US 20230258456A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2023/0258456 A1

(43) Pub. Date: Aug. 17, 2023

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(54) **INERTIAL SENSOR**

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(21) Appl. No.: **18/002,005**

(22) PCT Filed: **Jun. 24, 2021**

(86) PCT No.: **PCT/JP2021/023940**

§ 371 (c)(1), (2) Date: **Dec. 15, 2022**

(30) **Foreign Application Priority Data**

Jun. 24, 2020 (JP) 2020-109127

Publication Classification

(51) **Int. Cl.**

G01C 21/28 (2006.01)
G01C 21/16 (2006.01)
G01C 21/18 (2006.01)
G01C 19/5776 (2006.01)

(52) **U.S. Cl.**

CPC *G01C 21/28* (2013.01); *G01C 21/166* (2020.08); *G01C 21/18* (2013.01); *G01C 19/5776* (2013.01)

(57) **ABSTRACT**

An inertial sensor includes: a plurality of inertial force detection elements each configured to output an output signal corresponding to a detected inertial force; and a processor configured to execute processing relating to the output signal from each of the plurality of inertial force detection elements. The plurality of inertial force detection elements include a first inertial force detection element and a second inertial force detection element. A detection range of the first inertial force detection element and a detection range of the second inertial force detection element are different from each other. A sensitivity of the first inertial force detection element and a sensitivity of the second inertial force detection element are different from each other.

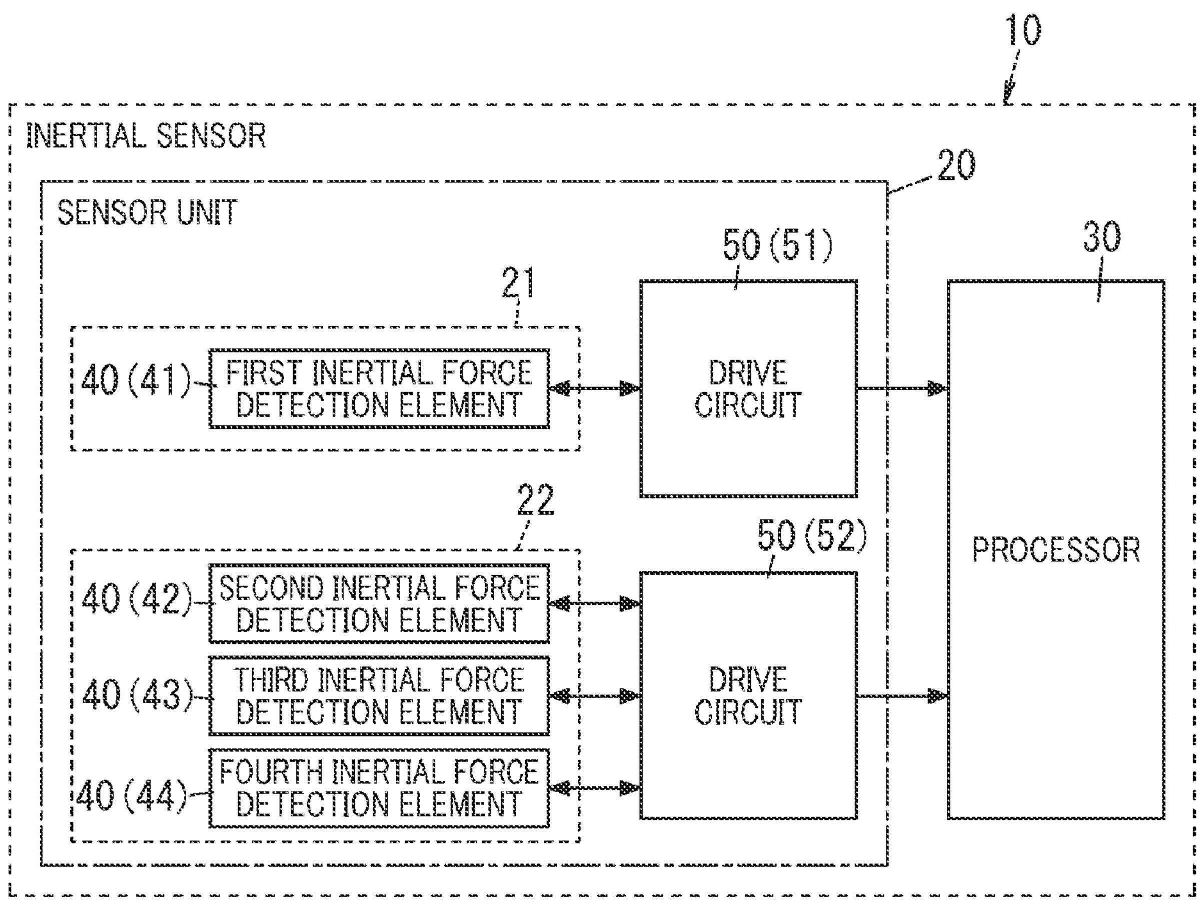


FIG. 1

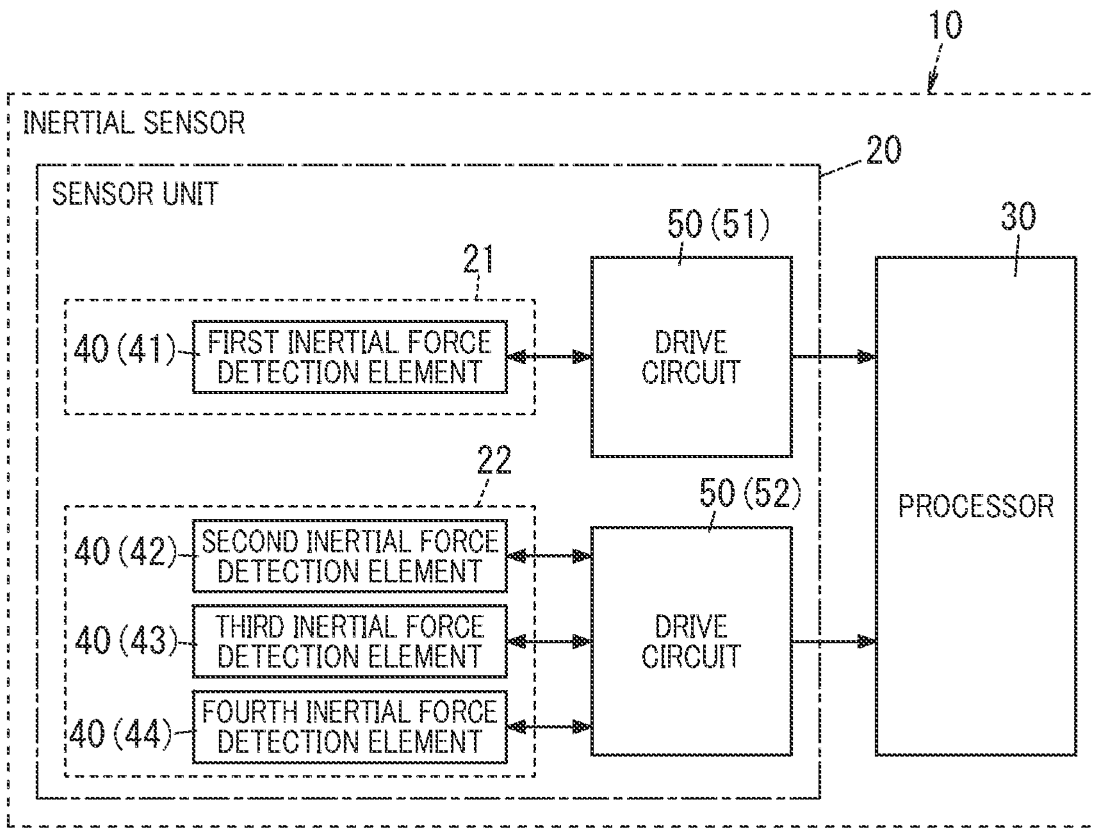

10
INERTIAL SENSOR
20
SENSOR UNIT
50 (51)
30
21
40 (41)
FIRST INERTIAL FORCE DETECTION ELEMENT
DRIVE CIRCUIT
22
50 (52)
PROCESSOR
40 (42)
SECOND INERTIAL FORCE DETECTION ELEMENT
40 (43)
THIRD INERTIAL FORCE DETECTION ELEMENT
DRIVE CIRCUIT
40 (44)
FOURTH INERTIAL FORCE DETECTION ELEMENT

