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Robot And Robot System

Abstract

A robot including a base, a first arm, a second arm rotatably connected to the first arm, a shaft on which an end effector is mounted, an inertia sensor that is installed in the second arm, a motor unit installed in the second arm and configured to drive the shaft, and a duct connected to the base and to the second arm, wherein the second arm includes a first member having a first connection section to which the duct is connected and a second member that has a second connection section to which a wiring or a piping connected to the end effector is connected and that is positioned further to the shaft side than the first connection section, and an arm base having an attachment section to which the second member is attached and the inertia sensor is disposed between the motor unit and the attachment section.

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Background/Summary

[0001] The present application is based on, and claims priority from JP Application Serial Number 2024-018205, filed Feb. 8, 2024, the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a robot and a robot system.

2. Related Art

[0003] The robot described in JP-A-2017-144545 includes a base, a first arm connected to the base so as to be rotatable around a first rotation axis, a second arm connected to the first arm so as to be rotatable around a second rotation axis, which is parallel to the first rotation axis, and a shaft connected to the second arm so as to be rotatable around a third rotation axis, which is parallel to the second rotation axis. The shaft is connected so as to be movable along the axial direction of the third rotation axis. An end effector is attached to a lower end section of the shaft. The second arm includes a base body and a cover that covers the upper section of the base body. The base body is provided with an intermediate body installed so as to cover further from the shaft toward the second rotation axis side. Various connector parts are installed on the upper section of the intermediate body.

[0004] In a configuration like that of JP-A-**2017-144545**, for example, when an inertia sensor for vibration damping control is provided in the second arm, the inertia sensor may pick up the vibration of the intermediate body. In addition, there is a problem in that the vibration component that is undesirably picked up becomes noise, and detection accuracy decreases.

SUMMARY

[0005] A robot of the present disclosure includes a base, a first arm connected to the base so as to be rotatable around a first rotation axis; a second arm connected to the first arm so as to be rotatable around a second rotation axis parallel to the first rotation axis; a shaft connected to the second arm so as to be rotatable around a third rotation axis parallel to the second rotation axis and so as to be movable along an axial direction of the third rotation axis, an end effector being mounted on the shaft; an inertia sensor that is installed in the second arm and that detects at least one of angular velocity or acceleration; a motor unit that is installed in the second arm and that is configured to drive the shaft; and a duct connected to the base and to the second arm, wherein the second arm includes a first member having a first connection section to which the duct is connected, a second member that includes a second connection section to which wiring or piping connected to the end effector is connected and that is positioned closer to a shaft side than is the first connection section, and an arm base having an attachment section to which the second member is attached and the inertia sensor is disposed between the motor unit and the attachment section.

[0006] A robot system of the present disclosure includes a robot including a base, a first arm connected to the base so as to be rotatable around a first rotation axis; a second arm connected to the first arm so as to be rotatable around a second rotation axis parallel to the first rotation axis; a shaft connected to the second arm so as to be rotatable around a third rotation axis parallel to the second rotation axis and so as to be movable along an axial direction of the third rotation axis, an end effector being mounted on the shaft; an inertia sensor that is installed in the second arm and that detects at least one of angular velocity or acceleration; a motor unit that is installed in the second arm and that is configured to drive the shaft; and a duct connected to the base and the second arm and a control device configured to control drive of the robot, wherein the second arm includes a first member having a first connection section to which the duct is connected, a second member provided with a second connection section to which wiring or piping connected to the end

effector is connected, the second member being positioned closer toward the shaft side than is the first connection section, and an arm base having an attachment section to which the second member is attached and the inertia sensor is disposed between the motor unit and the attachment section.
[0007] A robot of the present disclosure includes a base, a first arm connected to the base so as to be rotatable around a first rotation axis; a second arm connected to the first arm so as to be rotatable around a second rotation axis parallel to the first rotation axis; a shaft connected to the second arm so as to be rotatable around a third rotation axis parallel to the second rotation axis and so as to be movable along an axial direction of the third rotation axis, an end effector being mounted on the shaft; an inertia sensor that is installed in the second arm and that detects at least one of angular velocity or acceleration; a first motor that is installed in the second arm and that is configured to output a drive force for rotating the shaft around the third rotation axis; a second motor that is installed in the second arm and that is configured to output a drive force for moving the shaft along an axial direction of the third rotation axis; a first endless belt configured to transmit a drive force output by the first motor to the shaft; a second endless belt configured to transmit the drive force output by the second motor to the shaft; and a duct connected to the base and to the second arm, wherein the second arm includes a first member having a first connection section to which the duct is connected, a second member provided with a second connection section to which wiring or piping connected to the end effector is connected, the second member being positioned closer toward the shaft side than is the first connection section, and an arm base having an attachment section to which the second member is attached and the first endless belt and the second endless belt intersect with each other when viewed along a straight line parallel to the second rotation axis, and the inertia sensor is disposed between the attachment section and a position where the first endless belt and the second endless belt intersect each other.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0008] FIG. **1** is a schematic configuration diagram of a robot system according to a first embodiment of the present disclosure.
[0009] FIG. **2** is a partial sectional side view for explaining the internal structure of a second arm included in the robot shown in FIG. **1**.
[0010] FIG. **3** is a view seen from the direction of arrow A in FIG. **2**.
[0011] FIG. **4** is an enlarged partial cross-sectional view of an arm base of a second arm in a robot system according to a second embodiment of the present disclosure.
[0012] FIG. **5** is an enlarged top view of an arm base of a second arm in a robot according to the third embodiment of the present disclosure.
DESCRIPTION OF EMBODIMENTS
[0013] Hereinafter, a robot and a robot system according to the present disclosure will be described in detail based on embodiments illustrated in the accompanying drawings.
First Embodiment
[0014] FIG. **1** is a schematic configuration diagram of a robot system according to a first embodiment of the present disclosure. FIG. **2** is a partial sectional side view for explaining the internal structure of a second arm included in the robot shown in FIG. **1**. FIG. **3** is a view seen from the direction of arrow A in FIG. **2**.
[0015] Note that the up-down direction in FIG. **1** coincides with the vertical direction, and that in FIG. **1** upward is referred to as up and the downward is referred to as down. Regarding a robot arm **72**, a first arm **73**, and a second arm **74**, the right side in FIG. **1** is referred to as a “proximal end” or a “proximal end section”, and the left side is referred to as a “distal end” or a “distal end section.
[0016] In the present specification, the term “vertical” means not only a case of being coincident

with vertical, but also a case of being slightly inclined with respect to vertical, for example, within ±10°. In the present specification, the term “parallel” means not only a case where two objects are parallel to each other but also a case where two objects are slightly inclined from parallel to each other, for example, within ±10°. In the present specification, a “straight line” is a virtual straight line.

[0017] The robot system **1** illustrated in FIG. **1** includes a robot **7** and a control device **3** that controls drive of each part of the robot **7**.

[0018] In the present embodiment, the robot **7** is a SCARA robot and performs various operations such as holding, transporting, assembling, processing, coating, and inspecting workpieces such as electronic components (hereinafter, these are collectively referred to as “operations”). However, the use of the robot **7** and the type of operation are not limited to the above. The robot **7** may be a ceiling-mounted SCARA robot, and in this case, the orientation of the robot **7** in the present embodiment would be inverted (upside down).

