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Sensor module

Abstract

A sensor module includes a housing having a first cavity and a second cavity that are in communication with each other, a liquid level sensing module mounted on the housing and sensing liquid level related information when liquid flows into the second cavity, a turbidity sensing module mounted on a section of the housing having the first cavity, and a temperature sensing module integrated with the turbidity sensing module and sensing temperature related information of the liquid when the liquid flows into the first cavity. The turbidity sensing module includes a light transmitting unit and a light receiving unit that are located on opposite sides of the first cavity to allow light emitted from the light transmitting unit to pass through the first cavity and to be received by the light receiving unit.

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Field of Classification Search

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims the benefit of the filing date under 35 U.S.C. § 119(a)-(d) of Chinese

Patent Application No. 202111036912.0, filed on Sep. 6, 2021.

FIELD OF THE DISCLOSURE

(2) The disclosure relates to a sensor and, more particularly, to a sensor module.

BACKGROUND

(3) Some existing intelligent cleaning equipment (such as washing machines or dishwashers) are equipped with a liquid level sensor, a turbidity sensor, and a temperature sensor that are installed independently in different positions. The liquid level sensor is fixed near the liquid flow path to detect the liquid level by the liquid pressure. The measuring part of the turbidity sensor is inserted into the liquid flow path to detect the turbidity of the liquid. The temperature sensor is fixed in the liquid flow path to detect the liquid temperature.

(4) The sensors are connected to a control system via different wiring. The control system automatically sets the cleaning mode of the intelligent cleaning equipment according to the measurement conditions of the three sensors. However, installing each sensor independently at different positions complicates wiring installation, which also creates wasted space.

SUMMARY

(5) A sensor module includes a housing having a first cavity and a second cavity that are in communication with each other, a liquid level sensing module mounted on the housing and sensing liquid level related information when liquid flows into the second cavity, a turbidity sensing module mounted on a section of the housing having the first cavity, and a temperature sensing module integrated with the turbidity sensing module and sensing temperature related information of the liquid when the liquid flows into the first cavity. The turbidity sensing module includes a light transmitting unit and a light receiving unit that are located on opposite sides of the first cavity to allow light emitted from the light transmitting unit to pass through the first cavity and to be received by the light receiving unit.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

(2) FIG. **1** is a perspective view of a sensor module according to an embodiment;

(3) FIG. **2** is a partial sectional perspective view of the sensor module of FIG. **1**;

(4) FIG. **3** is another partial sectional perspective view of the sensor module of FIG. **1**, in which an outer cover is removed;

(5) FIG. **4** is an enlarged front view of a portion of FIG. **3**;

(6) FIG. **5** is an exploded perspective view of the sensor module of FIG. **1**;

(7) FIG. **6** is another exploded perspective view of the sensor module of FIG. **1**; and

(8) FIG. **7** is a sectional perspective view of the sensor module of FIG. **1**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

(9) Various embodiments will be illustrated and explained hereinafter with reference to the accompanying figures. The figures serve to illustrate the basic principle, so that only aspects necessary for understanding the basic principle are illustrated. It should be noted that the figures are not drawn to scale and the use of the same reference numbers in different figures indicates similar or identical features.

(10) Hereinafter, details of embodiments will be described with reference to the figures that form part of the invention. The figures illustrate embodiments of the invention by way of example only and the illustrated embodiments are not intended to present an exhaustive list of embodiments of the invention. It is to be understood that other embodiments may be utilized and that structural or logical modifications may be made without departing from the spirit and scope of the invention.

Therefore, the following description is not intended to limit the scope of the invention, which is defined by the appended claims.

(11) As shown in FIGS. **1**-**7**, the sensor module **100** according to one embodiment of the present invention is used to detect liquid level, turbidity and liquid temperature of the household appliances such as washing machines and dishwashers. Specifically, as shown in FIGS. **1**-**7**, the sensor module **100** includes a housing **102**, a liquid level sensing module **110**, a turbidity sensing module **112**, a temperature sensing module **116**, and an outer cover **108**.