FIG. 2

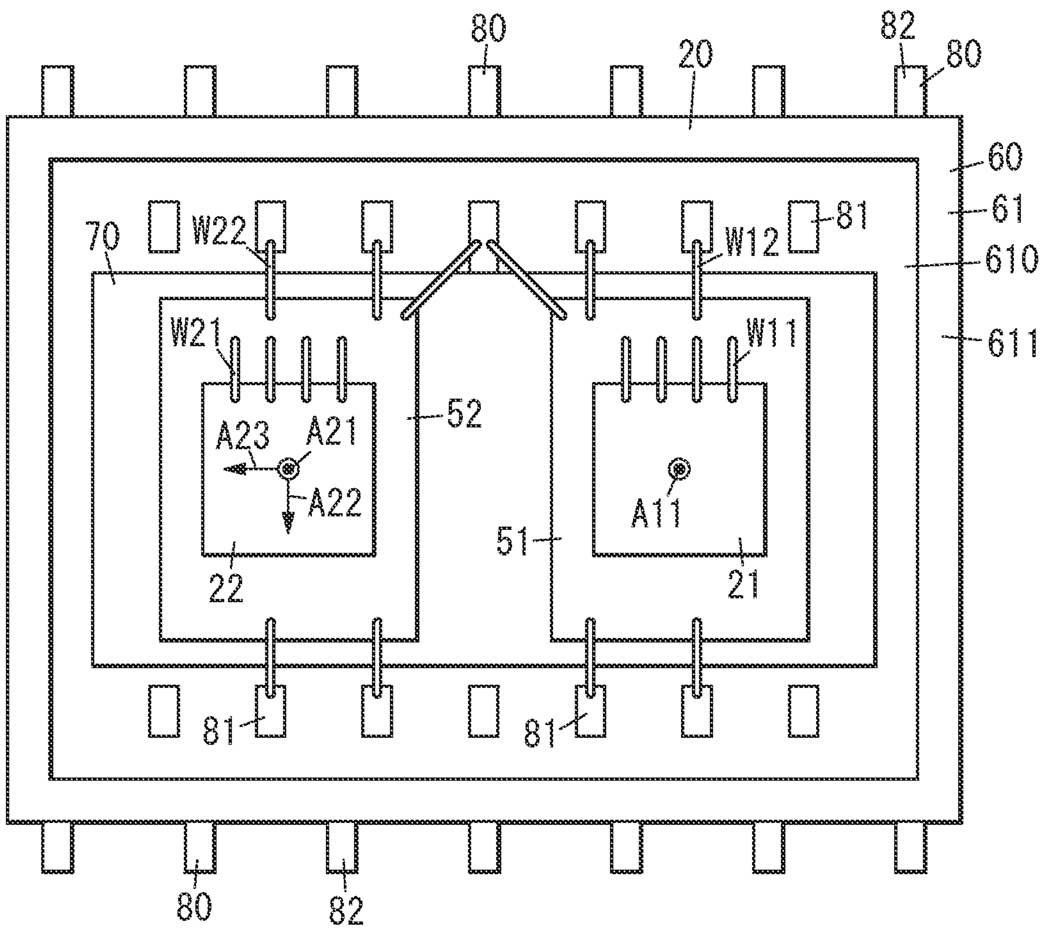

80
82
80
20
60
61
81
W22
70
W12
610
W21
W11
611
52
A23
A21
A22
A11
51
22
21
81
81
80
82

FIG. 3

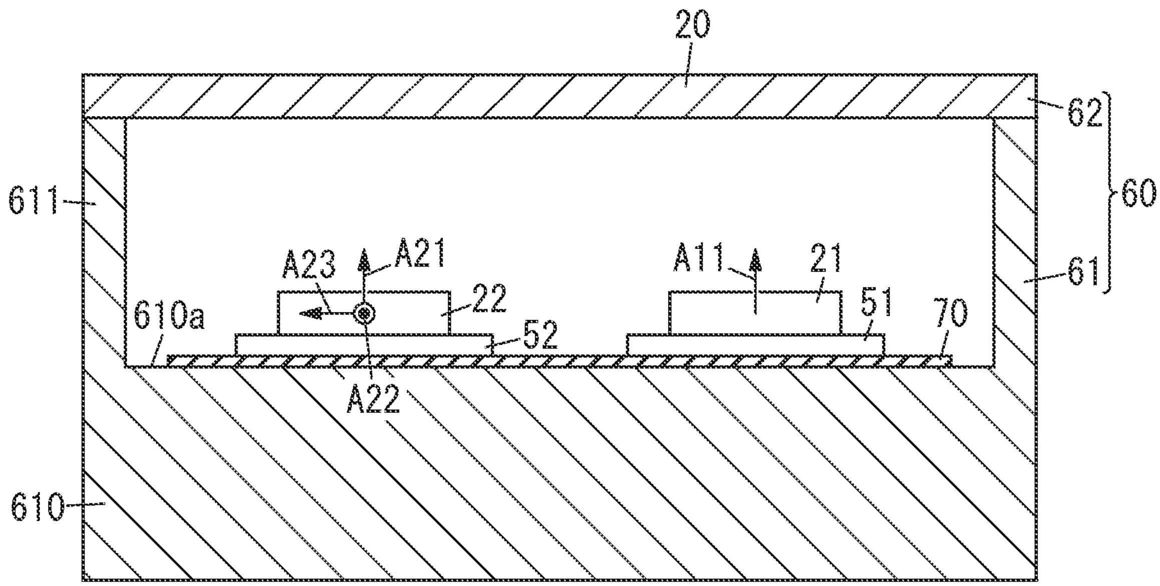


FIG. 4

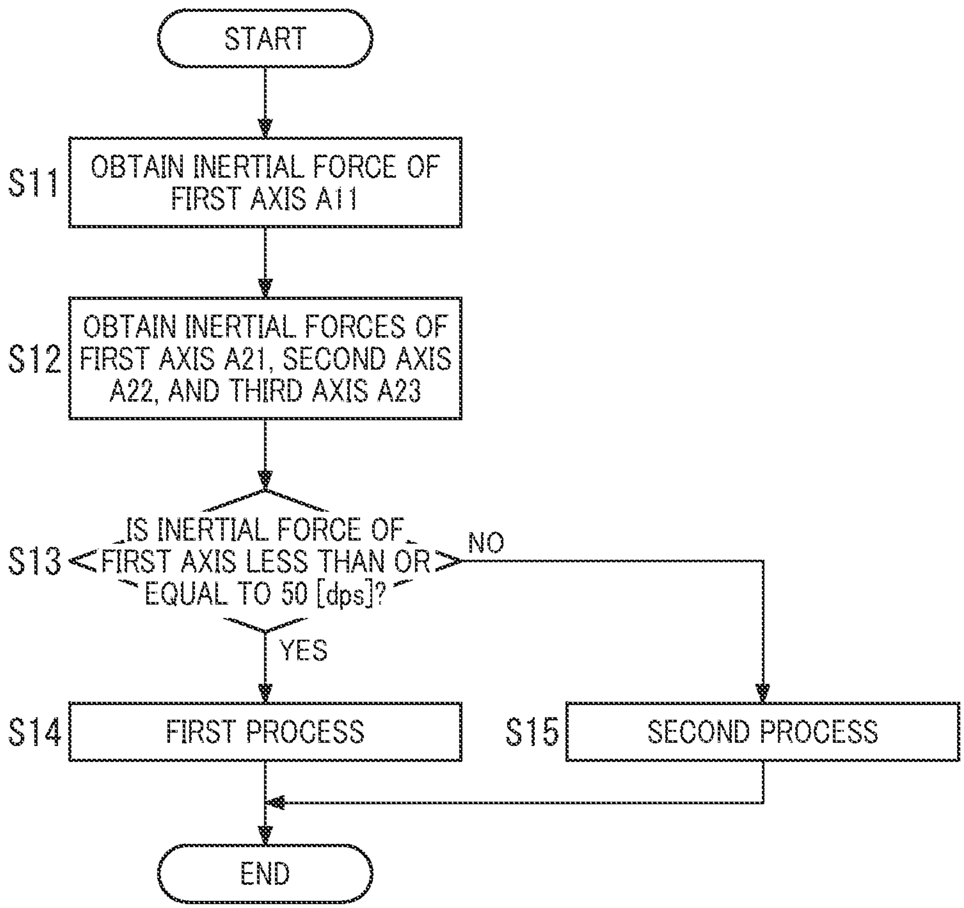

START
S11
OBTAIN INERTIAL FORCE OF FIRST AXIS A11
S12
OBTAIN INERTIAL FORCES OF FIRST AXIS A21, SECOND AXIS A22, AND THIRD AXIS A23
S13
IS INERTIAL FORCE OF FIRST AXIS LESS THAN OR EQUAL TO 50 [dps]?
NO
YES
S14
FIRST PROCESS
S15
SECOND PROCESS
END

FIG. 5

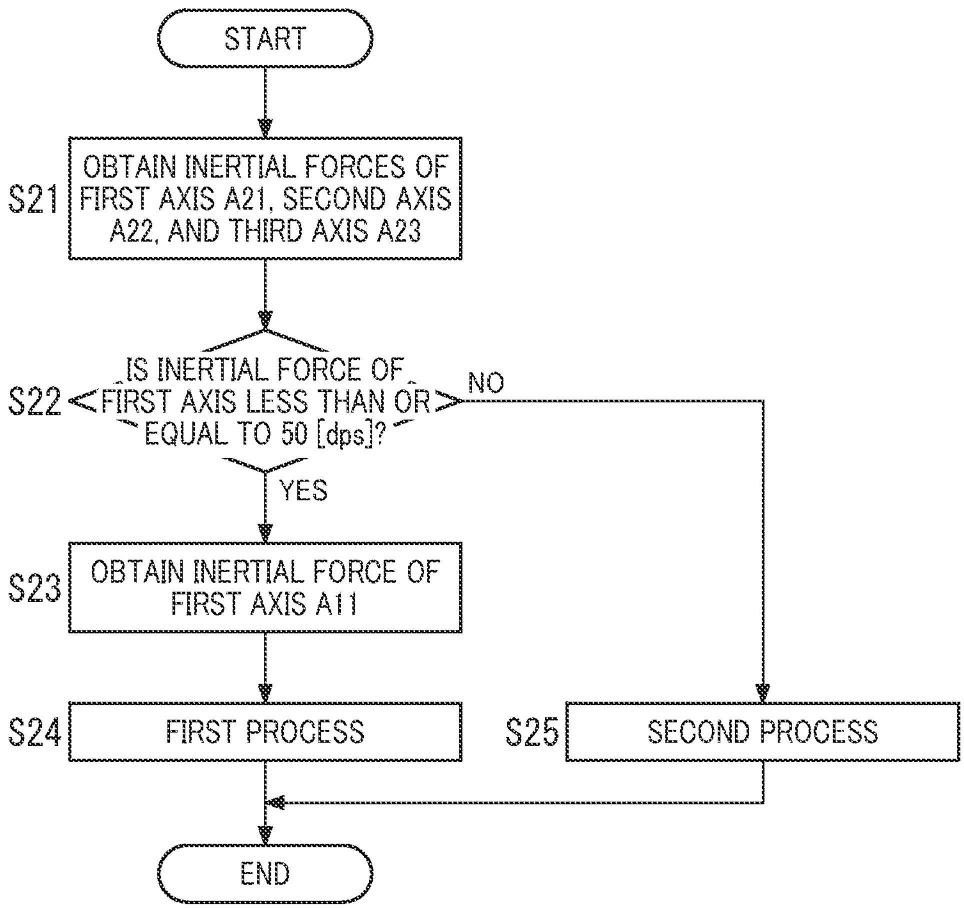

START
S21
OBTAIN INERTIAL FORCES OF FIRST AXIS A21, SECOND AXIS A22, AND THIRD AXIS A23
S22
IS INERTIAL FORCE OF FIRST AXIS LESS THAN OR EQUAL TO 50 [dps]?
NO
YES
S23
OBTAIN INERTIAL FORCE OF FIRST AXIS A11
S24
FIRST PROCESS
S25
SECOND PROCESS
END