[0019] As shown in FIG. **1**, the robot **7** includes a base **71** and a robot arm **72** rotatably connected to the base **71**. The robot arm **72** includes a first arm **73** that has a proximal end section connected to the base **71** and that rotates with respect to the base **71** around a first rotation axis J**1**, which is along the vertical direction, and a second arm **74** that has a proximal end section connected to a distal end section of the first arm **73** and that rotates with respect to the first arm **73** around a second rotation axis J**2**, which is along the vertical direction. Note that the first rotation axis J**1** and the second rotation axis J**2** are virtual straight lines.

[0020] A proximal end section of a duct **77**, which has a tubular outer shell, is connected to the base **71**, and a distal end section of the duct **77** is connected to an upper section of second arm **74**. The duct **77** is connected to the base **71** and the second arm **74**, and guides a first elongated wire **21**, which is inserted in the duct **77**. The first elongated wire **21** is inserted into the inside of the duct **77**. The first elongated wire **21** is a cable for driving an inertia sensor **5**, a cable for driving a motor unit **8**, a cable for driving a motor unit **61**, and a cable for driving an end effector **76**. That is, in the embodiment, the first elongated wire **21** includes wiring and piping, and is configured by wiring for supplying power to the inertia sensor **5**, the motor unit **8**, the motor unit **61**, and the end effector **76**, wiring for controlling the inertia sensor **5**, the motor unit **8**, the motor unit **61**, and the end effector **76**, supply piping for supplying a fluid such as compressed air to the end effector **76**, and the like. Note that the first elongated wire **21** may include at least a cable for driving the end effector **76**. The first elongated wire **21** may have a configuration that includes only one of either wiring or piping.

[0021] A proximal end side of the first elongated wire **21** is connected to, for example, the control device **3** or a power supply unit (not shown), and a distal end side of the first elongated wire **21** is connected to predetermined parts of the inertia sensor **5**, the motor unit **8**, the motor unit **61**, and a second connection section **94** (to be described later).

[0022] The first elongated wire **21** may be provided as a single wire, or may be provided as a bundle of a plurality of wires. One or more connectors (not shown) may be provided along the first elongated wire **21**.

[0023] A shaft **75** is provided at the distal end section of the second arm **74**. The shaft **75** is also referred to as an operation shaft. The shaft **75** includes a spline nut **751** and a ball screw nut **752**, which are coaxially disposed at the distal end section of the second arm **74**, and a spline shaft **753**, which is inserted through the spline nut **751** and the ball screw nut **752**. The spline shaft **753** is rotatable with respect to the second arm **74** around a third rotation axis J**3**, which is the central axis of the spline shaft **753** and which extends along the vertical direction, and is movable up and down in a direction along the third rotation axis J**3**. Note that the third rotation axis J**3** is a virtual straight line.

[0024] The end effector **76** is attached to a lower end section of the spline shaft **753**. The end effector **76** is detachable with respect to the spline shaft **753**, and an end effector suitable for the

intended operation is selected as appropriate. Examples of the type of end effector **76** include a hand, a drill, a suction head, and the like.
[0025] The spline shaft **753** is composed of an elongated hollow body extending in the vertical direction, and a second elongated wire **22** is inserted inside the spline shaft **753**. The second elongated wire **22** is a cable for driving the end effector **76**. That is, in the present embodiment, the second elongated wire **22** includes wiring and piping, and is constituted by wiring for supplying power to the end effector **76**, wiring for controlling the end effector **76**, supply piping for supplying a fluid such as compressed air to the end effector **76**, and the like. Note that the second elongated wire **22** may have a configuration that includes only one of either wiring or piping.
[0026] The proximal end side of the second elongated wire **22** is connected to a predetermined portion of the second connection section **94**, and the distal end side of the second elongated wire **22** extends through the inner cavity of the spline shaft **753** to the end effector **76** and is connected to a predetermined portion of the end effector **76**.
[0027] The second elongated wire **22** may be provided as a single wire or as a bundle of plural wires.
[0028] The robot **7** includes a first joint section **4**K that rotatably connects the base **71** and the first arm **73**. A drive section **4** that rotates the first arm **73** around the first rotation axis J**1** with respect to the base **71** is installed in the first joint section **4**K.
[0029] The robot **7** includes a second joint section **6**K that rotatably connects the first arm **73** and the second arm **74**. A drive section **6** that rotates the second arm **74** with respect to the first arm **73** around the second rotation axis J**2** is installed in the second joint section **6**K.
[0030] The drive section **4** includes a motor unit **41** and a power transmission mechanism (not shown) that includes, for example, a speed reducer. The drive section **6** includes a motor unit **61** and a power transmission mechanism (not shown) that includes, for example, a speed reducer.
[0031] The motor unit **41** generates a drive force for rotating the first arm **73** with respect to the base **71**. The motor unit **61** generates a drive force for rotating the second arm **74** with respect to the first arm **73**. Each of the motor units **41** and **61** includes a motor (not shown) and an encoder (not shown). The motor units **41** and **61** are not particularly limited, but are preferably servo motors such as an AC servo motor or a DC servo motor.
[0032] The robot **7** has a motor unit **8** for driving the shaft **75**. The motor unit **8** is provided in the second arm **74** and includes a first motor unit **81** that rotates the spline nut **751** to rotate the spline shaft **753** around the third rotation axis J**3** and a second motor unit **82** that rotates the ball screw nut **752** to raise and lower the spline shaft **753** in a direction along the third rotation axis J**3**, that is, in the vertical direction.
[0033] The robot **7** includes a first endless belt **83** that transmits the drive force output by the first motor unit **81** to the spline nut **751** of the shaft **75**, and a second endless belt **84** that transmits the drive force output by the second motor unit **82** to the ball screw nut **752** of the shaft **75**.
[0034] The first motor unit **81** includes a first motor **811** and an encoder (not shown). The second motor unit **82** includes a second motor **821** and an encoder (not shown). The first motor **811** and the second motor **821** are electrically connected to the control device **3**. Energization conditions such as energization pattern, energization timing, and energization amount to the first motor **811** and the second motor **821** are controlled by the control device **3**.
[0035] Note that one or both of the first motor unit **81** and the second motor unit **82** may include a speed reducer.
[0036] As shown in FIG. **2**, the first endless belt **83** is wound around an output pulley provided on an output shaft **812** of the first motor **811** and an input pulley provided on the spline nut **751**. By this, the drive force output from the first motor **811** can be transmitted to the shaft **75**, and the shaft **75** can be rotated around the third rotation axis J**3**.
[0037] The second endless belt **84** is wound around an output pulley provided on an output shaft **822** of the second motor **821** and an input pulley provided on the ball screw nut **752**. By this, the

drive force output by the second motor **821** can be transmitted to the shaft **75**, and the shaft **75** can be raised and lowered in the vertical direction.

[0038] The motors of the motor units **41** and **61**, the first motor **811**, and the second motor **821** are electrically connected to control device **3**. Although not shown, each of the motors of the motor units **41** and **61**, the first motor **811**, and the second motor **821** includes a stator, a rotor that rotates inside the stator, and a case that houses these components. The stator is disposed along the inner periphery of the case and has a winding such as a three phase winding. The stator generates a magnetic field by energization of the winding, for example, by energization of a three phase alternating current. The energization pattern, the energization timing, the energization amount, and the like of the winding included in the stator of the motors of the motor units **41** and **61**, the first motor **811**, and the second motor **821** are controlled by the control device **3**.

