emitted from both the sides. Smaller light sources are preferable, given that they need to pass through the inner wall of the catheter. On the other hand, a certain size is necessary to emit light that is strong enough to be recognized from the outside the patient's body. The area of the light source (light-emitting area) is preferably ranged from around 0.25 mm.sup.2 to 10 mm.sup.2.

[0052] In FIG. **5**, a form is shown in which the light sources **10** are placed on the catheter **30**. In FIGS. **6**A and **6**B, a mode is shown in which the light sources **10** are embedded in the catheter **30**. FIG. **6**B schematically shows a cross section along A**1**-A**1** line in FIG. **6**A. As shown in FIG. **6**B, the light sources **10** may be provided in portions of the catheter **30** located in the horizontal direction of the opening **32** of the catheter **30**, and may be provided to be fit into the catheter **30**. In this mode, the vicinity of the opening may be measured from the center of the opening. FIG. **6**B shows that one opening **32** and three light sources **10** are arranged on the single cross section that is a view cut perpendicular to the axis of the catheter, in such a way that they are evenly spaced in the circumferential direction. FIG. **6**B shows an embodiment of the present invention that the gap between the opening and the light source(s) in the axial direction is zero.

[0053] Putting it another way, the light sources are arranged in the vicinity of the opening, and the vicinity may mean a range from 0 to 5 mm from the opening with respect to the axial direction. The gap between the opening and one of the light sources is denoted with G, see in FIG. **5**. The gap may be measured as a distance between the edge of the opening and the edge of the light source, which is arranged close to the opening. The edge of the light source means the closest point to the opening.

[0054] As shown in FIGS. **7**A and **7**B, a plurality of (for example, three or four) light sources **10** may be provided not in the portions of the catheter **30** located in the horizontal direction of the opening **32** of the catheter **30**, but in the circumference of the catheter **30** in positions adjacent to each other in the axial direction. By providing a plurality of light sources **10** in this manner, the light of the light sources **10** will be positively spread over a wider area centering on the axial direction. As shown in FIG. **7**A, there are three light sources arranged evenly spaced each other in the circumferential direction. FIG. **7**B shows four light sources arranged with a gap of **90** degrees around the axis of the catheter. The light sources arranged around the circumference of the catheter need not be evenly distributed. They can be arranged at intervals of 45°, 60°, 90°, 120°, etc., in any combination. They may also be two, three, four or five light sources, or even a single line or multiple lines that are composed with a series of micro light sources running around the axis (or circumference).

[0055] As shown in FIGS. **8**A and **8**B, the light sources **10** may be provided in the insertion facilitating member **34** for the catheter **30**. A first light source **10***a* can be, for example, a light source that emits light in the horizontal direction with respect to the axial direction of the catheter **30**. A second light source **10***b* can be a light source that emits light in the axial direction of the catheter **30**. Accordingly, even if the body position or posture is changed, a photographing unit **42**

can more positively photograph the light of the light sources **10**.

[0056] As shown in FIG. **9**, the light source **10** can also be configured to include a plurality of light emitting elements. Specifically, the light source **10** can include a light emitting element **10***c* that emits light in the axial direction, and a light emitting element **10***d* that emits light in a direction (for example, the horizontal direction) intersecting the axial direction. Additionally, a plurality of light sources **10** that emit light in the axial direction and a plurality of light sources **10** that emit light in a direction (for example, the horizontal direction) intersecting the axial direction may be provided. Accordingly, even if the body position or posture is changed, the photographing unit **42** can more positively photograph the light of the light sources.

[0057] By providing a plurality of light sources **10** for identifying the same opening **32**, and changing the respective wavelengths of the plurality of light sources **10**, it is possible to identify which direction the opening **32** faces.

[0058] A case is considered where the catheter **30** has a plurality of openings **32**, and the light source **10** is provided for each of the plurality of openings **32**. In that case, it is possible to identify which opening **32** is located in which position, by changing the wavelengths of the light of light sources **10** that identify the different openings **32**.