FIG. 6

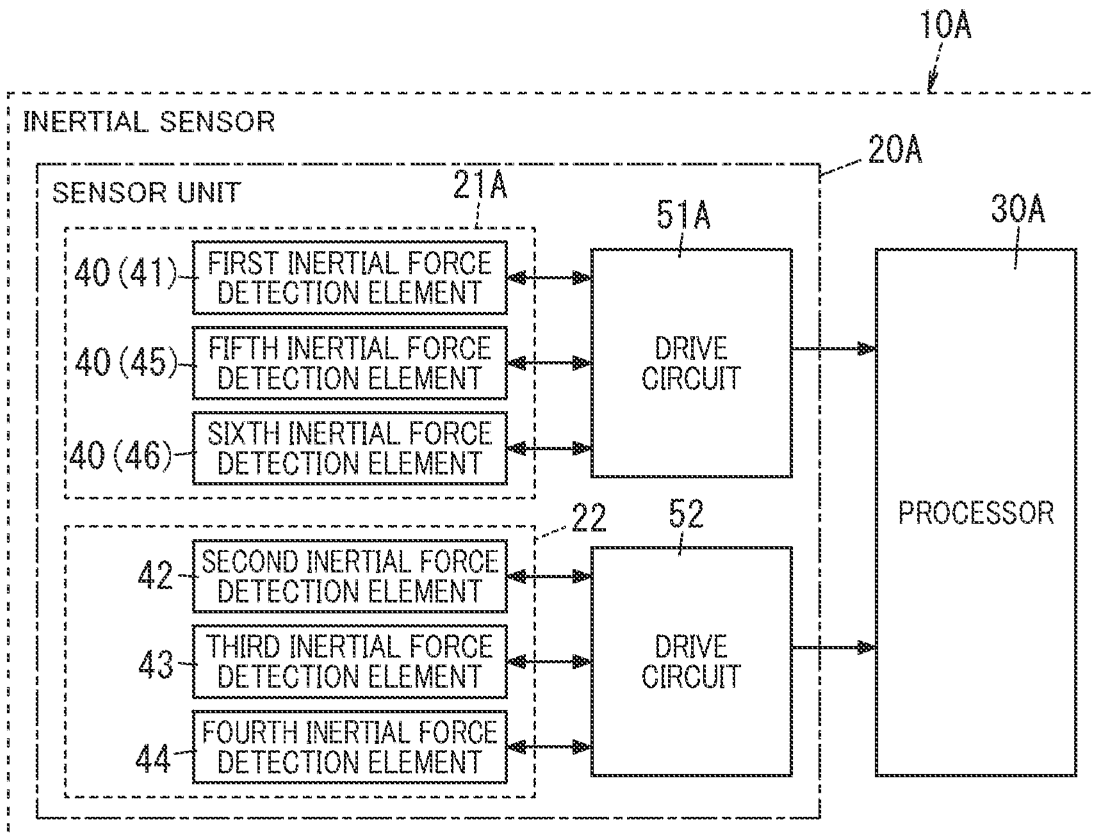

10A
INERTIAL SENSOR
20A
SENSOR UNIT
21A
51A
30A
40 (41)
FIRST INERTIAL FORCE DETECTION ELEMENT
40 (45)
FIFTH INERTIAL FORCE DETECTION ELEMENT
40 (46)
SIXTH INERTIAL FORCE DETECTION ELEMENT
DRIVE CIRCUIT
PROCESSOR
22
52
42
SECOND INERTIAL FORCE DETECTION ELEMENT
43
THIRD INERTIAL FORCE DETECTION ELEMENT
44
FOURTH INERTIAL FORCE DETECTION ELEMENT
DRIVE CIRCUIT

FIG. 7

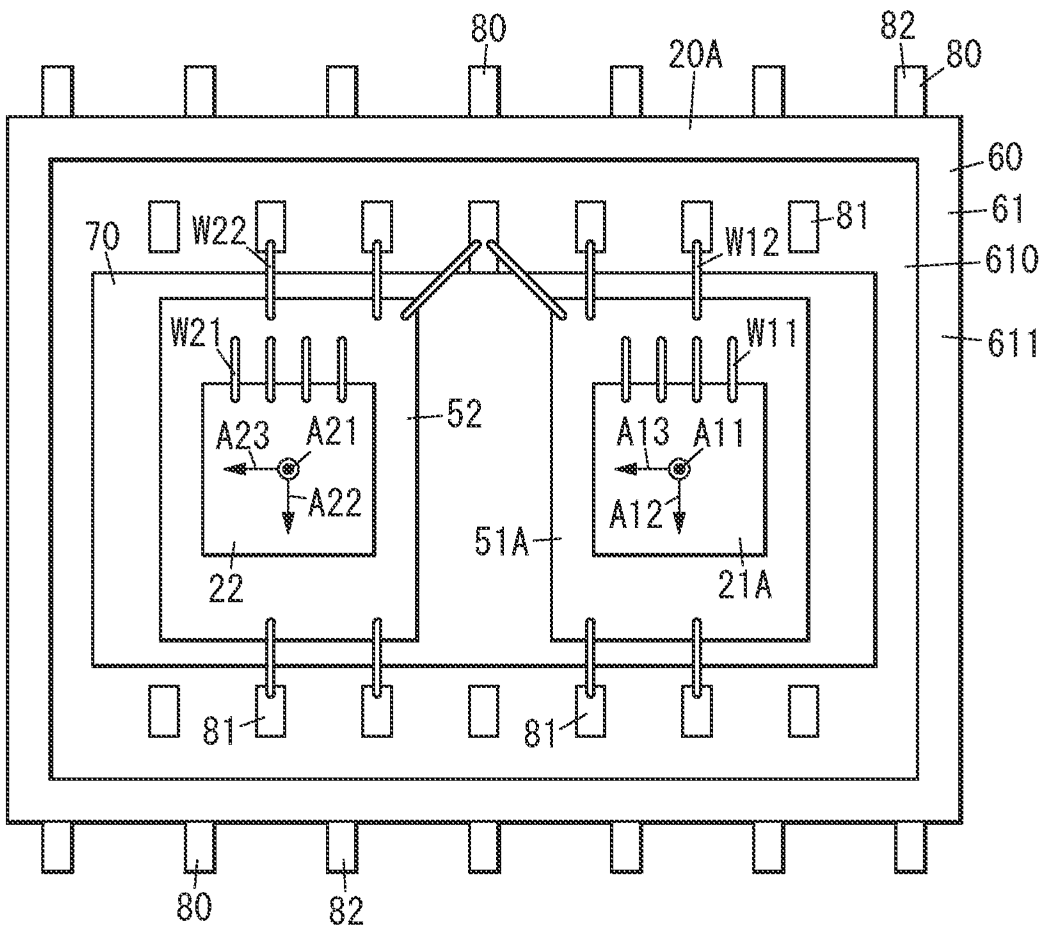
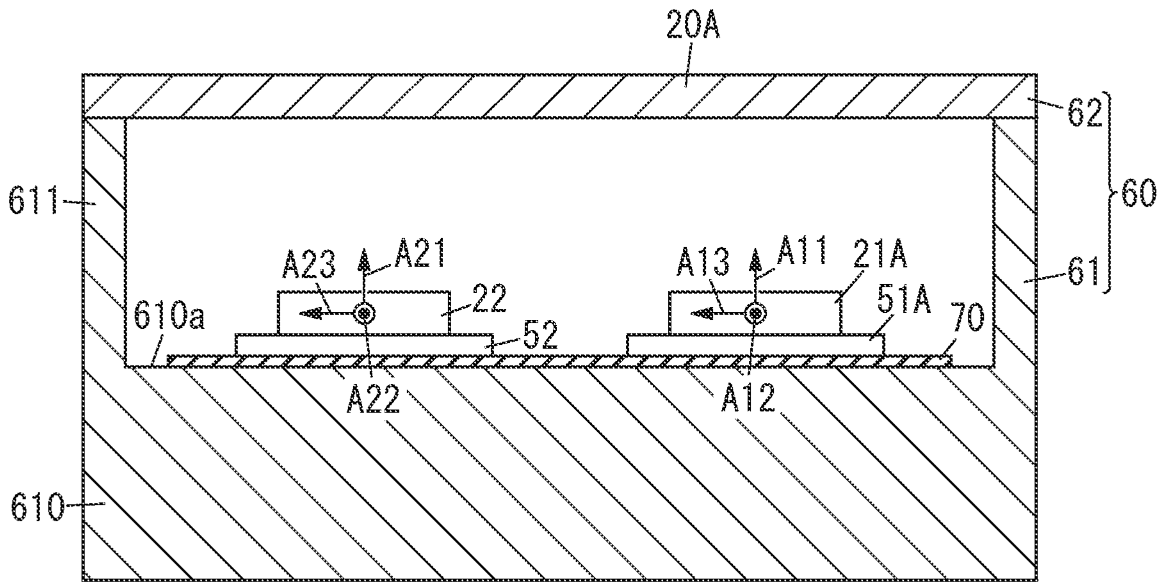

80
82
80
20A
60
61
610
611
81
W22
W12
70
W21
W11
52
A23
A21
A13
A11
A22
A12
51A
22
21A
81
81
80
82

FIG. 8



INERTIAL SENSOR

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is the U.S. National Phase under 35 U.S.C. § 371 of International Patent Application No. PCT/JP2021/023940, filed on Jun. 24, 2021 which in turn claims the benefit of Japanese Patent Application No. 2020-109127, filed on Jun. 24, 2020, the entire disclosures of which Applications are incorporated by reference herein.

TECHNICAL FIELD

[0002] The present disclosure relates to inertial sensors. Specifically, the present disclosure relates to an inertial sensor for use in various electronic devices.

BACKGROUND ART

[0003] Patent Literature 1 discloses an angular velocity sensor element for use in angular velocity sensors for use in various electronic devices. The angular velocity sensor element of Patent Document 1 includes a pair of fixed portions; a first drive arm whose one end is supported by one fixed portion of the pair of fixed portions; a second drive arm whose one end is supported by the other fixed portion of the pair of fixed portions, the second drive arm being continuous with the first drive arm; a plumb portion supported by the other end of the first drive arm and the other end of the second drive arm; a connector connecting both of the pair of fixed portions to each other; a driving electrode provided with a piezoelectric layer which is provided to one or both of the first drive arm and the second drive arm and which is configured to drive and vibrate the plumb portion in a direction connecting the fixed portion and the plumb portion to each other; and a detection electrode provided with a piezoelectric layer which is provided to one or both of the first drive arm and the second drive arm and which is configured to detect Coriolis force generated at the first drive arm and the second drive arm.

[0004] In the angular velocity sensor element of Patent Literature 1, which is a type of inertial force detection elements, enlarging (increasing the weight of) the plumb portion makes significant a change in an electric signal from the detection electrode in response to a change in the angular velocity, thereby improving sensitivity. However, enlarging (increasing the weight of) the plumb portion narrows an angular velocity range (detection range) within which the linearity of the change in the electric signal from the detection electrode in response to the change in the angular velocity. Therefore, an inertial sensor such as the angular velocity sensor has difficulty in achieving both an improvement in the sensitivity and a wide detection range.

CITATION LIST

Patent Literature

[0005] Patent Literature 1: JP 2011-209270 A

SUMMARY OF INVENTION

[0006] It is an object to provide an inertial sensor having increased sensitivity in a desired range with an extended detection range of an inertial force.