[0039] Each of the motor units **41** and **61**, the first motor unit **81**, and the second motor unit **82** includes a motor driver (not shown), but may not include a motor driver.

[0040] According to drive control of the control device **3**, the motors of motor units **41** and **61**, the first motor **811**, and the second motor **821** rotate in either forward or reverse directions. The motors of motor units **41** and **61**, the first motor **811**, and the second motor **821** each rotate independently.

[0041] Note that the motors of the motor units **41** and **61**, the first motor **811**, and the second motor **821** may be the same type and have the same configuration, or may include motors that are different types and that have different configurations.

[0042] As shown in FIGS. **1**, **2**, and **3**, the inertia sensor **5** is installed in the second arm **74**, and detects inertial force of the second arm **74**, that is, at least one of angular velocity or acceleration, and in the embodiment, the inertia sensor **5** detects both of them. The inertia sensor **5** may be an individual detection element, a detection element mounted on a circuit board, or a module in which these elements are accommodated in a housing. Note that when the detection element is mounted on a circuit board, the circuit board may have a function of acquiring the output of the inertia sensor **5** at least at a constant cycle and transmitting the output to the control device **3**.

[0043] In the present embodiment, the inertia sensor **5** is installed on the arm base **78** of the second arm **74**. In this case, the inertia sensor **5** may be directly supported or fixed to a predetermined portion of the arm base **78**, or may be supported or fixed to the arm base **78** via some intermediate member (support member) different from the arm base **78**. The inertia sensor **5** is disposed at a position overlapping, when viewed along a straight line parallel to the second rotation axis J**2**, a straight line extending so as to connect the second rotation axis J**2** and the third rotation axis J**3**, that is, a straight line passing through the widthwise direction center of the second arm **74**. Note that the inertia sensor **5** may be disposed at a position that does not overlap the straight line connecting the second rotation axis J**2** and the third rotation axis J**3** when viewed along the straight line parallel to the second rotation axis J**2**. The inertia sensor **5** is installed on the arm base **78**, but may be installed under the arm base **78**. The inertia sensor **5** is installed inside the second arm **74**, but may be installed outside the second arm **74**. Viewing along a straight line parallel to the second rotation axis J**2** includes viewing from the axial direction of the second rotation axis J**2** and viewing from the axial direction of the third rotation axis J**3**. In the present embodiment, the straight line parallel to the second rotation axis J**2** is a straight line extending in the vertical direction.

[0044] In the configuration shown in FIG. **2**, the inertia sensor **5** is installed on an upper section of a first protruding section **783** that constitutes a part of the arm base **78**, but the inertia sensor **5** may be installed on the arm base **78** via another member (intermediate member) corresponding to a first protruding section **783**.

[0045] A sensor coordinate system is set in the inertia sensor **5**. The sensor coordinate system has an arbitrary point set in the inertia sensor **5** as the origin, and has an x-axis, a y-axis, and a z-axis, which are three axes orthogonal to each other.

[0046] In the embodiment, the inertial force detected by the inertia sensor **5** includes a total of six types of acceleration: acceleration in the direction along the x-axis, acceleration in the direction along the y-axis, acceleration in the direction along the z-axis, angular velocity around the x-axis, angular velocity around the y-axis, and angular velocity around the z-axis. That is, the inertia sensor **5** is an inertial measurement unit (IMU) that detects acceleration and angular velocity in three axial directions that are orthogonal to each other.

[0047] However, the configuration is not limited to this, and the inertia sensor **5** may be configured to detect only the acceleration in the direction along the x-axis, the acceleration in the direction along the y-axis, and the acceleration in the direction along the z-axis, or may be configured to detect only the angular velocity around the x-axis, the angular velocity around the y-axis, and the angular velocity around the z-axis. A configuration may be adopted in which only acceleration in a direction along one or two of the x-axis, the y-axis, and the z-axis is detected, or a configuration may be adopted in which only angular velocity around one or two axes of the x-axis, the y-axis, and the z-axis is detected.

[0048] In addition to these, the inertia sensor **5** may be configured to detect only angular acceleration around the x-axis, angular acceleration around the y-axis, and angular acceleration around the z-axis. A configuration may be adopted in which only the angular acceleration in a direction along one or two of the x-axis, the y-axis, and the z-axis is detected, or a configuration may be adopted in which only the angular acceleration around one or two axes of the x-axis, the y-axis, and the z-axis is detected.

[0049] Although not illustrated, the control device **3** shown in FIG. **1** includes a control section having at least one central processing unit (CPU), a storage section that stores various programs and the like executed by the control section, and a communication section that transmits and receives signals to and from the robot **7** or an external device. These sections are communicably connected to each other via, for example, a bus. In the present embodiment, the control device **3** is installed inside the base **71**, but it may be installed in another location.

[0050] The control device **3** is connected to the inertia sensor **5** and acquires a signal from the inertia sensor **5** over time. Based on the signal from the inertia sensor **5**, the control device **3** controls operation of one or both of the motor units **41** and **61** so as to suppress vibration of the second arm **74**. By this, vibration damping control can be performed on the second arm **74**. Note that the control device **3** may perform learning based on the signal from the inertia sensor **5** and, based on the learning result, control the operation of the motor units **41** and **61** so as to suppress vibration of the second arm **74**.

[0051] Next, the internal structure of the second arm **74** will be described.

[0052] As shown in FIG. **1**, the second arm **74** has an arm base **78** and a cover **79**. Note that the cover **79** is not shown in FIG. **2**.

[0053] The cover **79** is constituted by a housing whose lower portion is open, and has the function of covering the upper section of the arm base **78** by being mounted on the arm base **78** to protect internal components. The cover **79** is composed of, for example, a plate material formed by molding a resin material into a desired three-dimensional shape. The cover **79** preferably has elasticity to such an extent that it is slightly deformed when a force is applied to it. For example, the cover **79** may be formed by shaping a plate material made of a metal material, such as stainless steel or aluminum, into a desired three-dimensional shape. The cover **79** may be a frame-shaped body.

[0054] The arm base **78** is constructed of a rigid body that has the function of supporting internal components within the second arm **74** and the shaft **75**. Examples of the constituent material of the arm base **78** include various metal materials, various resin materials, particularly hard resin materials, various ceramics, and the like. Also, a composite material obtained by arbitrarily combining these materials may be used. Of these, examples of the metal material include stainless steel and aluminum.

[0055] The arm base **78** is shaped like an elongated block extending in one direction, that is, the left-right direction in FIGS. **1** to **3**. Note that the form, shape, and the like of the arm base **78** are not limited to those described above and, for example, the arm base **78** may be formed of a plate-like body, a frame-like body, or a combination of these.

[0056] As shown in FIGS. **2** and **3**, an installation section **781** in which the drive section **6** is installed is provided at a proximal end section of the arm base **78**, and a through hole **782** through which the shaft **75** is inserted is provided at a distal end section of the arm base **78**.

[0057] The installation section **781** is formed of a through hole having the second rotation axis J**2** as its central axis. The drive section **6** is fixed to an inner peripheral portion of the installation section **781**.

