(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 828 663 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.06.2021 Bulletin 2021/22

(51) Int Cl.:
G05G 9/047 *(2006.01)* ***G05G 1/06*** *(2006.01)*

(21) Application number: **19212103.6**

(22) Date of filing: **28.11.2019**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
KH MA MD TN

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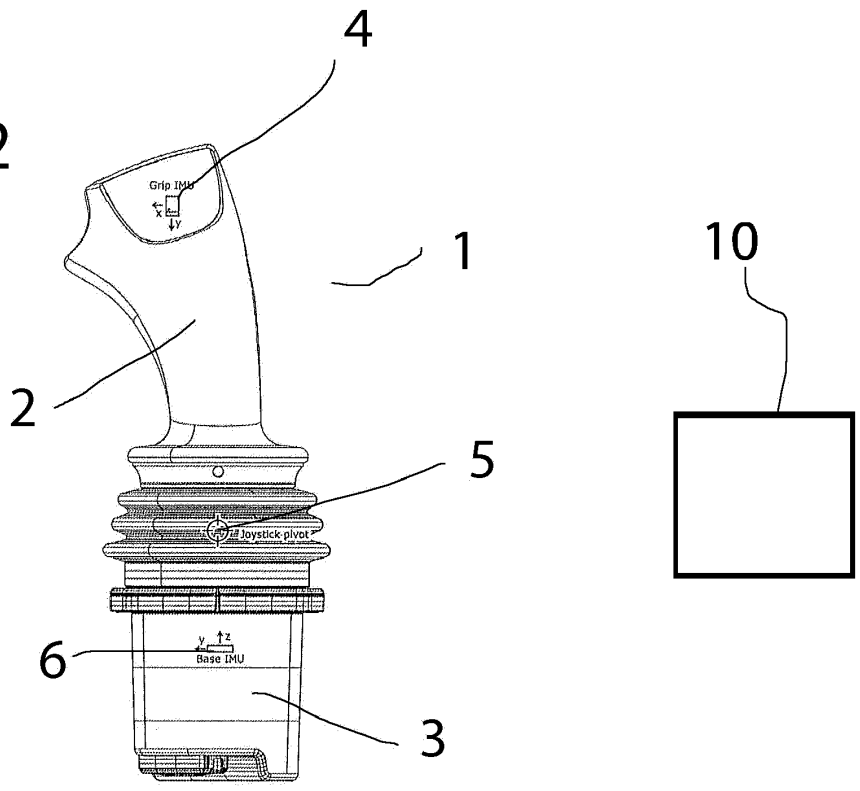
(54) **INERTIAL JOYSTICK ORIENTATION MEASUREMENT**

(57) Previous joystick arrangements, comprising a joystick handle, which is pivotable around a pivoting point on a joystick base, use touching or non-touching sensor to determine a position of the joystick handle relative to the joystick base. Due to exposed sensors, maintenance levels are high.

The present invention relates to joystick arrangements, comprising a joystick handle, a joystick base and a processing unit, wherein the joystick handle is pivotable around a pivoting point of the joystick base, characterized in that said joystick arrangement comprises a sensor unit comprising an accelerometer connected to the processing unit. The present invention uses a sensor unit consisting of non-moving parts. As a result, the sensor unit requires a low maintenance effort.

Fig. 2



EP 3 828 663 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to joystick arrangements, comprising a joystick handle, a joystick base and a processing unit, wherein the joystick handle is pivotable around a pivoting point of the joystick base.

BACKGROUND OF THE INVENTION

[0002] Joysticks are used to control different applications, e.g. excavators, cranes, drilling machines, etc. Mostly those applications are used in an environment being dusty or having other severe pollutions. Positions of joystick are mostly determined by sensors. The sensors can be touching sensors or non-touching sensors, in either case sensors within joystick applications need to detect relative movements between a joystick handle and a joystick base. As a consequence sensors of joysticks are polluted by dust or other pollutions. These pollutions affect mostly joystick arrangements comprising touching sensors. As a result, the joystick arrangements need to be maintained on a regular basis. This regular maintenance is cost intensive.

PROBLEM

[0003] The present invention aims for a low maintenance effort of joysticks.

[0004] This object if solved with a joystick arrangement as described in the outset in that said joystick arrangement comprises a sensor unit comprising an accelerometer connected to the processing unit.