[0007] An inertial sensor according to an aspect of the present disclosure includes: a plurality of inertial force detection elements each configured to output an output signal corresponding to a detected inertial force; and a processor configured to execute a process relating to the output signal from each of the plurality of inertial force detection elements. The plurality of inertial force detection elements include a first inertial force detection element and a second inertial force detection element. A detection range of the first inertial force detection element and a detection range of the second inertial force detection element are different from each other. A sensitivity of the first inertial force detection element and a sensitivity of the second inertial force detection element are different from each other.

BRIEF DESCRIPTION OF DRAWINGS

[0008] FIG. **1** is a block diagram of an inertial sensor according to an embodiment of the present disclosure;

[0009] FIG. **2** is a schematic plan view of the inertial sensor;

[0010] FIG. **3** is a schematic sectional view of the inertial sensor;

[0011] FIG. **4** is a flowchart of an example of a process executed by a processor of the inertial sensor;

[0012] FIG. **5** is a flowchart of another example of the process executed by the processor of the inertial sensor;

[0013] FIG. **6** is a block diagram of an inertial sensor according to a variation;

[0014] FIG. **7** is a schematic plan view of the inertial sensor according to the variation; and

[0015] FIG. **8** is a schematic sectional view of the inertial sensor according to the variation;

DESCRIPTION OF EMBODIMENTS

[0016] An embodiment of the present disclosure will be described hereinafter with reference to the drawings in some cases. The embodiment described below is illustrative for describing the present disclosure and is not intended to limit the present disclosure to the following contents. The relative positions and other positional relationships comply with the drawings unless otherwise specified. Note that the drawings to be referred to in the following description of the embodiment are all schematic representations, that is, the ratio of the dimensions (including thicknesses) of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio. In addition, the dimensional ratio of each element is not limited to the ratio illustrated in the drawings.

[0017] In the present disclosure, an inertial sensor is a sensor that detects an inertial force. The inertial force is expressed in acceleration in the translationally accelerated system and in an angular velocity in the rotating coordinate system. That is, detection of the inertial force means detection of at least one of the acceleration or the angular velocity. In this regard, the inertial sensor is a sensor that detects at least one of the acceleration or the angular velocity.

[0018] (1) Embodiment

[0019] (1-1) Overview

[0020] FIG. **1** is a block diagram of an inertial sensor **10** according to the present embodiment. The inertial sensor **10** includes a plurality of inertial force detection elements **40** and a processor **30**. The plurality of inertial force detection elements **40** output signals corresponding to respective detected inertial forces. The processor **30** executes a process relating to the output signals from the plurality of inertial force detection elements **40**. The plurality of inertial force detection elements **40** include a first inertial force detection element **41** and a second inertial force detection element **42**. The first inertial force detection element **41** and the second inertial force detection element **42** have detection ranges different from each other. The first inertial force detection element **41** and the second inertial force detection element **42** have sensitivities different from each other.

[0021] In the inertial sensor **10** of the present embodiment, the first inertial force detection element **41** and the second inertial force detection element **42** which detect inertial forces of detection axes (predetermined axes) parallel to each other have the detection ranges different from each other and have the sensitivities different from each other. Thus, the detection range of the inertial sensor **10** as a whole can be wider than that in the case where the first inertial force detection element **41** and the second inertial force detection element **42** have the same detection ranges. Further, the inertial sensor **10** has the detection range of one inertial force detection element of the first inertial force detection element **41** and the second inertial force detection element **42**, the one inertial force detection element having higher sensitivity than the other of the first inertial force detection element **41** and the second inertial force detection element **42**. Thus, the sensitivity of the inertial sensor **10** as a whole can be improved more than that in the case where the first inertial force detection element **41** and the second inertial force detection element **42** have the same sensitivities. Therefore, the inertial sensor **10** of the present embodiment has increased sensitivity while the detection range of the inertial force is extended.

[0022] (1-2) Details

[0023] The inertial sensor **10** according to the present embodiment will be described hereinafter in detail referring to the drawings.

[0024] As shown in FIG. **1**, the inertial sensor **10** includes a sensor unit **20** and the processor **30**.

[0025] The sensor unit **20** includes the plurality of inertial force detection elements **40** and a plurality of drive circuits **50**.

[0026] The plurality of inertial force detection elements **40** detect inertial forces and output output signals corresponding to the respective inertial forces thus detected. Each of the plurality of inertial force detection elements **40** is a mechano-electrical transduction element (e.g., Micro Electro Mechanical Systems: MEMS). Each of the plurality of inertial force detection elements **40** is an angular velocity detection element. Each of the plurality of inertial force detection elements **40** detects an angular velocity as the inertial force. Since the structure of each inertial force detection element **40** may be a structure of a conventionally well-known angular velocity detection element, the detailed description thereof will be omitted.

[0027] The plurality of inertial force detection elements **40** include the first inertial force detection element **41**, the second inertial force detection element **42**, a third inertial force detection element **43**, and a fourth inertial force detection element **44**.

[0028] The first inertial force detection element **41** detects an inertial force of a first axis A**11** (see FIGS. **2** and **3**) and outputs an output signal corresponding to the inertial force thus detected. In the present embodiment, the first inertial force detection element **41** is an angular velocity detection element. The inertial force of the first axis A**11** is an angular velocity around the first axis A**11**.

[0029] The second inertial force detection element **42** detects an inertial force of a first axis A**21** (see FIGS. **2** and **3**) and outputs an output signal corresponding to the inertial force thus detected. In the present embodiment, the second inertial force detection element **42** is an angular velocity detection element. The inertial force of the first axis A**21** is an angular velocity around the first axis A**21**.

[0030] The third inertial force detection element **43** detects an inertial force of a second axis A**22** (see FIGS. **2** and **3**) and outputs an output signal corresponding to the inertial force thus detected. The second axis A**22** is orthogonal to the first axis A**21**. In the present embodiment, the third inertial force detection element **43** is an angular velocity detection element. The inertial force of the second axis A**22** is an angular velocity around the second axis A**22**.

[0031] The fourth inertial force detection element **44** detects an inertial force of a third axis A**23** (see FIGS. **2** and **3**) and outputs an output signal corresponding to the inertial force thus detected. The third axis A**23** is orthogonal to each of the first axis A**21** and the second axis A**22**. In the present embodiment, the fourth inertial force detection element **44** is an angular velocity detection element. The inertial force of the third axis A**23** is an angular velocity around the third axis A**23**.

[0032] As shown in FIGS. **2** and **3**, the first axis A**11** and the first axis A**21** are parallel to each other. In the present embodiment, the distance between the first axis A**11** and the first axis A**21** is in a range in which the angular velocity around the first axis A**11** and the angular velocity around the first axis A**21** can be regarded as substantially equal to each other. Therefore, the first inertial force detection element **41** and the second inertial force detection element **42** detect inertial forces of the same axes (predetermined axes). In the present embodiment, the predetermined axes are axes corresponding to the first axis A**11** and the first axis A**21**. Thus, the first inertial force detection element **41** and the second inertial force detection element **42** respectively detect the inertial forces of the first axes A**11** and A**21**. The first axis A**11** is an axis in an element vertical direction of the first inertial force detection element **41** (axis orthogonal to an arrangement surface (element arrangement surface) **610***a* described later). The first axis A**21** is an axis in an element vertical direction of the second inertial force detection element **42** (axis orthogonal to the arrangement surface (element arrangement surface)). The first axis A**11** and the first axis A**21** are axes parallel to each other.

[0033] The first inertial force detection element **41** and the second inertial force detection element **42** have detection ranges different from each other. The detection range is a detection range of the inertial force (the angular velocity in the present embodiment). In particular, in the present embodiment, the detection range is intended to a range in which a change in the output signal of each inertial force detection element **40** in response to the change in the inertial force is regarded as having linearity. In the present embodiment, the detection range of the first inertial force detection element **41** is narrower than the detection range of the second inertial force detection element **42**. For example, the detection range of the first inertial force detection element **41** is 0 to 50 [deg/sec], and the detection range of the second inertial force detection element **42** is 0 to 200 [deg/sec].

[0034] The first inertial force detection element **41** and the second inertial force detection element **42** have sensitivities different from each other. The sensitivity is, for example, the amount of change in the output with respect to a unit input. As for the angular velocity, the sensitivity is the amount of change in the output signal when the angular velocity changes by 1 “deg/sec”. The higher the sensitivity, the easier a minute change in the angular velocity is detected. In the present embodiment, the sensitivity of the first inertial force detection element **41** is higher than the sensitivity of the second inertial force detection element **42**.

[0035] The first inertial force detection element **41** and the second inertial force detection element **42** have bias stabilities different from each other. The bias stability is, for example, the magnitude of the variation in the output signal when the inertial force is zero (at rest). High bias stability reduces erroneous detection when the inertial force is zero. In the present embodiment, the bias stability of the first inertial force detection element **41** is higher than the bias stability of the second inertial force detection element **42**.

[0036] The third inertial force detection element **43** and the fourth inertial force detection element **44** are equivalent to the second inertial force detection element **42** in terms of the detection range, sensitivity, and bias stability. In other words, the second inertial force detection element **42**, the third inertial force detection element **43** and the fourth inertial force detection element **44** may be the same except for the axes of which the inertial forces are detected. Thus, the detection range of the first inertial force detection element **41** is narrower than the detection range of each of the third inertial force detection element **43** and the fourth inertial force detection element **44**. The sensitivity of the first inertial force detection element **41** is higher than that of each of the third inertial force detection element **43** and the fourth inertial force detection element **44**. The bias stability of the first inertial force detection element **41** is higher than that of each of the third inertial force detection element **43** and the fourth inertial force detection element **44**.

[0037] The plurality of drive circuits **50** give the output signals from the plurality of inertial force detection elements **40** to the processor **30**. In the present embodiment, the plurality of drive circuits **50** drive the plurality of inertial force detection elements **40** to cause the plurality of inertial force detection elements **40** to output signals corresponding to the respective inertial forces thus detected. Each of the plurality of drive circuits **50** is, for example, an Application Specific Integrated Circuit (ASIC). Since the structure of each drive circuit **50** may be the structure of a drive circuit for conventionally well-known angular velocity detection elements, the detailed description thereof will be omitted.

[0038] The plurality of drive circuits **50** include two drive circuits **51** and **52**. The drive circuit (first drive circuit) **51** acquires the output signal from the first inertial force detection element **41** and gives the output signal to the processor **30**. The drive circuit (second drive circuit) **52** acquires the output signals from the second to fourth inertial force detection elements **42** to **44** and gives the output signals to the processor **30**. As shown in FIGS. **2** and **3**, each of the two drive circuits **51** and **52** is generally rectangular plate-shaped.