[0058] The through hole **782** is constituted by a through hole having the third rotation axis J**3** as a central axis. The ball screw nut **752** is fixed to the edge of the upper opening of the through hole **782**.

[0059] The arm base **78** supports the drive section **6** and the shaft **75** as described above, and also supports the first motor unit **81**, the second motor unit **82**, the inertia sensor **5**, a first stay **91**, a second stay **92**, and the like.

[0060] The first motor unit **81** and the second motor unit **82** are installed between the drive section **6** and the shaft **75** with respect to the horizontal direction in FIGS. **1** to **3**, that is, in the longitudinal direction of the arm base **78**. When viewed along a straight line parallel to the second rotation axis J**2** or when viewed along the widthwise direction (to be described later), at least a part of the first motor unit **81** and the second motor unit **82** is located between the inertia sensor **5** and the drive section **6**, that is, at least a part is installed at a position nearer to the drive section **6** side than to the inertia sensor **5**. By this, it is possible to keep the drive section **6** at a distance from the inertia sensor **5**, to shorten the second arm **74** and also to effectively utilize the space between the second rotation axis J**2** and the third rotation axis J**3**. At this time, the distance between the rotation center of the first motor unit **81** and the second rotation axis J**2** is shorter than the distance between the rotation center of the first motor unit **81** and the third rotation axis J**3**, and the distance between the rotation center of the second motor unit **82** and the second rotation axis J**2** is shorter than the distance between the rotation center of the second motor unit **82** and the third rotation axis J**3**. As shown in FIG. **3**, the first motor unit **81** and the second motor unit **82** are arranged side by side along the widthwise direction of the arm base **78**. That is, when viewed from the widthwise direction, at least a portion of the first motor unit **81** overlaps at least a portion of the second motor unit **82**. Note that when viewed along a straight line parallel to the second rotation axis J**2**, the widthwise direction is a direction intersecting with a straight line that connects the second rotation axis J**2** and the third rotation axis J**3** and, in the present embodiment, is a direction orthogonal to a straight line that connects the second rotation axis J**2** and the third rotation axis J**3**.

[0061] Note that in FIG. **2**, the first motor unit **81** and the second motor unit **82** are illustrated as being shifted along the longitudinal direction of the arm base **78** to make them easily visible.

[0062] The first motor unit **81** is fixed to the arm base **78** via a fixing member (not shown) in an orientation in which the output shaft **812** protrudes downward. The fixing member of the first motor unit **81** is attached to the case of the first motor **811**. The second motor unit **82** is fixed to the arm base **78** via a fixing member (not shown) in an orientation in which the output shaft **822** protrudes downward. The fixing member of the second motor unit **82** is attached to the case of the second motor **821**. The lower end of the output shaft **812** of the first motor unit **81**, that is, the output pulley of the output shaft **812**, is positioned higher than the lower end of the output shaft **822** of the second motor unit **82**, that is, the output pulley of the output shaft **822**. By this, as shown in FIG. **2**, the first endless belt **83** and the second endless belt **84** are disposed so as to be spaced apart from each other in the vertical direction, and can be prevented from interfering with each other.

[0063] The lower end section of the first stay **91** is installed further in the longitudinal direction of the arm base **78** toward the proximal end side (right side in FIG. **2**) than is the installation section

781, that is, further to the side opposite from the shaft **75** than is the installation section **781** in which the drive section **6** is installed. The first stay **91** is a first member with a first connection section **93**. The first stay **91** includes a first portion **911** that is upright in the vertical direction and a second portion **912** that extends in the horizontal direction from an upper end of the first portion **911** toward the distal end side. Both the first portion **911** and the second portion **912** are each flat plate-shaped. However, they are not limited to this configuration, and the first portion **911** and the second portion **912** may have other shapes, such as a rod shape. A plurality of first portions **911** may be provided, and the second portion **912** may be supported by the plurality of first portions **911**.

[0064] The first connection section **93** to which the duct **77** is connected is provided on the upper surface side of the second portion **912**. When viewed along a straight line parallel to the second rotation axis J**2**, the first connection section **93** overlaps with the second rotation axis J**2**. That is, the first connection section **93** is positioned on a straight line extending along the second rotation axis J**2**. The first connection section **93** may be a connector to which the duct **77** is attachable and detachable, a fixing section that fixes the duct **77**, or the like.

[0065] The first elongated wire **21** protrudes downward from the first connection section **93** from the lower surface side of the second portion **912**, that is, a wiring for driving the motor unit **61** of the drive section **6** extends from the first connection section **93**. The first elongated wire **21** protrudes from the first connection section **93** from the lower surface side of the second portion **912** toward the distal end side, that is, wiring for driving the inertia sensor **5**, the first motor unit **81**, and the second motor unit **82** extends from the first connection section **93**. A locking member (not shown) is provided on the distal end side of the first portion **911**, and the first elongated wire **21** is locked by the locking member. Note that the locking member may be provided on the second portion **912**, or may be provided in neither the first portion **911** nor the second portion **912**.

[0066] The second stay **92** is installed at a position in the longitudinal direction of the arm base **78** that is between the installation section **781** and the through hole **782** and that is nearer to the through hole **782**. The second stay **92** is a second member that includes the second connection section **94** and that is positioned further to the shaft **75** side than is the first connection section **93**. The second stay **92** includes a first portion **921** that is upright in the vertical direction and a second portion **922** that extends in the horizontal direction from an upper end of the first portion **921** toward the proximal end side. Both the first portion **921** and the second portion **922** are each flat plate-shaped. However, they are not limited to this configuration, and the first portion **921** and the second portion **922** may have other shapes, such as a rod shape. A plurality of first portions **921** may be provided, and the second portion **922** may be supported by the plural first portions **921**.

[0067] The second portion **922** extends toward the proximal end side and is positioned above the inertia sensor **5**. That is, the second portion **922** has a portion overlapping with the inertia sensor **5**. By this, the second arm **74** can be shortened, and the space between the second rotation axis J**2** and the third rotation axis J**3** can be effectively utilized.

[0068] The second portion **922** is provided with a second connection section **94** to which the second elongated wire **22** is connected. The second connection section **94** may be a connector to which the second elongated wire **22** is attachable and from which the second elongated wire **22** is detachable, a fixing portion that fixes a proximal end section (terminal portion) of the second elongated wire **22** by, for example, a screw or soldering, or the like. The second elongated wire **22** is routed to an upper section of the spline shaft **753** through a through hole (not shown) provided in an upper section of the cover **79**.

[0069] The first elongated wire **21** is connected to the second connection section **94** from the lower surface side of the second portion **922**. A locking member (not shown) is provided at the proximal end side of the first portion **921**, and the first elongated wire **21** is locked by the locking member. Note that the locking member may be provided on the distal end side of the first portion **921** or on the second portion **922**.