[0005] In such a joystick arrangement, it is possible to determine the position of a joystick handle without having sensors exposed. The sensor unit is composed of non-moving parts and therefore the sensor unit does not need any maintenance. Furthermore, the joystick arrangement has a high EMC tolerance which is beneficial for working environments having a high electromagnetic impact, for example around electrical furnaces.

[0006] Accelerometer detect forces applied onto it. In this case, the accelerometer can detect gravitational forces. Depending on the joystick handle position and therefore on the position of the accelerometer, the accelerometer detects the gravitational forces differently. The sensor unit hands the over to the processing unit. The processing unit determines the position of the joystick handle by using the output of the sensor unit.

[0007] In an embodiment, the accelerometer comprises at least two axes. Using at least two axes enables the accelerometer to detect a joystick handle movement on a high accuracy level. Mostly accelerometers are able to cover all three spatial directions. These directions are covered by the accelerometer to detect movements of the joystick handle.

[0008] In an embodiment, the joystick base is mounted on a structure. This is a simple way to guarantee a fix position of the joystick arrangement. Furthermore, the structure and the joystick base can be formed as one-part.

[0009] In an embodiment, the sensor unit is a first sensor unit comprising a first accelerometer wherein the joystick base or the structure comprise a second sensor unit comprising a second accelerometer. Using a first sensor unit and a second sensor unit increase the accuracy of the detection of the position of the joystick handle.

[0010] In an embodiment, the processing unit processes outputs of both sensor units. The processing unit can use both sensor data output to determine the position of the joystick handle. This arrangement cuts costs, since just one processing unit is needed and increases the accuracy the joystick arrangement.

[0011] In a embodiment, the processing unit compares signals of the first sensor unit and of the second sensor unit. By comparing both signals, movements which the joystick handle and the joystick base or the structure experience are detected and filtered. Therefore the processing unit can detect the position of the joystick handle within a moving joystick arrangement.

[0012] In an embodiment, respective axes of the first accelerometer and axes of the second accelerometer are parallel to each other when the joystick arrangement is in a neutral position. This is a simplifies the implementation of a software used by the processing unit.

[0013] In another embodiment, respective axes of the first sensor unit in the joystick handle and respective axes of the second sensor unit in the joystick base or the structure are rotationally offset to each other when the joystick arrangement is in a neutral position. This simplifies the mounting process, since mounting tolerances are reduced.

[0014] In an embodiment, the sensor unit comprises a gyroscope. The gyroscope can detect rotational movement. Since the pivoting movement of the joystick handle around the pivoting point in the base is a rotational movement, the usage of a gyroscope increases the accuracy of a joystick arrangement.

[0015] In an embodiment, respective axes of the gyroscope comprised in the first sensor unit and respective axes of the gyroscope comprised in the second sensor unit are aligned. By aligning respective axes of first sensor unit with respective axes of the second sensor unit, the processing unit can process the output of the sensors easily.

[0016] In an embodiment, the sensor unit comprises a magnetometer. Magnetic impacts can influence electronic devices, e.g. sensors. The influence of magnetic impacts can affect sensitivities of sensors. A magnetometer detects such magnetic impacts. As a result, sensitivity levels of sensors can be adjusted and the joystick arrangement to be used in working environments with a high magnetic or electromagnetic impact like around induction furnaces or in metal mines.

[0017] In an embodiment, the sensor unit comprises a

barometer. Barometers detect air pressure. If an operated unit controlled via a control stand is used in contaminated environments, like landfills, the control stand has a higher air pressure than the environment. To monitor the air pressure barometers are used. The sensor unit comprises a barometer in order to cut costs, since just one type of sensor unit needs to be developed and manufactured.

[0018] In an embodiment, the position of the joystick handle determined by the processing unit is handed over to a control unit. This simplifies the control of the operated unit and reduces the parts needed for controlling.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 depicts a side view of a joystick arrangement;

Fig. 2 depicts a front view of a joystick arrangement.