[0039] As shown in FIGS. **1** to **3**, the sensor unit **20** includes two sensor elements **21** and **22**. The sensor element **21** includes the first inertial force detection element **41** of the plurality of inertial force detection elements **40**. The sensor element **22** includes the second inertial force detection element **42**, the third inertial force detection element **43**, and the fourth inertial force detection element **44** of the plurality of inertial force detection elements **40**. The second inertial force detection element **42**, the third inertial force detection element **43**, and the fourth inertial force detection element **44** are integrated into one piece. As shown in FIGS. **2** and **3**, the two sensor elements **21** and **22** are generally rectangular plate-shaped.

[0040] The sensor unit **20** further includes a package **60** as shown in FIGS. **2** and **3**.

[0041] The package **60** houses the two sensor elements **21** and **22** and the two drive circuits **51** and **52**. The package **60** includes a base **61** and a cover **62**. The two sensor elements **21** and **22** and the two drive circuits **51** and **52** are housed in a space between the base **61** and the cover **62**. In FIG. **2**, the cover **62** is omitted.

[0042] The base **61** includes a base part **610** and a sidewall part **611**. Both the base part **610** and the sidewall part **611** are electrically insulating. The base part **610** and the sidewall part **611** are formed as a continuous one piece. For example, the base part **610** and the sidewall part **611** are a molded article made of an electrically insulating resin. The base part **610** has the arrangement surface **610*a***. The arrangement surface **610*a*** is a surface (element arrangement surface) on which the two sensor elements **21** and **22** and the two drive circuits **51** and **52** are arranged. The base part **610** has a rectangular plate shape. The base part **610** has a surface constituting the arrangement surface **610*a***. The surface is one surface in a thickness direction. The sidewall part **611** protrudes from the outer periphery of the one surface in the thickness direction defined with respect to the base part **610**. The sidewall part **611** has a rectangular frame shape. The cover **62** is attached to the sidewall part **611** so as to face the arrangement surface **610*a*** of the base part **610**. The cover **62** has a rectangular plate shape. The cover **62** is electrically insulating. For example, the cover **62** is a molded article made of an electrically insulating resin.

[0043] The base **61** further includes an anti-vibration portion **70** and a plurality of connecting members **80**.

[0044] The anti-vibration portion **70** is arranged on the arrangement surface **610*a*** of the base **61**. In particular, the anti-vibration portion **70** lies between the arrangement surface **610*a*** and the two sensor elements **21** and **22** and the two drive circuits **51** and **52**. The anti-vibration portion **70** is provided to reduce the influence of a vibration outside the package **60** on the two sensor elements **21** and **22**. This reduces noise generated in the inertial sensor **10**. For example, the anti-vibration portion **70** is made of an elastic and electrically insulating material.

[0045] The plurality of connecting members **80** are used for electrical connection of at least the drive circuits **51** and **52** to the processor **30**. Each of the plurality of connecting members **80** includes an electrode portion **81** and a terminal portion **82**. The plurality of connecting members **80** are embedded in the base **61**. In each connecting member **80**, the electrode portion **81** is exposed at the arrangement surface **610*a*** of the base part **610**, the terminal portion **82** protrudes outward from a side surface of the base part **610**. The electrode portions **81** of the plurality of connecting members **80** are used for electrical connection to the drive circuits **51** and **52**. The terminal portions **82** of the plurality of connecting members **80** are used for electrical connection to the processor **30**. In the present embodiment, the plurality of connecting members **80** are held by the base **61** by insert molding.

[0046] The two sensor elements **21** and **22** and the two drive circuits **51** and **52** are arranged on the arrangement surface **610***a*. As shown in FIGS. **2** and **3**, the two drive circuits **51** and **52** are arranged on the anti-vibration portion **70** on the arrangement surface **610***a*. In the present embodiment, the two drive circuits **51** and **52** are aligned along the length direction (left/right direction in FIG. **2**) of the arrangement surface **610***a*. The two sensor elements **21** and **22** are arranged on opposite sides respectively of the two drive circuits **51** and **52** from the arrangement surface **610***a*. The sensor element **21** is electrically connected to the first drive circuit **51** by one or more conductive wires W**11**. The sensor element **22** is electrically connected to the second drive circuit **52** by one or more conductive wires W**21**. The first drive circuit **51** is electrically connected to corresponding one or more of the electrode portions **81** respectively by one or more conductive wires W**12**. The second drive circuit **52** is electrically connected to corresponding one or more of the electrode portions **81** respectively by one or more conductive wires W**22**.

[0047] In this embodiment, as shown in FIGS. **2** and **3**, the first axis A**11** of the first inertial force detection element **41** and the first axis A**21** of the second inertial force detection element **42** are orthogonal to the arrangement surface **610***a*. The second axis A**22** of the third inertial force detection element **43** is along the width direction of the arrangement surface **610***a* (up/down direction in FIG. **2**). In particular, the second axis A**22** of the third inertial force detection element **43** is orthogonal to a direction in which the two sensor elements **21** and **22** (two drive circuits **51** and **52**) are aligned (left/right direction in FIG. **2**). The third axis A**23** of the fourth inertial force detection element **44** is along the length direction of the arrangement surface **610***a* (left/right direction in FIG. **2**). In particular, the third axis A**23** of the fourth inertial force detection element **44** is orthogonal to a direction in which the two sensor elements **21** and **22** (two drive circuits **51** and **52**) are aligned (left/right direction in FIG. **2**).

[0048] The processor **30** executes a process relating to the output signals from the plurality of inertial force detection elements **40**. The processor **30** acquires, from the drive circuits **51** and **52**, the output signals from the plurality of inertial force detection elements **40**. The processor **30** acquires the output signal from the first inertial force detection element **41** at a first interval and acquires the output signal from the second inertial force detection element **42** at a second interval wider than the first interval. This is because the sensitivity of the first inertial force detection element **41** is higher than that of the second inertial force detection element **42**. In the present embodiment, the second inertial force detection element **42**, the third inertial force detection element **43**, and the fourth inertial force detection element **44** are integrated into the sensor element **22**. Therefore, the processor **30** acquires the output signals from the second to fourth inertial force detection elements **42** to **44** at the second interval. The first interval and the second interval are at least accordingly set in accordance with the sensitivities of the first and second inertial force detection elements **41** and **42**. Incidentally, reducing the first interval to be shorter than an interval based on the ratio of the sensitivities of the first and second inertial force detection elements **41** and **42** enables a first inertial force to be finely output. Further, depending on a required resolution, the second interval may be made shorter than the ratio of the sensitivities of the first and second inertial force detection elements **41** and **42**.

[0049] The processor **30** obtains the inertial force of the predetermined axis (first axis A**11**) with reference to the output signal from the first inertial force detection element **41**. In sum, the processor **30** obtains the inertial force of the first axis A**11** (angular velocity around the first axis A**11**) with reference to the output from the sensor element **21**, that is, the angular velocity of the one axis. The processor **30** obtains the inertial force of the predetermined axis (first axis A**21**) with reference to the output signal from the second inertial force detection element **42**. The processor **30** obtains the inertial force of the second axis A**22** with reference to the output signal from the third inertial force detection element **43**. The processor **30** obtains the inertial force of the third axis A**23** with reference to the output signal from the fourth inertial force detection element **44**. In sum, the processor **30** obtains the inertial forces of the first to third axes A**21** to A**23** (angular velocities around the first to third axes A**21** to A**23**), that is, the angular velocities of the three axis with reference to the output from the sensor element **22**.

[0050] An example of the processing by the processor **30** will be described with reference to the flowchart of FIG. **4**. First, the processor **30** obtains the inertial force (angular velocity) of the first axis A**11** from the output signal of the first inertial force detection element **41** (S**11**). The processor **30** obtains inertial force (angular velocities) of the first axis A**21**, the second axis A**22**, and the third axis A**23** from the output signals of the second inertial force detection element **42**, the third inertial force detection element **43**, and the fourth inertial force detection element **44** (S**12**). Then, the processor **30** determines whether or not the inertial force of the first axis is less than or equal to 50 [dps] (S**13**). The inertial force of the first axis may be any of the inertial force of the first axis A**11** from the first inertial force detection element **41** and the inertial force of the first axis A**21** from the second inertial force detection element **42**. Using the inertial force from the first inertial force detection element **41** (inertial force of the first axis A**11**) enables inertial force to be more finely detected, thereby improving the determination accuracy. Here, if the inertial force of the first axis is less than or equal to 50 [dps] (first range) (S**13**: YES), the processor **30** performs a first process (S**14**). In the first process, the processor **30** performs processing with reference to the inertial forces output from the plurality of inertial force detection elements **40**. In the first process, the processor **30** selects the angular velocity of the first axis A**11**, the angular velocity of the second axis A**22**, and the angular velocity of the third axis A**23** as the inertial forces output from the plurality of inertial force detection elements **40**. That is, the first process is a process of outputting the inertial force of the first axis A**11** obtained with reference to the output signal from the first inertial force detection element **41**, the inertial force of the second axis A**22** obtained with reference to the output signal from the third inertial force detection element **43**, and the inertial force of the third axis A**33** obtained with reference to the output signal from the fourth inertial force detection element **44**. On the other hand, if the inertial force of the first axis is greater than 50 [dps] (second range) (S**13**: NO), the processor **30** performs a second process (S**15**). In the second process, the processor **30** performs processing with reference to the inertial forces output from the plurality of inertial force detection elements

40. In the second process, the processor 30 selects the angular velocity of the first axis A21, the angular velocity of the second axis A22, and the angular velocity of the third axis A23 as the inertial forces output from the plurality of inertial force detection elements 40. That is, the second process is a process of outputting the inertial forces of the first axis A21, the second axis A22, and the third axis A23 obtained with reference to the output signals from the second inertial force detection element 42, the third inertial force detection element 43, and the fourth inertial force detection element 44. Thus, the angular velocities of the three axes are output in each of the first process and the second process, but the inertial force detection element of one of the three axes is different between the first process and the second process.