[0070] The arm base **78** includes a first protruding section **783** and a second protruding section **784**. The upper end of the first protruding section **783** and the upper end of the second protruding section **784** are both located above the first endless belt **83** and the second endless belt **84**. The first protruding section **783** and the second protruding section **784** are provided so as not to contact the first endless belt **83** and the second endless belt **84**.
[0071] In the present embodiment, the first protruding section **783** and the second protruding section **784** are projecting sections that protrude upward from the arm base **78**. The projecting sections have a trapezoidal shape, that is, their upper section has a planar shape, and in this embodiment, they have a block shape, particularly, a prismatic shape. However, this is not a limitation, and the projecting sections may have another shape such as a truncated pyramid shape, a columnar shape, a truncated cone shape, a cylindrical shape, a plate shape which is bent as desired, or a frame shape, and may be solid or hollow.
[0072] The first protruding section **783** and the second protruding section **784** are provided between the motor unit **8** and the shaft **75** in the longitudinal direction of the arm base **78**. That is, the first protruding section **783** and the second protruding section **784** are provided between the motor unit **8** and the shaft **75** when viewed along a straight line parallel to the second rotation axis J**2** or when viewed along the widthwise direction. The first protruding section **783** and the second protruding section **784** are disposed so as to be spaced apart from each other by being shifted in a direction in which the second rotation axis J**2** and the third rotation axis J**3** are arranged. Regarding the positional relationship between the first protruding section **783** and the second protruding section **784**, the first protruding section **783** is located on the motor unit **8** side (proximal end side), and the second protruding section **784** is located on the shaft **75** side (distal end side).
[0073] The inertia sensor **5** is installed on the upper section of the first protruding section **783**. A lower end section of the second stay **92** is installed on an upper section of the second protruding section **784**. Both the inertia sensor **5** and the second stay **92** are installed on a protruding section and fixed to a protruding section, for example, by using one or more fixing members such as screws. An upper surface of the second protruding section **784** is an attachment section **100** to which the second stay **92** is attached. The attachment section **100** is positioned between the inertia sensor **5** and the shaft **75** when viewed along a straight line parallel to the second rotation axis J**2** or when viewed along the widthwise direction.
[0074] Note that each of the first protruding section **783** and the second protruding section **784** may be formed of a plurality of projecting sections. Since the inertia sensor **5** or the second stay **92** is supported by a plurality of projecting sections, the inertia sensor **5** or the second stay **92** is less likely to vibrate, and the projecting sections can be easily arranged or shaped so as not to interfere with the endless belt or the like. In this case, a fixing member such as a screw may be used for each projecting section. The plurality of projecting sections may have different configurations. The projecting sections may be separate members from the arm base **78**. For example, the projecting sections may be rod-shaped members separate from the arm base **78**, and the first protruding section **783** and the second protruding section **784** may be constituted by a plurality of rod-shaped members spaced apart from each other, like leg sections. The configurations of the first protruding section **783** and the second protruding section **784** may be different from each other. For example, the first protruding section **783** may include a plurality of columnar projecting sections, and the second protruding section **784** may include only one prismatic projecting section. The first protruding section **783** and the second protruding section **784** may be omitted. In this case, the inertia sensor **5** and the second stay **92** are fixed to the arm base **78** using, for example, a fixing member such as a screw. At this time, the location where the second stay **92** is attached by a fixing member such as a screw is the attachment section **100**.
[0075] The first protruding section **783** and the second protruding section **784** may be connected to each other. That is, instead of the first protruding section **783** and the second protruding section **784**, a single protruding section may be provided, or a connection member for connecting the first

protruding section **783** and the second protruding section **784** may be provided. In either case, the protruding section is less likely to vibrate, and the effect of the present disclosure can be remarkably obtained.

[0076] As shown in FIG. **3**, when viewed along a straight line parallel to the second rotation axis J**2**, the first endless belt **83** and the second endless belt **84** partially intersect each other and, when viewed along the straight line parallel to the second rotation axis J**2**, the inertia sensor **5** is installed on the inside of the first endless belt **83** and of the second endless belt **84** and to the attachment section **100** side (distal end side) of the position (intersecting position) P**1** where the first endless belt **83** and the second endless belt **84** intersect each other. By this, it is possible to further separate the inertia sensor **5** from the first motor unit **81** and the second motor unit **82**, which may be a generation source of vibration that is undesirable for damping control or the like, that is, is superfluous vibration.

[0077] The arm base **78** has a through hole **785** penetrating in the vertical direction, that is, in the axial direction of the second rotation axis J**2**. In the embodiment, the through hole **785** is provided at a position between the first protruding section **783** and the second protruding section **784**, that is, a position between the inertia sensor **5** and the attachment section **100** in the longitudinal direction of the arm base **78**. That is, the through hole **785** is provided between the inertia sensor **5** and the attachment section **100** when viewed along a straight line parallel to the second rotation axis J**2** or when viewed along the widthwise direction. However, the position where the through hole **785** is formed is not limited to this. For example, the through hole **785** may be formed closer to the proximal end side than the first protruding section **783** of the arm base **78**, may be formed closer to the distal end side than the second protruding section **784**, and further, a plurality of through holes **785** may be formed in at least one of these places.

[0078] Such a through hole **785** has, for example, a function of releasing, to outside, heat that was generated in the drive section **6**, the motor unit **8**, the inertia sensor **5**, and the like and that has accumulated inside the second arm **74**, that is, it has a heat dissipation function. By this, it is possible to prevent an excessive temperature rise inside the second arm **74**, and in particular, it is possible to dissipate heat generated by the inertia sensor **5** to the outside and to prevent a temperature rise of the inertia sensor **5**. Therefore, the detection accuracy of the inertia sensor **5** is maintained high, that is, it is possible to sufficiently detect the vibration that was originally desired to be detected, and it is possible to more accurately perform the above-described vibration damping control. As a result, it is possible to operate the robot **7** more stably.

[0079] When the position where the through hole **785** is formed is between the inertia sensor **5** and the attachment section **100**, vibration transmitted from the second stay **92** to the arm base **78** through the attachment section **100** is less likely to be directly transmitted to the inertia sensor **5** due to the through hole **785**, which is advantageous in suppressing vibration of the inertia sensor **5**.

[0080] As described above, the through hole **785** is provided in the arm base **78**, penetrating the arm base **78** in the axial direction of the second rotation axis J**2** in between the inertia sensor **5** and the attachment section **100**. By this, it is possible to radiate, to outside, the heat inside the second arm **74**, particularly, the heat generated by the inertia sensor **5**. Due to the through hole **785**, the vibration transmitted from the second stay **92** through the attachment section **100** is less likely to be transmitted to the inertia sensor **5**. Therefore, the detection accuracy of the inertia sensor **5** is maintained high, and the vibration damping control of the robot arm **72** can be performed more accurately. As a result, it is possible to operate the robot **7** more stably.

[0081] Note that the through hole **785** may be omitted. One or two or more through holes **785** may be provided in another location of the arm base **78** of the second arm **74** or any other arbitrary location, for example, in the cover **79**. For example, when the through hole **785** is provided between the through hole **782** and the second protruding section **784** or between the installation section **781** and the first protruding section **783**, in addition to being provided at the position shown in FIG. **2**, then the above-described heat dissipation effect is further improved.