4. Application Example of Catheter

[0059] As the catheter **30** according to the embodiment, for example, application examples in a tube from the mouth to the anus, a blood vessel including a cerebral blood vessel, a ureter, and a bladder can be considered.

5. Opening Position Identification Device and Opening Position Identification Method

[0060] As shown in FIG. **10**, an opening position identification device **40** for identifying the positions of the openings **32** of the catheter **30** can include the catheter **30** according to the embodiment, and the photographing unit **42** for photographing the light sources **10** of the catheter **30** when the catheter **30** is in the body. Here, it is assumed that the catheter **30** according to the embodiment includes the catheter **30** into which the guide wire **20** provided with the light sources **10** is inserted, and the catheter **30** provided with the light sources **10**.

[0061] The photographing unit **42** is not particularly limited as long as the light of the light sources **10** can be photographed, and a camera such as a CCD camera and a camera for astronomic observation can be applied. When the light sources **10** are light sources that emit near infrared rays, the photographing unit **42** can be a camera (including a digital camera) from which a filter for blocking near infrared ray is removed. When photographed by the photographing unit **42**, a photographed image or a photographed video in which the portions of the light sources **10** are illuminated as shown in FIG. **11** can be obtained.

[0062] The opening position identification device **40** can include a display device that displays information based on image information or video information photographed by the photographing unit **42**.

[0063] As shown in FIG. **12**, the opening position identification device **40** can include a light receiving unit **46** that receives the light of the light sources **10** of the catheter **30**, when the catheter **30** according to the embodiment is in the body. Although it is determined in relation to the light sources **10**, when the light sources **10** are LED light sources, the light receiving unit **46** can be configured by, for example, a diode. The light receiving state of the light receiving unit **46** may be displayed on the display device.

[0064] An example of the significance of identifying the positions of a plurality of openings **32** with a plurality of light sources **10** will be described by using FIG. **13** and FIG. **14**. Taking a case where the catheter **30** is in the stomach for an example, when the catheter **30** has a plurality of openings **32**, the positions of the openings **32** are not necessarily arranged sequentially from the top to the bottom from the rear end side toward the tip side. That is, even when the intermediate openings **32** are in the stomach, there are cases where the tip is above the cardia, and where two openings **32** are in the positions within the stomach, but the opening **32** between the two openings

32 is above the cardia. In such a case, it is possible to know in what mode the catheter **30** is in the stomach by photographing the light sources **10** by the photographing unit **42**, and identifying the positions of openings **32**.

[0065] The display device is not particularly limited as long as displaying is possible, and for example, a known display or the like can be applied.

[0066] The positions of predetermined portions and organs, such as the diaphragm and the lungs, may be displayed in a photographed image or video displayed on the display device. The positions of the diaphragm, the lungs, and the like may be recognized by the photographing unit **42**, or may be grasped by another inspection device, for example, an X-ray device.

[0067] It is also possible to recognize the state of the catheter **30** in the body by photographing the light from a plurality of light sources **10** by the photographing unit **42**, and displaying the photographed image on the display device. Additionally, it is also possible to focus on one light source **10**, and to display the trajectory along which the light source **10** has moved on the display device, from the photographed information or light reception information. When the catheter **30** has a plurality of openings **32**, the light source **10** is provided for each of the plurality of openings **32**, and the wavelengths of the light of the light sources **10** that identify the different openings **32** are changed, it is possible to identify which opening **32** is in which position by recognizing the wavelength of the light by the photographing unit **42** or the light receiving unit **46**.

[0068] The opening position identification device **40** can include an information processing unit. The information processing unit can have, for example, a first information processing unit to a fourth information processing unit as follows.

[0069] The first information processing unit has a function of identifying whether or not a predetermined opening **32** of the catheter **30** is in a lung.

[0070] The second information processing unit has a function of identifying whether or not a predetermined opening **32** of the catheter **30** is below the diaphragm.