[0051] Another example of the process by the processor 30 will be described with reference to the flowchart of FIG. 5. First of all, the processor 30 obtains inertial forces (angular velocities) of the first axis A21, the second axis A22, and the third axis A23 from the output signals of the second inertial force detection element 42, the third inertial force detection element 43, and the fourth inertial force detection element 44 (S21). Then, the processor 30 determines whether or not the inertial force of the first axis A21 is less than or equal to 50 [dps] (S22). Then, if the inertial force of the first axis A21 is less than or equal to 50 [dps] (first range) (S22; YES), the processor 30 obtains the inertial force (angular velocity) of the first axis A11 from the output signal of the first inertial force detection element 41 (S23). Thereafter, the processor 30 performs a first process (S24). In the first process, the processor 30 performs processing with reference to the inertial forces output from the plurality of inertial force detection elements 40. In the first process, the processor 30 selects the angular velocity of the first axis A11, the angular velocity of the second axis A22, and the angular velocity of the third axis A23 as the inertial forces output from the plurality of inertial force detection elements 40. That is, the first process is a process of outputting the inertial force of the first axis A11 obtained with reference to the output signal from the first inertial force detection element 41, the inertial force of the second axis A22 obtained with reference to the output signal from the third inertial force detection element 43, and the inertial force of the third axis A33 obtained with reference to the output signal from the fourth inertial force detection element 44. If the inertial force of the first axis A21 is greater than 50 [dps] (second range) (S22; NO), the processor 30 performs a second process (S25). The content of the second process is the same as the second process of the flowchart shown in FIG. 4. According to the example shown in the flowchart of FIG. 5, the inertial forces of the three axes suffice as data of the inertial force to be stored in memory at the time of the processing compared to the example shown in the flowchart of FIG. 4, and thus, when the first inertial force is greater than 50 [dps], one process can be reduced. Therefore, the processing can be efficiently performed.

[0052] The processor 30 executes the first process in the first range of the inertial force. The processor 30 executes the second process in the second range of the inertial force. The first range is a range within the detection range of the first inertial force detection element 41. The second range is a range within the detection range of the second inertial force detection element 42. In particular, the first range is a range overlapping the detection range of the first inertial force detection element 41 and the detection range of the second inertial force detection element 42. The second range is a range that is in the detection range of the second inertial force detection element 42 and that does not overlap with the first range. The upper limit value of the first range is less than or equal to the lower limit value of the second range. In the present embodiment, the first range is a range in which the angular velocities of the predetermined axes (the first axes A11 and A21) are each greater than or equal to 0 and less than or equal to 50 [dps], and the second range is a range in which the angular velocities are each greater than 50 and less than or equal to 200 [dps]. The inertial force (angular velocity) and the output from the processor 30 are in the relationship as shown in Table 1. That is, when the first process is executed, the range (first range) of the corresponding inertial force is greater than or equal to 0 [dps] and less than or equal to 50 [dps], but the detection sensitivity of the inertial force and the bias stability are increased. Further, when the second process is executed, the detection sensitivity of the inertial force and the bias stability is relatively low, but the range (second range) of the corresponding inertial force is greater than 50 [dps] and less than or equal to 200 [dps] and can thus be extended. Note that [dps] is "degree per seconds".

TABLE 1

Inertial Force (Angular Velocity [dps])	Process to be Executed	Output	Sensitivity	Bias Stability
Greater than or equal to 0 and less than or equal to 50	First Process	Angular Velocity of First Axis A11 Angular Velocity of Second Axis A22 Angular Velocity of Third Axis A23	High	High
Greater than 50 and less than or equal to 200	Second Process	Angular Velocity of First Axis A21 Angular Velocity of Second Axis A22 Angular Velocity of Third Axis A23	Low	Low

[0053] The processor 30 executes a diagnostic process in the first range. The diagnostic process is a process of performing a failure diagnosis for the first inertial force detection element **41** with reference to the output signal from the second inertial force detection element **42**. The first range overlaps the detection range of the first inertial force detection element **41** and the detection range of the second inertial force detection element **42**. Therefore, in the first range, usually, the inertial force obtainable from the output signal from the first inertial force detection element **41** (the angular velocity around the first axis A**11**) is equal to the inertial force obtainable from the output signal from the second inertial force detection element **42** (the angular velocity around the first axis A**21**). Thus, in the first range, the second inertial force detection element **42** whose sensitivity is lower than that of the first inertial force detection element **41** can be utilized in the failure diagnosis for the first inertial force detection element **41**. If the angular velocity around the first axis A**11** does not match the angular velocity around the first axis A**21**, the processor **30** determines that the first inertial force detection element **41** has a failure. If it is determined, as a result of the diagnostic process, that the first inertial force detection element **41** has a failure, the processor **30** outputs an angular velocity around the first axis A**21** instead of the angular velocity around the first axis A**11**. Therefore, even in case of a failure in the first inertial force detection element **41**, the inertial sensor **10** can continue operating. If it is determined, as a result of the diagnostic process, that the first inertial force detection element **41** has a failure, the processor **30** further notifies the occurrence of the failure.

[0054] (2) Variations

[0055] The embodiment of the present disclosure is not limited to the embodiment described above. The embodiment described above may be readily modified in various manners depending on a design choice or any other factor without departing from the scope of the present disclosure. Variations of the embodiment described above will be enumerated below. The variations described below are applicable accordingly in combination.

[0056] FIGS. **6** to **8** show an inertial sensor **10**A of a variation. As shown in FIG. **6**, the inertial sensor **10**A includes a sensor unit **20**A and a processor **30**A.

[0057] The sensor unit **20**A includes a plurality of inertial force detection elements **40** and a plurality of drive circuits **50** (**51**A and **52**).

[0058] The plurality of inertial force detection elements **40** includes a first inertial force detection element **41**, a second inertial force detection element **42**, a third inertial force detection element **43**, a fourth inertial force detection element **44**, a fifth inertial force detection element **45**, and a sixth inertial force detection element **46**.

[0059] The first inertial force detection element **41** to the fourth inertial force detection element **44** are the same as those in the embodiment described above.

[0060] The fifth inertial force detection element **45** detects inertial force of a second axis A**12** (see FIGS. **7** and **8**) and outputs an output signal corresponding to the inertial force thus detected. The second axis A**12** is orthogonal to a first axis A**11**. In the present variation, the fifth inertial force detection element **45** is an angular velocity detection element. The inertial force of the second axis A**12** is an angular velocity around the second axis A**12**.

[0061] The sixth inertial force detection element **46** detects inertial force of a third axis A**13** (see FIGS. **7** and **8**) and outputs an output signal corresponding to the inertial force thus detected. The third axis A**13** is orthogonal to each of the first axis A**11** and the second axis A**12**. In the present variation, the sixth inertial force detection element **46** is an angular velocity detection element. The inertial force of the third axis A**13** is an angular velocity around the third axis A**13**.

[0062] As shown in FIGS. **7** and **8**, the second axis A**12** and a second axis A**22** are parallel to each other. In the present variation, the distance between the second axis A**12** and the second axis A**22** is in a range in which the angular velocity around the second axis A**12** and an angular velocity around the second axis A**22** can be regarded as being substantially equal to each other. Therefore, the third inertial force detection element **43** and the fifth inertial force detection element **45** detect inertial forces of the same axes (predetermined axes). In the present variation, the axes corresponding to the second axis A**12** and the second axis A**22** are also predetermined axes.

[0063] As shown in FIGS. **7** and **8**, the third axis A**13** and a third axis A**23** are parallel to each other. In the present variation, the distance between the third axis A**13** and the third axis A**23** is in a range in which the angular velocity around the third axis A**13** and an angular velocity around the third axis A**23** can be regarded as being substantially equal to each other. Therefore, the fourth inertial force detection element **44** and the sixth inertial force detection element **46** detect inertial forces of the same axes (predetermined axes). In the present variation, the axes corresponding to the third axis A**13** and the third axis A**23** are also predetermined axes.

[0064] The fifth inertial force detection element **45** and the sixth inertial force detection element **46** are equivalent to the first inertial force detection element **41** in terms of the detection range, sensitivity, and bias stability. In other words, the first inertial force detection element **41**, the fifth inertial force detection element **45**, and the sixth inertial force detection element **46** may be the same except for the axes of which the inertial forces are detected. Thus, the detection range of each of the fifth inertial force detection element **45** and the sixth inertial force detection element **46** is narrower than that of each of the second to fourth inertial force detection elements **42** to **44**. Thus, the sensitivity of each of the fifth inertial force detection element **45** and the sixth inertial force detection element **46** is higher than that of each of the second to fourth inertial force detection elements **42** to **44**. Thus, the bias stability of each of the fifth inertial force detection element **45** and the sixth inertial force detection element **46** is higher than that of each of the second to fourth inertial force detection elements **42** to **44**.

[0065] The plurality of drive circuits **50** includes the two drive circuits **51**A and **52**. The first drive circuit **51**A acquires output signals from the first, fifth, and sixth inertial force detection elements **41**, **45**, and **46** and gives the output signals to the processor **30**A. The first drive circuit **51**A is generally rectangular plate-shaped.

[0066] As shown in FIGS. **6** to **8**, the sensor unit **20**A includes two sensor elements **21**A and **22**. The sensor element **21**A includes the first inertial force detection element **41**, the fifth inertial force detection element **45**, and the sixth inertial force detection element **46** of the plurality of inertial force detection elements **40**. The first inertial force detection element **41**, the fifth inertial force detection element **45**, and the sixth inertial force detection element **46** are integrated into one piece. As shown in FIGS. **7** and **8**, the two sensor elements **21**A and **22** are generally rectangular plate-shaped.

[0067] The processor **30**A executes a process relating to the output signals from the plurality of inertial force detection elements **40**. The processor **30** acquires, from the drive circuits **51**A and **52**, the output signals from the plurality of inertial force detection elements **40**. The processor **30**A acquires the output signal from the first inertial force detection element **41** at a first interval and acquires the output signal from the second inertial force detection element **42** at a second interval wider than the first interval. In the present variation, the first inertial force detection element **41**, the fifth inertial force detection element **45**, and the sixth inertial force detection element **46** are integrated into the sensor element **21**A. Therefore, the processor **30**A acquires the output signals from the first, fifth, and sixth inertial force detection elements **41**, **45**, and **46** at the first interval.

[0068] The processor **30**A obtains the inertial force of the first axis A**11** with reference to the output signal from the first inertial force detection element **41**. The processor **30**A obtains the inertial force of the second axis A**12** with reference to the output signal from the fifth inertial force detection element **45**. The processor **30**A obtains the inertial force of the third axis A**13** with reference to the output signal from the sixth inertial force detection element **46**. In sum, the processor **30**A obtains the inertial forces of the first to third axes A**11** to A**13** (angular velocities around the first to third axes A**11** to A**13**), that is, the angular velocities of the three axis with reference to the output from the sensor element **21**A.

[0069] In a similar manner to the processor **30**, the processor **30**A obtains the inertial forces of the first to third axes A**21** to A**23** (angular velocities around the first to third axes A**21** to A**23**), that is, the angular velocities of the three axis with reference to the output from the sensor element **22**.