DETAILED DESCRIPTION OF THE DRAWINGS

[0020] Fig. 1 depicts a side view of a joystick arrangement 1 in its neutral position. A joystick handle 2 of the joystick arrangement 1 can pivot around a pivoting point 5, based in a joystick base 3. The joystick base 3 can be mounted on a not depicted structure. The joystick handle 2 comprises a first sensor unit 4, which is connected to a processing unit 10. The first sensor unit 4 comprises a first accelerometer. The joystick base 3 or the structure can comprise a second sensor unit 6 comprising a not depicted second accelerometer. The second sensor unit 6 is connected to the processing unit 10.

[0021] Fig. 2 depicts a front view of the joystick arrangement 1 in its neutral position. The joystick handle 2 of the joystick arrangement 1 can pivot around a pivoting point 5, based in the joystick base 3. The joystick base 3 can be mounted on a not depicted structure. The joystick handle 2 comprises a first sensor unit 4 and a first accelerometer which is connected to the processing unit 10. The joystick base 3 or the structure can comprise a second sensor unit 6 comprising a not depicted second accelerometer. The second sensor unit 6 is connected to the processing unit 10.

[0022] In the neutral position of the joystick arrangement 1, the accelerometers detect forces applied on the joystick arrangement 1. In this case, the forces applying are gravitational forces. The accelerometers measure the gravitational forces along each axis of the respective accelerometer. If for example one axis of the accelerometer, which comprises three axes, is aligned with the gravitational force, the two other axes detect no gravitational force, since all axes are perpendicular to each other. If the joystick handle 2 is moved to a position, different form the neutral position, the accelerometer detects gravitational forces with at least one additional axis. Using outputs detected by the first sensor unit 4, the processing unit 10 can determine the position of the joystick handle 2 in relation to its neutral position.

[0023] If the joystick arrangement 1 is moved as a whole, the sensor comprised by the joystick handle 2 detects a movement. This movement however might be unintended by an operator operating the operated unit, controlled via the joystick arrangement 1. Therefore, the joystick base 3 comprises the second sensor unit 6. First, the axes of the first accelerometer and the axes of the second accelerometer are aligned, for calibration purposes. This sensor unit 6 is used as a reference. If the joystick arrangement is moved as a whole, the first sensor unit 4 and the second sensor unit 6 detect a same movement. If the joystick handle 2 is moved to a position, different form the neutral position, the sensor unit 4 detects the same movement like the sensor unit 6 detects and in addition sensor unit 4 detects the movement of the joystick handle 2. The processing unit 10 compares the output of the first sensor unit 4 and the output of the second sensor unit 6 to determine the actual movement of the joystick handle 2.

[0024] In addition to accelerometers, the sensor units can comprise gyroscopes. Gyroscopes can detect rotational movements. Due to the pivoting movement of the joystick handle 2, which basically describes a rotational movement, gyroscopes help improving the accuracy of the determination of the joystick handle 2 position. In accordance with the above described method using accelerometers only, the processing unit 10 compares the output of the gyroscope comprised in the first sensor unit 4 and the output of the gyroscope comprised in the second sensor unit 6. Based on this comparison, the processing unit 10 determines the position of the joystick handle 2.

[0025] In the case of using accelerometers and gyroscopes, signals of the accelerometers are re-oriented so that the measurements align along the same axes in the neutral position. This includes a single fixed rotation between coordinate systems of the first accelerometer and the second accelerometer. The fixed position is found during a calibration process. In a position, different from the neutral position, the axes of the accelerometers might be not aligned. Signals of the gyroscopes are re-oriented so that the measurements align along the same axes. The signals of the gyroscopes need to be aligned always. Therefore, the gyroscopes need additional rotation to correct for a current joystick handle 2 position.

[0026] Using a combination of the signals of accelerometers and gyroscopes comprised in the first sensor unit 4 and in the second sensor unit 6, a highly accurate determination of the position of the joystick handle 2 is possible.

Claims

1. A joystick arrangement (1) comprising a joystick handle (2), a joystick base (3) and a processing unit (10), wherein the joystick handle (2) is pivotable around

a pivoting point (5) of the joystick base (3), **characterized in that** the joystick handle (2) comprises a sensor unit (4) comprising an accelerometer connected to the processing unit (10).

2. A joystick arrangement (1) according to claim 1 **characterized in that** the accelerometer comprises at least two axes.

3. A joystick arrangement (1) according to claim 1 and 2 **characterized in that** the joystick base (3) is mounted on a structure.