(12) The housing **102** includes a horizontal section **104** and a bending section **106**, as shown in FIGS. **1**-**3**. The horizontal section **104** includes a first cavity **1040**, and the bending section **106** includes a second cavity **1060** (as shown in FIG. **7**). The first cavity **1040** and the second cavity **1060** communicate with each other. The liquid level sensing module **110** is mounted on the bending section **106** and is configured to sense liquid level related information when the liquid flows into the second cavity **1060**. The turbidity sensing module **112** is mounted on the horizontal section **104** to sense turbidity related information of the liquid. At least part of the horizontal section **104** of the housing **102** is transparent. An outer cover **108** of the housing **102** is adapted to the bending section **106**, and is sized to shield the liquid level sensing module **110**, for waterproofing and dustproofing.

(13) As shown in FIGS. **3**-**4**, the turbidity sensing module **112** includes a light emitting unit **112***a* and a light receiving unit **112***b*. When part of the horizontal section **104** is transparent and the turbidity sensing module **112** is mounted on the horizontal section **104**, the light emitting unit **112***a* and the light receiving unit **112***b* are oppositely located on both sides of the transparent part of the horizontal section **104**, to allow the light emitted from the light emitting unit **112***a* to pass through the transparent part and the cavity **1040** and to be received by the light receiving unit **112***b*. When all of the horizontal section **104** is transparent, when the turbidity sensing module **112** is mounted on the horizontal section **104**, the light emitting unit **112***a* and the light receiving unit **112***b* are located on both sides of the horizontal section **104**, so as to allow the light emitted from the light emitting unit **112***a* to pass through the horizontal section **104** and the cavity **1040** and to be received by the light receiving unit **112***b*.

(14) As shown in FIG. **4**, the horizontal section **104** includes a plurality of first grooves **104***a* and a plurality of second grooves **104***b* oppositely located on both sides thereof. When the turbidity sensing module **112** is mounted on the horizontal section **104**, the light emitting unit **112***a* is fixed in the first groove **104***a*, and the light receiving unit **112***b* is fixed in the second groove **104***b*. It should be understood that, in another embodiment, the horizontal section **104** could be opaque and the horizontal section **104** includes an opening penetrating through the horizontal section **104**; when the turbidity sensing module **112** is mounted on the horizontal section **104**, the light emitting unit **112***a* and the light receiving unit **112***b* are oppositely sealed at the opening to allow light emitted from the light emitting unit **112***a* to pass through the opening and to be received by the light receiving unit **112***b*.

(15) In the embodiment as shown in FIGS. **3**-**4**, the turbidity sensing module **112** further includes a first protective casing **1120***a* and a second protective casing **1120***b*. The light emitting unit **112***a* is accommodated in the first protective casing **1120***a*, and the light receiving unit **112***b* is accommodated in the second protective casing **1120***b*. When the turbidity sensing module **112** is mounted on the horizontal section **104**, the light emitting unit **112***a* is fixed in the first groove **104***a* along with the first protective casing **1120***a*, and the light receiving unit **112***b* is fixed in the second groove **104***b* along with the second protective casing **1120***b*. It should be understood that, in another embodiment, the protective casings **1120***a* and **1120***b* are respectively provided with a first hole and a second hole that is paired with the first hole. When liquid (e.g., water) flows into the first cavity **1040** of the horizontal section **104**, the light emitted by the light emitting unit **112***a* can pass through the first hole, the horizontal section **104** and the first cavity **1040**, to be received by the light receiving unit **112***b* via the second hole. It should also be understood that in another embodiment, the turbidity sensing module **112** doesn't include the first protective casing **1120***a* and