[0082] Here, as described above, the inertia sensor **5** detects the inertial force of the second arm **74** in order to perform damping control of the robot arm **72**, but it also picks up superfluous vibration components, that is, undesirable vibration components with respect to damping control (hereinafter referred to as "superfluous vibration" or "superfluous vibration component") such as vibration of the shaft **75**, vibration of the attachment section **100**, vibration of the second stay **92**, vibration of the motor unit **8**, vibration of the drive section **6**, and other noise. When a superfluous vibration component is included, the accuracy of damping control decreases. Therefore, it is necessary to dispose the inertia sensor **5** at a position where superfluous vibration components are not detected as much as possible. In the related art, this problem has not been sufficiently studied. However, in the present disclosure, the above-described problem has been resolved by configuring the positional relationship of each portion in the longitudinal direction of the second arm **74** as follows. This will be described below.
[0083] As shown in FIGS. **2** and **3**, the attachment section **100**, the inertia sensor **5**, and the motor unit **8** are arranged in the robot **7** in this order from the third rotation axis J**3** toward the second rotation axis J**2** so as to be spaced apart from each other in the longitudinal direction of the second arm **74**. That is, since the shaft **75**, the attachment section **100**, the motor unit **8**, and the drive section **6**, which are sources of superfluous vibration, are disposed to be separated from the inertia sensor **5**, it is possible to suppress detection by the inertia sensor **5** of superfluous vibration components. In particular, it is possible to keep the shaft **75** and the drive section **6**, which generate particularly large vibrations among the superfluous vibrations, farther from the inertia sensor **5** than the second stay **92** and the motor unit **8**, which generate relatively small vibrations, and it is possible to more remarkably suppress detection by the inertia sensor **5** of superfluous vibrations.
[0084] Due to these synergistic effects, by adopting the above-described arrangement, it is possible to remarkably suppress the detection of superfluous vibration by the inertia sensor **5**, and it is possible to more accurately perform damping control of the robot arm **72** with high accuracy. As a result, it is possible to increase the accuracy of the operation performed by the robot **7**. Note that when the motor unit **8** is the first motor unit **81** and the second motor unit **82**, the inertia sensor **5** may be disposed, for example, between the attachment section **100** and the midpoint between the rotation centers of the first motor unit **81** and the second motor unit **82**. It may alternatively be disposed between the attachment section **100** and the outer shape or the rotation center of the first motor unit **81** and also between the attachment section **100** and the outer shape or the rotation center of the second motor unit **82**. Note that motor unit **8** may be only one of the first motor unit **81** or second motor unit **82**. In this case, the inertia sensor **5** may be disposed between the attachment section **100** and the outer shape or the rotation center of either the first motor unit **81** or the second motor unit **82**.
[0085] In the present embodiment, unlike the related art configuration, the first stay **91** and the second stay **92** are installed independently of each other, so that the degree of freedom of installation of members such as wiring is improved in the space between the first stay **91** and the second stay **92**. For example, it is also possible to reduce the height of either or both the first stay **91** and the second stay **92**. Therefore, it is possible to reduce the size, the length, and the weight of the second arm **74**, and consequently to reduce the size of the robot **7**. In particular, since miniaturization, shortening, and weight reduction of the second arm **74** contribute to a reduction in the inertial mass of the second arm **74**, the operating speed of the robot arm **72** can be increased, and the efficiency of the operation performed by the robot **7** can be improved. Note that since the first stay **91** and the second stay **92** are independent from each other, the second stay **92**, which supports the weight of the second connection section **94**, is likely to vibrate. In particular, in the case of a cantilever structure with only the single first portion **921** of the present embodiment, or in the case where the second arm **74** is elongated in the longitudinal direction, the vibration of the second stay **92** becomes large. However, since the attachment section **100** of the second stay **92** is located between the inertia sensor **5** and the shaft **75**, that is, closer to the shaft **75** than is the inertia

sensor **5**, it is possible to distance the shaft **75** from the inertia sensor **5**, to shorten the second arm **74**, and to effectively utilize the space between the second rotation axis J**2** and the third rotation axis J**3**. The second connection section **94** of the second stay **92** can be brought closer to the shaft **75**. By shortening the length of the second elongated wire **22**, the second elongated wire **22** is less likely to shake, so it is possible to suppress vibration transmitted from the second elongated wire **22** to the inertia sensor **5** via the second stay **92**.

[0086] As described above, the robot **7** includes the base **71**, the first arm **73**, which is connected to the base **71** so as to be rotatable around first rotation axis J**1**, the second arm **74**, which is connected to the first arm **73** so as to be around the second rotation axis J**2**, which is parallel to the first rotation axis J**1**, the shaft **75**, which is connected to the second arm **74** so as to be rotatable around the third rotation axis J**3**, which is parallel to the second rotation axis J**2**, and also so as to be movable along the axial direction of the third rotation axis J**3**, and on which the end effector **76** is mounted, the inertia sensor **5**, which is installed on the second arm **74** and which detects at least one of angular velocity or acceleration, the motor unit **8**, which is installed in the second arm **74** and which drives the shaft **75**, and the duct **77** which is connected to the base **71** and to the second arm **74**. The second arm **74** includes the first stay **91**, which is a first member having the first connection section **93** to which duct **77** is connected, the second stay **92**, which is a second member positioned closer to the shaft **75** than is the first connection section **93** and which has the second connection section **94** to which the second elongated wire **22**, which includes one of a wiring and piping connected to end effector **76**, is connected, and the arm base **78**, which has the attachment section **100** to which the second stay **92** is attached. The inertia sensor **5** is positioned between the motor unit **8** and the attachment section **100**. By this, it is possible to effectively suppress that the inertia sensor **5** detects superfluous vibration. As a result, it is possible to more appropriately perform various kinds of control using the detection value of the inertia sensor **5**, for example, vibration damping control of the robot arm **72**.

[0087] The robot system **1** includes the robot **7** including the base **71**, the first arm **73**, which is connected to the base **71** so as to be rotatable around the first rotation axis J**1**, the second arm **74**, which is connected to the first arm **73** so as to be rotatable around the second rotation axis J**2**, which is parallel to the first rotation axis J**1**, the shaft **75**, which is connected to the second arm **74** so as to be rotatable around the third rotation axis J**3**, which is parallel to the second rotation axis J**2**, which is movable along the axial direction of the third rotation axis J**3**, and to which the end effector **76** is mounted, the inertia sensor **5**, which is installed on the second arm **74** and which detects at least one of angular velocity or acceleration, the motor unit **8**, which is installed in the second arm **74** and which drives the shaft **75**, and the duct **77**, which is connected between the base **71** and the second arm **74**, and the control device **3**, which controls drive of the robot **7**. The second arm **74** includes the first stay **91**, which is a first member having the first connection section **93** to which the duct **77** is connected, the second stay **92**, which is a second member positioned closer to the shaft **75** than is the first connection section **93** and which has the second connection section **94** to which the second elongated wire **22**, which includes one of a wiring or piping connected to end effector **76**, is connected, and the arm base **78**, which has the attachment section **100** to which the second stay **92** is attached. The inertia sensor **5** is positioned between motor unit **8** and attachment section **100**. By this, it is possible to effectively suppress that the inertia sensor **5** detects superfluous vibration. As a result, it is possible to more appropriately perform various kinds of control using the detection value of the inertia sensor **5**, for example, vibration damping control of the robot arm **72**.

[0088] Note that the present embodiment describes the case where the first stay **91** is provided, but the present disclosure is not limited to this, and the first stay **91** may be omitted. In this case, the first connection section **93** to which the duct **77** is connected is installed, for example, on the upper section of the cover **79**. The cover **79** is a first member to which the duct **77** is connected.