4. A joystick arrangement (1) according to claims 1 to 3, **characterized in that** the sensor unit (4) is a first sensor unit (4) comprising a first accelerometer wherein the joystick base (3) or the structure comprises a second sensor (6) unit comprising a second accelerometer.

5. A joystick arrangement (1) according to claim 4 **characterized in that** the processing unit (10) processes outputs of both sensor units (4, 6).

6. A joystick arrangement (1) according to claims 1 to 5 **characterized in that** the processing unit (10) compares signals of the first sensor (4) unit and of the second sensor unit (6).

7. A joystick arrangement (1) according to claims 1 to 6 **characterized in that** respective axes of the first accelerometer and axes of the second accelerometer are parallel to each other when the joystick arrangement (1) is a neutral position.

8. A joystick arrangement (1) according to claims 1 to 6 **characterized in that** respective axes of the first sensor unit (4) in the joystick handle (2) and respective axes of the second sensor (6) unit in the joystick base (3) or the structure are rotationally offset to each other when the joystick arrangement (1) is a neutral position.

9. A joystick arrangement (1) according to claims 1 to 8 **characterized in that** the sensor unit (4, 6) comprises a gyroscope.

10. A joystick arrangement (1) according to claim 9 **characterized in that** respective axes of the gyroscope comprised in the first sensor (4) unit and respective axes of the gyroscope comprised in the second sensor (6) unit are aligned.

11. A joystick arrangement (1) according to claims 1 to 10 **characterized in that** the sensor unit (4, 6) comprises a magnetometer.

12. A joystick arrangement (1) according to claims 1 to 11 **characterized in that** the sensor unit (4, 6) comprises a barometer.

13. A joystick arrangement (1) according to claims 1 to 12 **characterized in that** the position of the joystick handle (2) determined by the processing unit (10) is handed over to a control unit.