[0071] The third information processing unit has a function of identifying whether or not a predetermined opening **32** of the catheter **30** is in a predetermined position or region of an alimentary canal. As the predetermined position of the alimentary canal, for example, a predetermined position of the stomach, the duodenum, the large intestine, and the small intestine can be listed. As the predetermined region of the alimentary canal, the region of an organ, such as the stomach, the duodenum, the large intestine, and the small intestine, or a partial region can be listed.

[0072] The fourth information processing unit has a function of identifying whether or not a predetermined opening **32** of the catheter **30** is in a predetermined position or region from the ureter to the bladder.

[0073] The processing in the information processing unit can be performed by a computer. The computer and the photographing unit **42** may be connected to each other, the information processing unit may process the photographed information photographed by the photographing unit **42**, and the processed information may be displayed on the display device.

[0074] As a first aspect of a method of identifying the positions of the openings **32** of the catheter **30**, there is a method that includes a step of inserting the catheter **30** according to the embodiment into the body, a step of causing the light sources **10** of the catheter **30** to emit light, and a step of photographing the light of the light sources **10** by the photographing unit **42**.

[0075] As a second aspect of a method of identifying the positions of the openings **32** of the catheter **30**, there is a method that include a step of inserting the catheter **30** according to the embodiment into the body, a step of causing the light sources **10** of the catheter **30** to emit light, and a step of receiving the light of the light sources **10** by the light receiving unit **46**.

[0076] The first aspect and the second aspect may be combined.

[0077] The light sources **10** can be controlled by a control device **48**. The control device **48** can be electrically connected to the light sources **10** via the wiring **36**.

6. Internal Object Presence Determination Assistance Device

[0078] The opening position identification device **40** according to the embodiment can be applied as an object presence determination assistance device for determining whether or not a liquid material or a solid matter exists in an organ where the catheter **30** exists, such as the stomach or the intestines. It is possible to determine whether or not an object exists in the organ where the catheter **30** exists by photographing the light of the light sources **10** in the body, and based on the difference in at least one of the hue, brightness, and saturation of the photographed image, the difference in the amount of light of the light receiving unit **46**, or the difference in illuminance. The content existing in the body may be grasped by transmission of the wavelength of the light.

7. Diagnostic Assistance Device

[0079] The opening position identification device **40** according to the embodiment can be used as a device that assists diagnosis of the state of a surface of an organ in the body where the catheter **30** exists, such as the stomach and the intestines, and a portion of the body between the surface and the skin. It is possible to grasp the state of the surface of the organ in the body where the catheter **30** exists, such as the stomach or the intestines, and the portion of the body between the surface and the skin, by photographing the light of the light sources **10** in the body, and based on the difference in at least one of the hue, brightness, and saturation of the photographed image, the difference in the amount of light of the light receiving unit **46**, or the difference in illuminance.

[0080] When the light of the light sources **10** emit near infrared rays, oxyhemoglobin and deoxyhemoglobin may be measured, the near infrared rays that have passed through the body are detected by a detection device such as a light receiving element, and the oxygen concentration may be derived from the intensity of the transmitted wavelength.

[0081] The diagnostic assistance device can be applied to various diagnostic devices.

8. Treatment Assistance Device

[0082] The opening position identification device **40** according to the embodiment can be applied as a treatment assistance device that photographs the light sources **10** (including the light sources **10** of the guide wire **20**) of the catheter **30** in the body by the photographing unit **42**, and while recognizing the positions of the openings **32** with the light sources **10**, kills cancer cells or reduces the activity of cancer cells through the light.

[0083] The treatment assistance device can be applied to various treatment devices.

9. Operations and Effects

[0084] Although it is conceivable to identify the position of the catheter **30** with the impedance of an electrode, the position of the catheter **30** can only be grasped as a relative position. Additionally, in the case of a magnetic sensor, a correct position cannot be grasped when the magnetic sensor is shifted.

[0085] According to the present embodiment, since the positions can be identified based on the light sources **10** of the catheter **30**, the positions of the openings **32** can be accurately identified. Additionally, the positions of the openings **32** can be visually and easily grasped by displaying an image or a video obtained by photographing the light of the light sources **10** on the display device.