[0089] The motor unit **8** includes the first motor unit **81** and the second motor unit **82**, the second

arm **74** has the first endless belt **83** that transmits drive force output from the first motor unit **81** to the shaft **75** and the second endless belt **84** that transmits drive force output from the second motor unit **82** to the shaft **75**, the arm base **78** has the first protruding section **783** that protrudes further upward than the first endless belt **83** and the second endless belt **84**, and the inertia sensor **5** is installed on the upper section of the first protruding section **783**. By this, it is possible to prevent the inertia sensor **5** from interfering with the first endless belt **83** and the second endless belt **84**. As a result, it is possible to prevent the inertia sensor **5** from detecting superfluous vibration caused by contact and interference with the first endless belt **83** and the second endless belt **84**, and it is possible to smoothly and desirably perform drive of the shaft **75**, that is, rotation and raising and lowering of the spline shaft **753**.
[0090] It is possible to keep the inertia sensor **5** a distance away from the shaft **75**, the second stay **92**, and the motor unit **8**, which may be generation sources of superfluous vibration. Therefore, it is possible to more effectively suppress that the inertia sensor **5** detects superfluous vibration.
[0091] Note that the upper section of the first protruding section **783** may be at the same height as the first endless belt **83** or the second endless belt **84**, or may be located at a position lower than the first endless belt **83** and the second endless belt **84**. The first protruding section **783** may be omitted.
[0092] The arm base **78** includes the second protruding section **784**, which protrudes upward higher than the first endless belt **83** and the second endless belt **84**, and the attachment section **100** is disposed on the upper section of the second protruding section **784**. By this, it is possible to prevent the second stay **92** from interfering with the first endless belt **83** and the second endless belt **84**, and to keep the second stay **92**, which may be a source of superfluous vibration, away from the inertia sensor **5**. As a result, it is possible to more remarkably suppress the detection of superfluous vibration by the inertia sensor **5**, and it is possible to smoothly and favorably perform drive of the shaft **75**, that is, the rotation and elevation of the spline shaft **753**.
[0093] Note that the upper section of the second protruding section **784** may have the same height as the first endless belt **83** or the second endless belt **84**, or may be located at a position lower than the first endless belt **83** and the second endless belt **84**. The second protruding section **784** may be omitted.
[0094] When viewed along a straight line parallel to the second rotation axis J**2**, the first endless belt **83** and the second endless belt **84** intersect each other and the inertia sensor **5** is installed further to the attachment section **100** side than is the position P**1** where the first endless belt **83** and the second endless belt **84** intersect each other. By this, it is possible to further separate the inertia sensor **5** from the first motor unit **81** and the second motor unit **82**, which may be a generation source of superfluous vibration. As a result, it is possible to more remarkably suppress the inertia sensor **5** from detecting superfluous vibration.
[0095] Note that the inertia sensor **5** may be installed closer to the first motor unit **81** and the second motor unit **82** side than is position P**1**.
[0096] The clearance between the second rotation axis J**2** and the third rotation axis J**3** is preferably 375 mm or more and 1000 mm or less, and more preferably 425 mm or more and 600 mm or less. In a case where the clearance between the second rotation axis J**2** and the third rotation axis J**3** is in the above-described range, the second arm **74** is relatively long and easily vibrates, and thus the effect of the present disclosure is more remarkably obtained.
[0097] It should be noted that in the present disclosure, the clearance between the second rotation axis J**2** and the third rotation axis J**3** is not particularly limited, and may be out of the above range.
[0098] When viewed along a straight line parallel to the second rotation axis J**2**, the inertia sensor **5** has a portion overlapping the second connection section **94**. By this, it is possible to further shorten the length of the second arm **74** and to reduce the inertial weight of the second arm **74**. As a result, it is possible to increase the operation speed of the robot arm **72** and to improve the efficiency of the operations performed by the robot **7**. The space between the second rotation axis J**2** and the

third rotation axis J**3** can be effectively utilized.

Second Embodiment

[0099] Note that when viewed along a straight line parallel to the second rotation axis J**2**, the inertia sensor **5** may or may not entirely overlap the second connection section **94**.

[0100] FIG. **4** is an enlarged partial cross-sectional view of an arm base of a second arm in a robot system according to a second embodiment of the present disclosure.

[0101] Hereinafter, a robot and the robot system according to the second embodiment of the present disclosure will be described with reference to FIG. **4**, although the description will focus mainly on the differences from the first embodiment, and description of similar matters will be omitted.

[0102] As shown in FIG. **4**, the inertia sensor **5** is installed spanning between the first protruding section **783** and the second protruding section **784**. That is, a proximal end section (the end section on the second rotation axis J**2** side) of the inertia sensor **5** is fixed to the upper section of the first protruding section **783**, and a distal end section (the end portion on the third rotation axis J**3** side) of the inertia sensor **5** is fixed to the upper section of the second protruding section **784**. With such a configuration, the length of the second arm **74** can be shortened, and the space between the second rotation axis J**2** and the third rotation axis J**3** can be effectively utilized.

[0103] In this manner, the inertia sensor **5** is installed spanning across the first protruding section **783** and the second protruding section **784**. By this, it is possible to further shorten the length of the second arm **74** and to reduce the inertial weight of the second arm **74**. As a result, it is possible to increase the operation speed of the robot arm **72** and to improve the efficiency of the operations performed by the robot **7**. The space between the second rotation axis J**2** and the third rotation axis J**3** can be effectively utilized.

Third Embodiment

[0104] FIG. **5** is an enlarged top view of an arm base of a second arm in a robot according to a third embodiment of the present disclosure.

[0105] Hereinafter, the robot and a robot system according to the third embodiment of the present disclosure will be described with reference to FIG. **5**, although differences from the first embodiment will be mainly described, and description of similar matters will be omitted.

[0106] As shown in FIG. **5**, the first endless belt **83** and the second endless belt **84** intersect each other at position P**1** when viewed along a straight line parallel to the second rotation axis J**2**. The inertia sensor **5** is separated from the first motor **811**, the second motor **821**, and the attachment section **100**. The inertia sensor **5** is installed between the position P**1**, where the first endless belt **83** and the second endless belt **84** intersect each other, and the attachment section **100** in the longitudinal direction of the arm base **78**. According to such a configuration, it is possible to position the inertia sensor **5** separated from the shaft **75**, the attachment section **100**, the first motor **811**, and the second motor **821**, which may be sources of superfluous vibration. Therefore, it is possible to suppress that the inertia sensor **5** detects superfluous vibration.

[0107] Further, since the inertia sensor **5** is installed between the position P**1**, where the first endless belt **83** and the second endless belt **84** intersect each other, and the attachment section **100**, it is possible to keep the inertia sensor **5** away from the first motor **811** and the second motor **821**, which generate particularly large vibration among the superfluous vibrations, and it is possible to more remarkably suppress the inertia sensor **5** from detecting superfluous vibrations.

[0108] Due to the above-described synergistic effect, it is possible to more effectively suppress that the inertia sensor **5** detects superfluous vibration, and it is possible to more accurately perform vibration damping control of the robot arm **72** with high precision. As a result, it is possible to increase the accuracy of the operations performed by the robot **7**.