[0070] The processor **30**A has a function of executing a first process and a second process. The first process is a process of outputting the inertial forces obtained with reference to the output signals from the first, fifth, and sixth inertial force detection elements **41**, **45**, and **46**. The second process is a process of outputting the inertial forces obtained with reference to the output signals from the second to fourth inertial force detection elements **42** to **44**. Therefore, the angular velocities of the three axes are output in the first process and the second process.

[0071] The processor **30**A executes the first process in a first range of the inertial force and executes the second process in a second range of the inertial force. The first range and the second range are the same as those in the embodiment described above. The inertial force (angular velocity) and the output from the processor **30**A are in the relationship as shown in Table 2. The first range and the second range are not limited to the angular velocities of the first axes A**11** and A**21** but may be set based on the angular velocities of the second axes A**12** and A**22** or the angular velocities of the third axes A**13** and A**23**.

TABLE 2

Inertial Force (Angular Velocity [dps])	Process to be Executed	Output	Sensitivity	Bias Stability
Greater than or equal to 0 and less than or equal to 50	First Process	Angular Velocity of First Axis A11 Angular Velocity of Second Axis A12 Angular Velocity of Third Axis A13	High	High
Greater than 50 and less than or equal to 200	Second Process	Angular Velocity of First Axis A21 Angular Velocity of Second Axis A22 Angular Velocity of Third Axis A23	Low	Low

[0072] In a similar manner to the processor **30**, the processor **30**A switches between the first process and the second process with reference to the output signal from the first inertial force detection element **41** and the output signal from the second inertial force detection element **42**. The processor **30**A may switch between the first process and the second process with reference to the output signal from the fifth inertial force detection element **45** and the output signal from the third inertial force detection element **43**. Alternatively, the processor **30**A may switch between the first process and the second process with reference to the output signal from the sixth inertial force detection element **46** and the output signal from the fourth inertial force detection element **44**. The switching between the first process and the second process may be determined for each axis.

[0073] The processor **30**A executes a diagnostic process in the first range. The diagnostic process includes a process of performing failure diagnosis for the first inertial force detection element **41** with reference to the output signal from the second inertial force detection element **42**. The diagnostic process includes a process of performing failure diagnosis for the fifth inertial force detection element **45** with reference to the output signal from the third inertial force detection element **43**. The diagnostic process includes a process of performing failure diagnosis for the sixth inertial force detection element **46** with reference to the output signal from the fourth inertial force detection element **44**. As described above, the processor **30**A performs, in the diagnostic process, failure diagnosis for an inertial force detection element **40** having high sensitivity by using an inertial force detection element **40** having low sensitivity among the plurality of inertial force detection elements **40** which detect the inertial forces of the same axes. If it is determined, as a result of the diagnostic process, that any of the first, fifth, and sixth inertial force detection elements **41**, **45**, and **46** has a failure, the processor **30**A outputs an angular velocity from the sensor element **21**A instead of the angular velocity from the sensor element **22**. If it is determined, as a result of the diagnostic process, that any of the first, fifth, and sixth inertial force detection elements **41**, **45**, and **46** has a failure, the processor **30**A further issues a notification of the occurrence of the failure.

[0074] Next, some other variations will be enumerated.

[0075] In a variation, the predetermined axes are not limited to the first axes A**11** and A**21**. As in the variation shown in FIGS. **6** to **8**, any of the first axes A**11** and A**21**, the second axes A**12** and A**22**, and the third axes A**13** and A**23** may be adopted as the predetermined axes. The predetermined axes are not limited to the first axes A**11** and A**21**, the second axes A**12** and A**22**, and the third axes A**13** and A**23** but may be axes of arbitrary angles.

[0076] In a variation, the plurality of inertial force detection elements **40** may include three or more inertial force detection elements **40** that detect the inertial forces of the predetermined axes. In this case, the three or more inertial force detection elements **40** that detect the inertial forces of the predetermined axes may be different from one another in terms of the detection range and sensitivity. In this case, the processor **30** may utilize an inertial force detection element having higher sensitivity for a smaller inertial force and may utilize an inertial force detection element having lower sensitivity for a larger inertial force. By way of example, the plurality of inertial force detection elements **40** may include an inertial force detection element having first sensitivity, an inertial force detection element having second sensitivity lower than the first sensitivity, and an inertial force detection element having third sensitivity lower than the second sensitivity. The processor **30** may output an inertial force obtainable from the inertial force detection element having the first sensitivity in the first range. The processor **30** may output an inertial force obtainable from the inertial force detection element having the second sensitivity in the second range in which the inertial force is larger than in the first range. The processor **30** may output an inertial force obtainable from the inertial force detection element having the third sensitivity in the third range in which the inertial force is larger than in the second range.

[0077] In a variation, each of the plurality of inertial force detection elements **40** may be an acceleration detection element. Each of the plurality of inertial force detection elements **40** detects an acceleration as the inertial force. The structure of each inertial force detection element may be a structure of a conventionally well-known acceleration detection element, and thus, the detailed description thereof will be omitted.

[0078] In a variation, the plurality of inertial force detection elements **40** may include a plurality of angular velocity detection elements and a plurality of acceleration detection elements. The plurality of angular velocity detection elements may include two or more angular velocity detection elements that detect angular velocity around the same axis. The plurality of acceleration detection elements may include two or more acceleration detection elements that detect accelerations of the same axes.

[0079] In a variation, the plurality of inertial force detection elements **40** do not necessarily have to be integrated into one sensor element. Each of the plurality of sensor elements may include a single inertial force detection element.

[0080] In a variation, each of the drive circuit **50** is not limited to an ASIC but may be, for example, a Field-Programmable Gate Array (FPGA) or may be configured by one or more processors and one or more memory elements. One drive circuit **50** may control a plurality of sensor elements.

[0081] In a variation, in the inertial sensor **10**, the plurality of inertial force detection elements **40** include at least the first inertial force detection element **41** and the second inertial force detection element **42** and do not have to necessarily include the third and fourth inertial force detection elements **43** and **44**.

[0082] In a variation, the processor **30** may switch between the first process and the second process depending on whether or not the inertial force obtainable from the output signal from the first inertial force detection element **41** is in the first range. The processor **30** may switch between the first process and the second process depending on whether the inertial force obtainable from the output signal from the second inertial force detection element **42** is in the first range or in the second range. In sum, the processor **30** may switch between the first process and the second process with reference to at least one of the output signal from the first inertial force detection element **41** or the output signal from the second inertial force detection element **42**.

[0083] In a variation, the first range does not necessarily have to overlap the detection range of the first inertial force detection element **41** and the detection range of the second inertial force detection element **42**. The second range does not necessarily have to be a range that does not overlap the first range in the detection range of the second inertial force detection element **42**. The first range and the second range may be appropriately set according to the application and the like of the inertial sensor **10**.

[0084] In a variation, in the diagnostic process, the processor **30** does not have to perform the failure diagnosis for the first inertial force detection element **41** with reference to the second inertial force detection element **42**. The processor **30** may perform failure diagnosis for the second inertial force detection element **42** with reference to the first inertial force detection element **41**, and if the inertial force of the first inertial force detection element **41** and the inertial force of the second inertial force detection element **42** do not match, the processor **30** may determine that the inertial sensor **10** itself has a failure.

[0085] In a variation, also when it is determined, as a result of the diagnostic process, that the first inertial force detection element **41** has a failure, the processor **30** does not necessarily have to output the angular velocity around the first axis A**21** instead of the angular velocity around the first axis A**11**. The processor **30** at least simply notify the occurrence of a failure. The processor **30** does not have to execute a diagnostic process in the first range.

[0086] (3) Aspects

[0087] As can be seen from the embodiment and the variations described above, the present disclosure includes the following aspects. In the following description, reference signs in parentheses are added only to clarify the correspondence relationship to the embodiment.

[0088] A first aspect is an inertial sensor (**10**; **10**A) and includes a plurality of inertial force detection elements (**40**) each configured to output an output signal corresponding to a detected inertial force; and a processor (**30**) configured to execute a process relating to the output signal from each of the plurality of inertial force detection elements (**40**). The plurality of inertial force detection elements (**40**) include a first inertial force detection element (**41**) and a second inertial force detection element (**42**). A detection range of the first inertial force detection element (**41**) and a detection range of the second inertial force detection element (**42**) are different from each other. A sensitivity of the first inertial force detection element (**41**) and a sensitivity of the second inertial force detection element (**42**) are different from each other. This aspect enables the sensitivity to be increased in a desired range while extending a detection range of an inertial force.

[0089] A second aspect is an inertial sensor (**10**; **10**A) according to the first aspect. In the second aspect, the inertial sensor (**10**; **10**A) further includes a base (**61**) having an arrangement surface (**610***a*) on which the first inertial force detection element (**41**) and the second inertial force detection element (**42**) are arranged. A detection axis of the first inertial force detection element (**41**) and a detection axis of the second inertial force detection element (**42**) are first axes (A**11**, A**21**) parallel to each other, and the first axes (A**11**, A**21**) are orthogonal to the arrangement surface (**610***a*). This aspect enables the sensitivity to be increased in a desired range while extending a detection range of the inertial force.

[0090] A third aspect is an inertial sensor (**10**; **10**A) according to the first or second aspect. In the third aspect, the detection range of the first inertial force detection element (**41**) is narrower than the detection range of the second inertial force detection element (**42**). The sensitivity of the first inertial force detection element (**41**) is higher than the sensitivity of the second inertial force detection element (**42**). This aspect enables the sensitivity to be increased in a desired range while extending a detection range of the inertial force.

[0091] A fourth aspect is an inertial sensor (**10**; **10**A) referring to any one of the first to third aspects. In the fourth aspect, in the inertial sensor (**10**; **10**A), the processor (**30**) is configured to execute a first process of outputting an inertial force obtained with reference to the output signal from the first inertial force detection element (**41**) in a first range and execute a second process of outputting an inertial force obtained with reference to the output signal from the second inertial force detection element (**42**) in a second range. This aspect enables the sensitivity to be increased in a desired range while extending a detection range of the inertial force.

[0092] A fifth aspect is an inertial sensor (**10**; **10**A) referring to the fourth aspect. In the fifth aspect, the first range overlaps the detection range of the first inertial force detection element (**41**) and the detection range of the second inertial force detection element (**42**). The second range is a range that overlaps the detection range of the second inertial force detection element (**42**) and that does not overlap the first range. This aspect enables the sensitivity to be increased in a desired range while extending a detection range of the inertial force.