[0086] The present embodiment can be modified in various manners within the scope of the present invention.

[0087] For example, a guide wire of the present invention to be inserted into a catheter having an opening for introducing a fluid substance into a body, or for sucking the fluid substance in the body, the catheter extending in an axial direction of the catheter, and the opening of the catheter facing in a radial direction around the axial direction of the catheter, which is perpendicular to the axial direction, wherein the guide wire, which extends in an axial direction of the guide wire, is provided with one or more light sources that are arranged along the axial direction of the guide wire from a distal end of the guide wire and a conducting wire that extends in the axial direction of the guide wire and is bundled with the guide wire to supply electric power to the light sources, wherein the light sources are configured to face in a radial direction around the axial direction of

the guide wire such that, when one of the light sources of the guide wire meets the opening, and light emitted from the one of the light sources is transmitted through the opening outside the catheter, identifying a position of the opening of the catheter, and the guide wire is made of a material having less flexible than a material of the catheter such that, when the guide wire is inserted into the catheter, the catheter is more easily to travel straight through the body in comparison to the catheter without the guide wire. The catheter may have a plurality of the openings that are arranged along the axial direction of the catheter at predetermined intervals from a tip of the catheter, the guide wire may have a plurality of the light sources that are arranged along the axial direction of the guide wire at predetermined intervals from the distal end of the guide wire, all facing the radial direction of the guide wire, and the light sources may be configured to be arranged such that, when one of the light sources of the guide wire, which is the closest to the distal end of the guide wire in the axial direction, meets one of the openings, which is the closest to the tip of the catheter, the lights emitted from the light sources are transmitted through the openings outside the catheter, identifying the position of the openings of the catheter. In the guide wire according to the present invention, the light sources may emit the light with intensity so sufficient that the light transmitting through the opening penetrates the body and is seen outside the body. In the guide wire according to the present invention, the catheter may be provided with an insertion facilitating member at the tip of the catheter. The insertion facilitating member may have a rounded shape with a smooth protruding tip, having an outer diameter larger than an outer diameter of the catheter, and the insertion facilitating member may function as a stopper for the guide wire such that the guide wire does not move farther beyond the insertion facilitating member in the axial direction. The catheter may have a plurality of the openings that are arranged along the axial direction of the catheter at predetermined intervals from a tip of the catheter, the guide wire may have a plurality of the light sources that are arranged along the axial direction of the guide wire at predetermined intervals from the distal end of the guide wire, all facing the radial direction of the guide wire, and the light sources may be configured to be arranged such that, when one of the light sources of the guide wire, which is the closest to the distal end of the guide wire in the axial direction, meets one of the openings, which is the closest to the tip of the catheter, the lights emitted from the light sources are transmitted through the openings outside the catheter, identifying the position of the openings of the catheter. The guide wire may be to be pull out of the catheter before either introducing the fluid substance or sucking the fluid substance.

[0088] A catheter into which the guide wire according to the present invention is inserted. In the above catheter, an end face of the tip of the catheter may be configured opened, and no light source is provided at the distal end of the guide wire such that light is not emitted from the end face of the opened tip.

[0089] An opening position identification device of the present invention may comprises the above catheter; and a photographing unit for photographing the light emitted from the light sources of the guide wire when the catheter is in the body to identify the position of the opening of the catheter. It may further comprise a display device that displays information based on image information or video information photographed by the photographing unit, or a light receiving unit that receives the light of the light sources of the guide wire when the catheter is in the body. It may further comprise an information processing unit, wherein the information processing unit has a function of identifying whether or not a predetermined opening of the catheter is in a predetermined position or region of an alimentary canal. It may further comprise a fourth information processing unit, wherein the fourth information processing unit has a function of identifying whether or not a predetermined opening of the catheter is in a predetermined position or region from a ureter to a bladder.

[0090] A method of identifying a position of an opening of a catheter according to the present invention comprises a step of inserting the above catheter into a body; a step of causing the light sources of the catheter to emit light; and a step of photographing light of the light sources by a

photographing unit. It may comprise: a step of inserting the above catheter into a body; a step of causing the light sources of the catheter to emit light; and a step of receiving light of the light sources by a light receiving unit.