[0109] The robot **7** includes the base **71**, the first arm **73**, which is connected to the base **71** so as to be rotatable around the first rotation axis J**1**, the second arm **74**, which is connected to the first arm **73** so as to be rotatable around the second rotation axis J**2**, which is parallel to the first rotation axis

J**1**, the shaft **75**, which is connected to the second arm **74** so as to be rotatable around a third rotation axis J**3**, which is parallel to the second rotation axis J**2**, and so as to be movable along the axial direction of the third rotation axis J**3**, with the end effector **76** mounted on the shaft **75**, the inertia sensor **5**, which is mounted on the second arm **74** and which detects at least one of angular velocity or acceleration, the first motor **811**, which is installed in the second arm **74** and which outputs a drive force that rotates the shaft **75** around the third rotation axis J**3**, the second motor **821**, which is installed in the second arm **74** and which outputs drive force that rotates the shaft **75** around the third rotation axis J**3**, the first endless belt **83**, which transmits drive force output by the first motor **811** to the shaft **75**, the second endless belt **84**, which transmits drive force output by the second motor **821** to the shaft **75**, and the duct **77**, which is connected to the base **71** and to the second arm **74**. The second arm **74** includes the first stay **91**, which is a first member having the first connection section **93** to which the duct **77** is connected, the second stay **92**, which is a second member positioned closer to the shaft **75** than is the first connection section **93** and which has the second connection section **94** to which the second elongated wire **22**, which includes one of wiring and piping connected to the end effector **76**, is connected, and the arm base **78**, which has the attachment section **100** to which the second stay **92** is attached. The inertia sensor **5** is positioned between the motor unit **8** and the attachment section **100**. When viewed along a straight line parallel to the second rotation axis J**2**, the first endless belt **83** and the second endless belt **84** intersect each other, and the inertia sensor **5** is disposed between the attachment section **100** and the position P**1**, where the first endless belt **83** and the second endless belt **84** intersect each other. By this, it is possible to effectively suppress that the inertia sensor **5** detects superfluous vibration. As a result, it is possible to more appropriately perform various kinds of control using the detection value of the inertia sensor **5**, for example, vibration damping control of the robot arm **72**.

[0110] Note that unlike the configuration shown in the drawings, in the present embodiment the shaft **75** may be adjacent to the second stay **92** (the attachment section **100**) or may be disposed between the second stay **92** (the attachment section **100**) and the inertia sensor **5**. The shaft **75** and the second stay **92** (the attachment section **100**) may be arranged at the second protruding section **784**.

[0111] Above, the robot and robot system according to the present disclosure have been described based on the illustrated embodiments, but the present disclosure is not limited thereto, and the configuration of each section of the robot and the robot system can be replaced with an arbitrary configuration having the same function. Other arbitrary components may be added to the robot and the robot system.

[0112] The robot may include a locking member that locks the second elongated wire. The locking member can be used by being fixed to the second stay, the inner wall of the arm base, or the like.

[0113] The robot may have a plate that supports the spline shaft. In this case, the inertia sensor is disposed separated from the spline shaft.

Claims

1. A robot comprising: a base; a first arm connected to the base so as to be rotatable around a first rotation axis; a second arm connected to the first arm so as to be rotatable around a second rotation axis parallel to the first rotation axis; a shaft connected to the second arm so as to be rotatable around a third rotation axis parallel to the second rotation axis and so as to be movable along an axial direction of the third rotation axis, an end effector being mounted on the shaft; an inertia sensor that is installed in the second arm and that detects at least one of angular velocity or acceleration; a motor unit that is installed in the second arm and that is configured to drive the shaft; and a duct connected to the base and to the second arm, wherein the second arm includes a first member having a first connection section to which the duct is connected, a second member that includes a second connection section to which wiring or piping connected to the end effector is connected and that is positioned closer to a shaft side than is the first connection section, and an arm base having an attachment section to which the second member is attached and the inertia sensor is disposed between the motor unit and the attachment section.

2. The robot according to claim 1, wherein the motor unit includes a first motor unit and a second motor unit, the second arm includes a first endless belt that transmits drive force output from the first motor unit to the shaft and a second endless belt that transmits drive force output from the second motor unit to the shaft, and the arm base includes a first protruding section that protrudes further upward than the first endless belt and the second endless belt, and the inertia sensor is installed on an upper section of the first protruding section.

3. The robot according to claim 2, wherein the arm base includes a second protruding section that protrudes further upward than the first endless belt and the second endless belt and the attachment section is disposed on an upper section of the second protruding section.

4. The robot according to claim 3, wherein the inertia sensor is installed spanning between the first protruding section and the second protruding section.

5. The robot according to claim 1, wherein the first endless belt and the second endless belt intersect with each other when viewed along a straight line parallel to the second rotation axis and the inertia sensor is installed closer to an attachment section side than a position where the first endless belt and the second endless belt intersect with each other.

6. The robot according to claim 1, wherein a clearance between the second rotation axis and the third rotation axis is 375 mm or more.

7. The robot according to claim 1, wherein when viewed along a straight line parallel to the second rotation axis, a portion of the inertia sensor overlaps the second connection section.

8. The robot according to claim 1, wherein a through hole penetrating in an axial direction of the second rotation axis is provided in the arm base between the inertia sensor and the attachment section.

9. A robot system comprising: a robot including a base, a first arm connected to the base so as to be rotatable around a first rotation axis, a second arm connected to the first arm so as to be rotatable around a second rotation axis parallel to the first rotation axis, a shaft connected to the second arm so as to be rotatable around a third rotation axis parallel to the second rotation axis and so as to be movable along an axial direction of the third rotation axis, an end effector being mounted on the shaft, an inertia sensor that is installed in the second arm and that detects at least one of angular velocity or acceleration, a motor unit that is installed in the second arm and that is configured to drive the shaft, and a duct connected to the base and the second arm and a control device configured to control drive of the robot, wherein the second arm includes a first member having a first connection section to which the duct is connected, a second member provided with a second connection section to which wiring or piping connected to the end effector is connected, the second member being positioned closer toward the shaft side than is the first connection section, and an arm base having an attachment section to which the second member is attached and the inertia sensor is disposed between the motor unit and the attachment section.

10. A robot comprising: a base; a first arm connected to the base so as to be rotatable around a first rotation axis; a second arm connected to the first arm so as to be rotatable around a second rotation axis parallel to the first rotation axis; a shaft connected to the second arm so as to be rotatable around a third rotation axis parallel to the second rotation axis and so as to be movable along an axial direction of the third rotation axis, an end effector being mounted on the shaft; an inertia sensor that is installed in the second arm and that detects at least one of angular velocity or acceleration; a first motor that is installed in the second arm and that is configured to output a drive force for rotating the shaft around the third rotation axis; a second motor that is installed in the second arm and that is configured to output a drive force for moving the shaft along an axial direction of the third rotation axis; a first endless belt configured to transmit a drive force output by the first motor to the shaft; a second endless belt configured to transmit the drive force output by the second motor to the shaft; and a duct connected to the base and to the second arm, wherein the second arm includes a first member having a first connection section to which the duct is connected, a second member provided with a second connection section to which wiring or piping connected to the end effector is connected, the second member being positioned closer toward the shaft side than is the first connection section, and an arm base having an attachment section to which the second member is attached, the first endless belt and the second endless belt intersect with each other when viewed along a straight line parallel to the second rotation axis, and the inertia sensor is disposed between the attachment section and a position where the first endless belt and the second endless belt intersect each other.