the second protective casing **1120***b*, the light emitting unit **112***a* and the light receiving unit **112***b* are directly fixed in the first groove **104***a* and the second groove **104***b*, respectively.
(16) As shown in FIGS. **3-6**, the turbidity sensing module **104** further includes a signal conversion unit such as a first printed circuit board (PCB) assembly **114**. The signal conversion unit **114** is coupled with the light emitting unit **112***a* and the light receiving unit **112***b* to convert intensity signal of light received by the light receiving unit **112***b* into an analog voltage signal representing turbidity.
(17) The sensor module **100** also includes a temperature sensing module **116** (e.g., NTC module), which is integrated with the turbidity sensing module **112**. Specifically, the temperature sensing module **116** is integrated with the first PCB assembly **114** (e.g., the temperature sensing module **116** is soldered to the first PCB assembly **114**) for sensing temperature related information of the liquid (i.e., the analog resistance value representing the liquid temperature) when the liquid flows into the first cavity **1040**.
(18) In addition, as shown in FIG. **3**, the sensor module **100** also includes a connector **120**, which includes a second PCB assembly **120***a*. The first PCB assembly **114** is connected to the second PCB assembly **120***a* of the connector **120** via four wires, specifically, via a ground line **118***a*, a power line **118***b* (e.g., a 5V power line), a signal line **118***c* for outputting the turbidity signal, and a signal line **118***d* for outputting the temperature signal, The connector **120** is connected to the external mating connector **200** (e.g., RAST interface connector) to send turbidity related information of the liquid sensed by the turbidity sensing module **112** and temperature related information of the liquid sensed by the temperature sensing module **116** to the outside of the sensor module.
(19) It should also be understood that, in another embodiment, the signal conversion unit **114** may be a component capable of converting intensity signal of light received by the light receiving unit **112***b* into a digital signal representing the turbidity. It should also be understood that in another embodiment, the signal conversion unit **114** may be integrated in the light receiving unit **112***b*, so that the light receiving unit **112***b* converts intensity signal of light into turbidity related information via the signal conversion unit **114** integrated in the light receiving unit **112***b* after receiving it.
(20) With reference to FIGS. **5-7**, in the illustrated embodiment, the liquid level sensing module **110** includes, for example, a calibrator **110***a*, a winding **110***b*, a spring **110***c*, a magnet core **110***d*, a diaphragm **110***e* and a spring **110***f*. The liquid pressure is converted into an analog frequency signal (i.e., liquid level related information) representing the liquid level height via a formed LC oscillation circuit. The liquid level sensing module **110** can be connected to the connection end **120***b* and **120***c* of the connector **120** as shown in FIG. **3**, FIG. **5** and FIG. **7** via two wires (not shown in the figures) to transmit the liquid level related information sensed by the liquid level sensing module **110** to the external controller, for example, through the mating connector **200** matched with the connector **120**.
(21) In the embodiment shown in FIG. **3** and FIGS. **5-7**, the liquid level sensing module **110** uses analog output to provide the detected liquid level height information. It should be understood that, in another embodiment, the liquid level sensing module **110** can use MEMS digital output to provide the detected liquid level height information (in this way, the liquid level related information is a digital signal representing the liquid level height), wherein the structure of the bending part and the outer cover need to be adjusted accordingly.
(22) In the embodiment shown in FIGS. **3-7**, the temperature sensing module **116** is an analog sensing module outputting an analog resistance value. In another embodiment, the temperature sensing module **116** may be a digital sensing module outputting a digital signal (the temperature related information is a digital signal representing the liquid temperature). It should be understood that, in an embodiment, the sensor module **100** may include only the turbidity sensing module **112** and the liquid level sensing module **110**, but not the temperature sensing module **116**.
(23) Compared with the prior art, the sensor module **100** provided by the present invention is more

compact and space-saving in structure, can reduce cost of the product, and improves the efficiency of the installation.
(24) While the invention has been described with reference to particular embodiments thereof, the particular embodiments are provided merely as examples and are not intended to limit the scope of the invention. It will be apparent to those skilled in the art that various alterations and modifications, additions or deletions may be made to the disclosed embodiments without departing from the spirit and scope of the invention.