[0093] A sixth aspect is an inertial sensor (**10**; **10**A) according to the fifth aspect. In the sixth aspect, the first range has an upper limit value less than or equal to a lower limit value of the second range. This aspect enables the sensitivity to be increased in a desired range while extending a detection range of the inertial force.

[0094] A seventh aspect is an inertial sensor (**10**; **10**A) referring to any one of the fourth to sixth aspects. In the seventh aspect, the processor (**30**) includes a diagnostic process of performing failure diagnosis for the first inertial force detection element (**41**) with reference to the output signal from the second inertial force detection element (**42**) in the first range. This aspect enables the reliability to be improved.

[0095] An eighth aspect is an inertial sensor (**10**; **10**A) referring to any one of the first to seventh aspects. In the eighth aspect, the processor (**30**) is configured to acquire the output signal from the first inertial force detection element (**41**) at a first interval and acquire the output signal from the second inertial force detection element (**42**) at a second interval wider than the first interval. This aspect enables the sensitivity to be further improved in a desired range.

[0096] A ninth aspect is an inertial sensor (**10**; **10**A) referring to any one of the first to eighth aspects. In the ninth aspect, each of the plurality of inertial force detection elements (**40**) is a mechano-electrical transduction element. This aspect enables the inertial sensor (**10**; **10**A) to be downsized.

[0097] A tenth aspect is an inertial sensor (**10**; **10**A) referring to any one of the first to ninth aspects. In the tenth aspect, the inertial sensor (**10**; **10**A) further includes a base (**61**) having an arrangement surface (**610***a*) on which the first inertial force detection element (**41**) and the second inertial force detection element (**42**) are arranged. A detection axis of the first inertial force detection element (**41**) and a detection axis of the second inertial force detection element (**42**) are first axes (A**11**, A**21**) parallel to each other, and the first axes (A**11**, A**21**) are orthogonal to the arrangement surface (**610***a*). The plurality of inertial force detection elements (**40**) further include a third inertial force detection element (**43**) configured to detect an inertial force of a second axis (A**22**) orthogonal to the first axes (A**11**, A**21**) and a fourth inertial force detection element (**44**) configured to detect an inertial force of a third axis (A**23**) orthogonal to the first axes (A**11**, A**21**) and the second axis (A**22**). This aspect enables the inertial forces of the three axes to be detected.

[0098] An eleventh aspect is an inertial sensor (**10**; **10**A) referring to the tenth aspect. In the eleventh aspect, the detection range of the first inertial force detection element (**41**) is narrower than each of a detection range of the third inertial force detection element (**43**) and a detection range of the fourth inertial force detection element (**44**). The sensitivity of the first inertial force detection element (**41**) is higher than each of sensitivity of the third inertial force detection element (**43**) and sensitivity of the fourth inertial force detection element (**44**). This aspect enables the sensitivity to the inertial force of the first axes to be increased in a desired range while extending a detection range of the inertial forces of the three axes.

[0099] A twelfth aspect is an inertial sensor (**10**; **10**A) referring to the tenth or eleventh aspect. In the twelfth aspect, the inertial sensor (**10**; **10**A) further includes a plurality of drive circuits (**50**) each configured to give the output signal from a corresponding one of the plurality of inertial force detection elements (**40**) to the processor (**30**). The plurality of drive circuits (**50**) include a first drive circuit (**51**; **51**A) and a second drive circuit (**52**). The first drive circuit (**51**; **51**A) and the second drive circuit (**52**) are connected to the processor (**30**). The first drive circuit (**51**; **51**A) is connected to the first inertial force detection element (**41**). The second drive circuit (**52**) is connected to the second inertial force detection element (**42**), the third inertial force detection element (**43**), and the fourth inertial force detection element (**44**). This aspect enables the sensitivity to the inertial force of the first axes to be increased in a desired range while extending a detection range of the inertial forces of the three axes.

[0100] A thirteenth aspect is an inertial sensor (**10**; **10**A) referring to any one of the first to twelfth aspects. In the thirteenth aspect, the first inertial force detection element (**41**) and the second inertial force detection element (**42**) have bias stabilities different from each other. This aspect enables the sensitivity to be increased in a desired range while extending a detection range of the inertial force.

[0101] A fourteenth aspect is an inertial sensor (**10**; **10**A) according to the twelfth aspect. In the fourteenth aspect, the inertial sensor (**10**; **10**A) further includes a base (**61**) having an arrangement surface (**610***a*) on which the first inertial force detection element (**41**) and the second inertial force detection element (**42**) are arranged. The first drive circuit (**51**; **51**A) and the second drive circuit (**52**) are on the arrangement surface (**610***a*).

[0102] A fifteenth aspect is an inertial sensor (**10**; **10**A) according to the second or fourteenth aspect. In the fifteenth aspect, the base (**61**) includes an anti-vibration portion (**70**) lying between the arrangement surface (**610***a*) and the plurality of inertial force detection elements (**40**).

REFERENCE SIGNS LIST

[0103] **10**, **10**A Inertial Sensor
[0104] **30** Processor
[0105] **40** Inertial Force Detection Element
[0106] **41** First Inertial Force Detection Element
[0107] **42** Second Inertial Force Detection Element
[0108] **43** Third Inertial Force Detection Element
[0109] **44** Fourth Inertial Force Detection Element
[0110] **50** Drive Circuit
[0111] **51**, **51**A First Drive Circuit
[0112] **52** Second Drive Circuit
[0113] **61** Base
[0114] **610***a* Arrangement Surface
[0115] **70** Anti-Vibration Portion
[0116] A**11**, A**21** First Axis
[0117] A**22** Second Axis
[0118] A**23** Third Axis

1. An inertial sensor comprising:
a plurality of inertial force detection elements each configured to output an output signal corresponding to a detected inertial force; and
a processor configured to execute a process relating to the output signal from each of the plurality of inertial force detection elements,
the plurality of inertial force detection elements including a first inertial force detection element and a second inertial force detection element,
a detection range of the first inertial force detection element and a detection range of the second inertial force detection element being different from each other,
a sensitivity of the first inertial force detection element and a sensitivity of the second inertial force detection element being different from each other.

2. The inertial sensor of claim **1**, further comprising a base having an arrangement surface on which the first inertial force detection element and the second inertial force detection element are arranged, and
a detection axis of the first inertial force detection element and a detection axis of the second inertial force detection element are first axes parallel to each other, and the first axes are orthogonal to the arrangement surface.

3. The inertial sensor of claim **1**, wherein
the detection range of the first inertial force detection element is narrower than the detection range of the second inertial force detection element, and the sensitivity of the first inertial force detection element is higher than the sensitivity of the second inertial force detection element.

4. The inertial sensor of claim **1**, wherein
the processor is configured to
execute a first process of outputting an inertial force obtained with reference to the output signal from the first inertial force detection element in a first range and
execute a second process of outputting an inertial force obtained with reference to the output signal from the second inertial force detection element in a second range.

5. The inertial sensor of claim **4**, wherein
the first range overlaps the detection range of the first inertial force detection element and the detection range of the second inertial force detection element, and
the second range is a range that overlaps the detection range of the second inertial force detection element and that does not overlap the first range.

6. The inertial sensor of claim **5**, wherein
the first range has an upper limit value less than or equal to a lower limit value of the second range.

7. The inertial sensor of claim **4**, wherein
the processor is configured to execute, in the first range, a diagnostic process of performing failure diagnosis for the first inertial force detection element with reference to the output signal from the second inertial force detection element.

8. The inertial sensor of claim **1**, wherein
the processor is configured to
acquire the output signal from the first inertial force detection element at a first interval and
acquire the output signal from the second inertial force detection element at a second interval wider than the first interval.

9. The inertial sensor of claim **1**, wherein
each of the plurality of inertial force detection elements is a mechano-electrical transduction element.

10. The inertial sensor of claim **1**, further comprising a base having an arrangement surface on which the first inertial force detection element and the second inertial force detection element are arranged, and
a detection axis of the first inertial force detection element and a detection axis of the second inertial force detection element are first axes parallel to each other, and the first axes are orthogonal to the arrangement surface, and
the plurality of inertial force detection elements further include

a third inertial force detection element configured to detect an inertial force of a second axis orthogonal to the first axes and

a fourth inertial force detection element configured to detect an inertial force of a third axis orthogonal to the first axes and the second axis.

11. The inertial sensor of claim **10**, wherein

the detection range of the first inertial force detection element is narrower than each of a detection range of the third inertial force detection element and a detection range of the fourth inertial force detection element, and

the sensitivity of the first inertial force detection element is higher than each of sensitivity of the third inertial force detection element and sensitivity of the fourth inertial force detection element.

12. The inertial sensor of claim **10**, further comprising a plurality of drive circuits each configured to give the output signal from a corresponding one of the plurality of inertial force detection elements to the processor, wherein

the plurality of drive circuits include a first drive circuit and a second drive circuit,

the first drive circuit and the second drive circuit are connected to the processor,

the first drive circuit is connected to the first inertial force detection element, and

the second drive circuit is connected to the second inertial force detection element, the third inertial force detection element, and the fourth inertial force detection element.

13. The inertial sensor of claim **1**, wherein

the first inertial force detection element and the second inertial force detection element have bias stabilities different from each other.

14. The inertial sensor of claim **12**, wherein

the first drive circuit and the second drive circuit are on the arrangement surface.

15. The inertial sensor of claim **2**, wherein

the base includes an anti-vibration portion lying between the arrangement surface and the plurality of inertial force detection elements.

16. The inertial sensor of claim **14**, wherein

the base includes an anti-vibration portion lying between the arrangement surface and the plurality of inertial force detection elements.

17. The inertial sensor of claim **2**, wherein

the detection range of the first inertial force detection element is narrower than the detection range of the second inertial force detection element, and the sensitivity of the first inertial force detection element is higher than the sensitivity of the second inertial force detection element.

18. The inertial sensor of claim **2**, wherein

the processor is configured to

execute a first process of outputting an inertial force obtained with reference to the output signal from the first inertial force detection element in a first range and

execute a second process of outputting an inertial force obtained with reference to the output signal from the second inertial force detection element in a second range.

19. The inertial sensor of claim **3**, wherein

the processor is configured to

execute a first process of outputting an inertial force obtained with reference to the output signal from the first inertial force detection element in a first range and

execute a second process of outputting an inertial force obtained with reference to the output signal from the second inertial force detection element in a second range.

20. The inertial sensor of claim **17**, wherein

the processor is configured to

execute a first process of outputting an inertial force obtained with reference to the output signal from the first inertial force detection element in a first range and

execute a second process of outputting an inertial force obtained with reference to the output signal from the second inertial force detection element in a second range.

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