[0091] An object presence determination assistance device for assisting determination of whether or not an object exists in a predetermined portion or organ in a body according to the present invention, the object presence determination assistance device may comprise the above opening position identification device. A diagnostic assistance device according to the present invention may comprise the above opening position identification device. A treatment assistance device according to the present invention may comprise the above opening position identification device.

INDUSTRIAL APPLICABILITY

[0092] The present invention can be applied to a catheter and various objects utilizing a catheter.

REFERENCE SIGNS LIST

[0093] **10** light source [0094] **20** guide wire [0095] **30** catheter [0096] **32** opening [0097] **34** insertion facilitating member [0098] **36** wiring [0099] **40** opening position identification device [0100] **42** photographing unit [0101] **44** display device [0102] **46** light receiving unit [0103] **48** control device

Claims

1. A catheter having an opening for introducing a fluid substance into a body, or for sucking the fluid substance in the body, wherein the catheter is provided with one or more light sources for identifying a position of the opening of the catheter.

2. The catheter according to claim 1, wherein the catheter extends in an axial direction of the catheter, and the opening of the catheter facing in a radial direction around the axial direction of the catheter, which is perpendicular to the axial direction, the light sources are arranged in a vicinity of the opening, and a conducting wire that extends in the axial direction of the catheter is provided to supply electric power to the light sources, wherein the light sources are configured to face in the radial direction, and the light sources all emit the light with intensity so sufficient that the light penetrates the body and is seen outside the body.

3. The catheter according to claim 2, wherein the vicinity of the opening is ranged from 0 to 5 mm with respect to the axial direction.

4. The catheter according to claim 2, wherein the catheter has a plurality of openings, which includes the opening, and the openings are arranged with an even interval along the axial direction of the catheter from a tip of the catheter.

5. The catheter according to claim 2, wherein a wavelength of lights emitted from the light sources is ranged from 650 to 1500 nm, and a light intensity of the light is larger than 1 mV/sr.

6. The catheter according to claim 2, wherein one of the light sources is configured to emit the light in both the axial and radial directions.

7. The catheter according to claim 2, wherein the opening has two or more of the light sources in the vicinity, and from a cross-sectional view of the catheter that is cut perpendicular to the axial direction, the light sources in the vicinity are arranged around the axial direction of the catheter and are spaced with an even interval in a circumferential direction of the catheter, which circulates the axial direction.

8. The catheter according to claim 2, wherein the opening has two or more of the light sources in the vicinity, and from a cross-sectional view of the catheter that is cut perpendicular to the axial direction, the opening and the light sources in the vicinity are arranged around the axial direction of the catheter and are spaced with an even interval in a circumferential direction of the catheter, which circulates the axial direction.

9. The catheter according to claim 7, wherein one of the light sources faces in the axial direction of the catheter, and the other of the light sources face in the radial direction of the catheter.

10. The catheter according to claim 8, wherein one of the light sources faces in the axial direction of the catheter, and the other of the light sources face in the radial direction of the catheter.

11. The catheter according to claim 1, wherein the catheter is provided with an insertion facilitating member at a tip of the catheter, wherein the insertion facilitating member has a rounded shape with a smooth protruding tip, having an outer diameter larger than an outer diameter of the catheter, and the opening is arranged in the insertion facilitating member, and faces in the radial direction of the catheter, and the light sources are arranged within an area between the opening and the smooth protruding tip of the insertion facilitating member in the axial direction.

12. The catheter according to claim 11, wherein some of the light sources are arranged to face in the radial direction of the catheter, and from a cross-sectional view of the catheter that is cut perpendicular to the axial direction, these light sources facing the radial direction are spaced with an even interval in a circumferential direction of the catheter, which circulates the axial direction.

13. The catheter according to claim 1, wherein the catheter has a hollow thereinside that extends along the axial direction such that a guide wire is to be inserted into the hollow to reach the tip of the catheter through the hollow.