Fig. 1

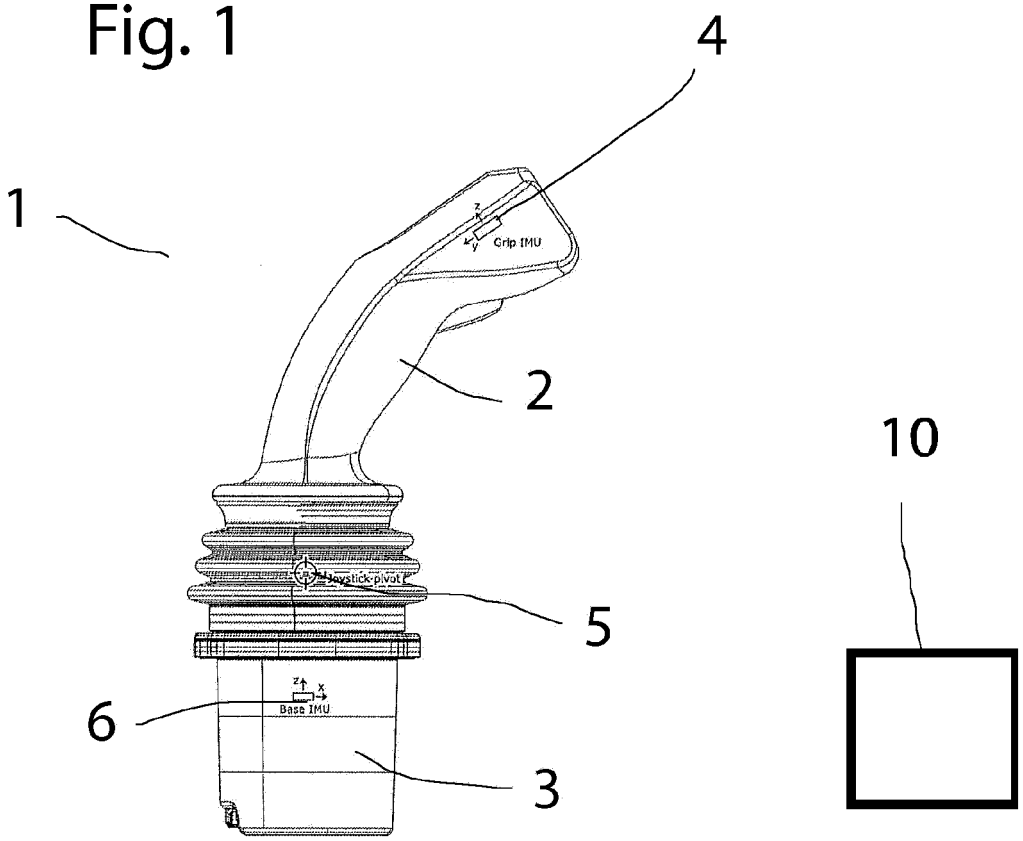
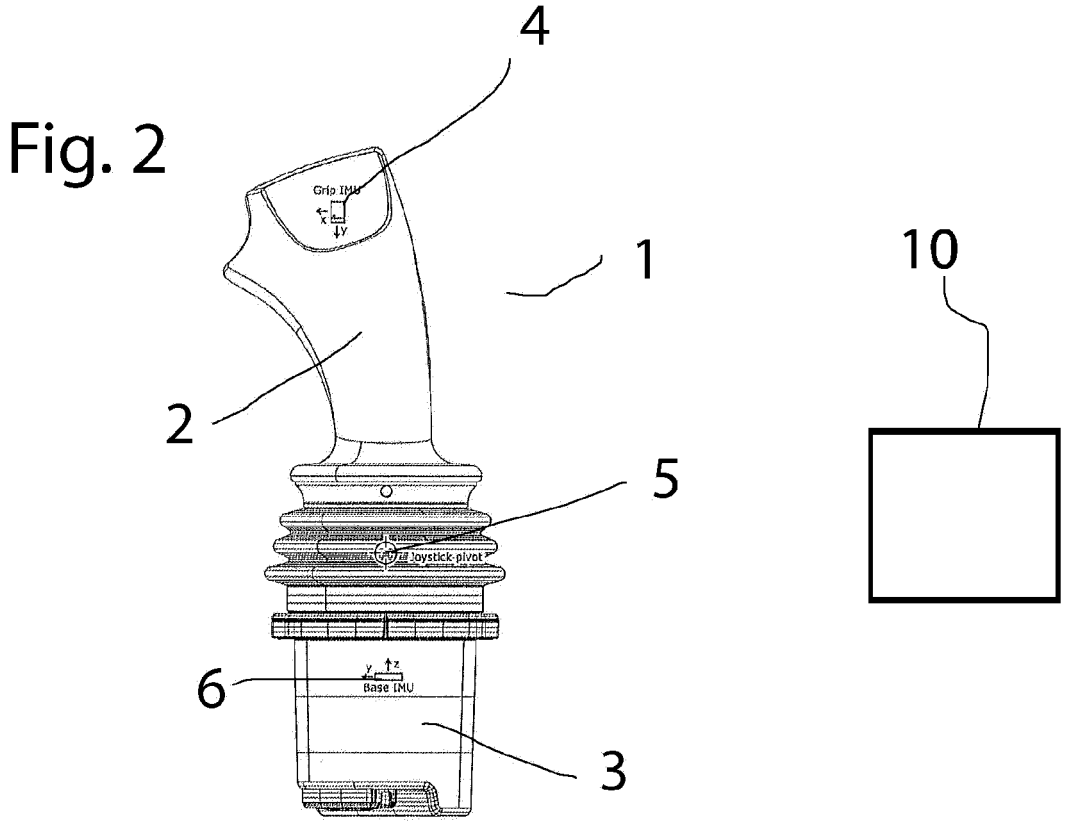

4
1
Grip IMU
2
10
Joystick-pivot
5
6
Base IMU
3

Fig. 2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6
Base IMU
3

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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 2103

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	BG 112 068 A (SISTEMNO INTEGRIRANE EOOD [BG]) 31 January 2017 (2017-01-31) * figure 1 * -----	1-7,12, 13 8-11	INV. G05G9/047 G05G1/06
X Y	US 9 114 865 B1 (GONRING STEVEN J [US]) 25 August 2015 (2015-08-25) * figure 8 * * column 1, line 65 - column 2, line 10 * -----	1-7,12, 13 8-11	
X Y A	US 2018/105407 A1 (PORTER RANDY DAVID [US] ET AL) 19 April 2018 (2018-04-19) * figure 3 * * paragraphs [0029], [0030] * -----	1-6,9,13 11 7,8,10, 12	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5 May 2020	Rossatto, Cédric

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82