Claims

1. A sensor module, comprising: a housing including a first cavity and a second cavity that are in communication with each other; a liquid level sensing module mounted on the housing and sensing liquid level related information when liquid flows into the second cavity; a turbidity sensing module mounted on a section of the housing having the first cavity, the turbidity sensing module including: a light transmitting unit and a light receiving unit that are located on opposite sides of the first cavity to allow light emitted from the light transmitting unit to pass through the first cavity and to be received by the light receiving unit; and a signal conversion unit converting an intensity signal of light received by the light receiving unit into turbidity related information; a first connector electrically connected to the liquid level sensing module and the signal conversion unit; and a temperature sensing module integrated with the turbidity sensing module and sensing temperature related information of the liquid when the liquid flows into the first cavity.
2. The sensor module of claim 1, wherein the housing has a horizontal section and a bending section.
3. The sensor module of claim 2, wherein the first cavity is located at the horizontal section and the second cavity is located at the bending section.
4. The sensor module of claim 3, wherein a portion of the horizontal section is transparent.
5. The sensor module of claim 4, wherein, when the turbidity sensing module is mounted on the horizontal section, the light emitting unit and the light receiving unit are located on opposite sides of the transparent portion of the horizontal section.
6. The sensor module of claim 3, wherein an entirety of the horizontal section is transparent.
7. The sensor module of claim 3, wherein the horizontal section has an opening penetrating the horizontal section.
8. The sensor module of claim 7, wherein, when the turbidity sensing module is mounted on the horizontal section, the light emitting unit and the light receiving unit are oppositely sealed and mounted at the opening to allow light emitted from the light emitting unit to pass through the opening and to be received by the light receiving unit.
9. The sensor module of claim 3, wherein the turbidity sensing module has a circuit board on which the light emitting unit and the light receiving unit are mounted.
10. The sensor module of claim 9, wherein the circuit board is mounted on top of the horizontal section.
11. The sensor module of claim 10, wherein the horizontal section includes a first groove and a second groove located on opposite sides thereof.
12. The sensor module of claim 11, wherein, when the turbidity sensing module is mounted on top of the horizontal section, the light emitting unit and the light receiving unit are respectively fixed in the first groove and the second groove.
13. The sensor module of claim 12, wherein the turbidity sensing module further has a first protective casing and a second protective casing, the light emitting unit is accommodated in the first protective casing and the light receiving unit is accommodated in the second protective casing.
14. The sensor module of claim 13, wherein, when the turbidity sensing module is mounted on the horizontal section, the first protective casing and the second protective casing are respectively fixed

in the first groove and the second groove.
15. The sensor module of claim 9, wherein the temperature sensing module is mounted on the circuit board and located outside the first cavity.
16. The sensor module of claim 2, further comprising an outer cover adapted to the bending section and sized to shield the liquid level sensing module.
17. The sensor module of claim 1, wherein the first connector is connectable to a second connector outside the sensor module to send information sensed by the sensor module to an external controller.
18. A sensor module, comprising: a housing including a first cavity located in a horizontal section, and a second cavity that are in communication with each other, the horizontal section having an opening penetrating the horizontal section; a liquid level sensing module mounted on the housing and sensing liquid level related information when liquid flows into the second cavity; a turbidity sensing module mounted on the horizontal section of the housing having the first cavity, the turbidity sensing module including a light transmitting unit and a light receiving unit that are located on opposite sides of the first cavity to allow light emitted from the light transmitting unit to pass through the first cavity and to be received by the light receiving unit, the light emitting unit and the light receiving unit are oppositely sealed and mounted at the opening to allow light emitted from the light emitting unit to pass through the opening and to be received by the light receiving unit; and a temperature sensing module integrated with the turbidity sensing module and sensing temperature related information of the liquid when the liquid flows into the first cavity.
19. A sensor module, comprising: a housing including a first cavity located in a horizontal section, and a second cavity that are in communication with each other, the horizontal section including a first groove and a second groove located on opposite sides thereof; a liquid level sensing module mounted on the housing and sensing liquid level related information when liquid flows into the second cavity; a turbidity sensing module mounted on a section of the housing having the first cavity, the turbidity sensing module including: a light transmitting unit and a light receiving unit that are located on opposite sides of the first cavity to allow light emitted from the light transmitting unit to pass through the first cavity and to be received by the light receiving unit, the light transmitting unit and the light receiving unit are respectively fixed in the first groove and the second groove; and a circuit board mounted on the horizontal section on which the light emitting unit and the light receiving unit are mounted; a temperature sensing module integrated with the turbidity sensing module and sensing temperature related information of the liquid when the liquid flows into the first cavity.