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(54) **ROBOT VACUUM CLEANER HAVING MICROBE SENSING FUNCTION**

(76) Inventors: **Soo-hyung Choi**, Hwaseong-si (KR); **Jung-im Han**, Seoul (KR); **Soo-suk Lee**, Suwon-si (KR)

Correspondence Address:
CANTOR COLBURN, LLP
55 GRIFFIN ROAD SOUTH
BLOOMFIELD, CT 06002

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(57) **ABSTRACT**

A robot vacuum cleaner having a microbe sensing function is provided. The robot vacuum cleaner includes: a cleaner body which automatically travels in an area to be cleaned; a suction unit which sucks dust in the area to be cleaned into a specific space included in the cleaner body; a microbe contamination sensor which detects a microbe contamination in the area to be cleaned; and a sterilizing unit which sterilizes a corresponding portion according to a microbe contamination measuring signal generated from the microbe contamination sensor. Accordingly, a robot vacuum cleaner directly measures a level of microbe contamination to perform a sterilizing operation according to the result obtained from measurement. As a result, the sterilizing operation is performed sufficiently in a severely contaminated area, the sterilizing operation is performed in a general manner in other areas, and thus a cleaning operation can be rapidly carried out. Therefore, efficiencies in the cleaning and sterilizing operations are improved.

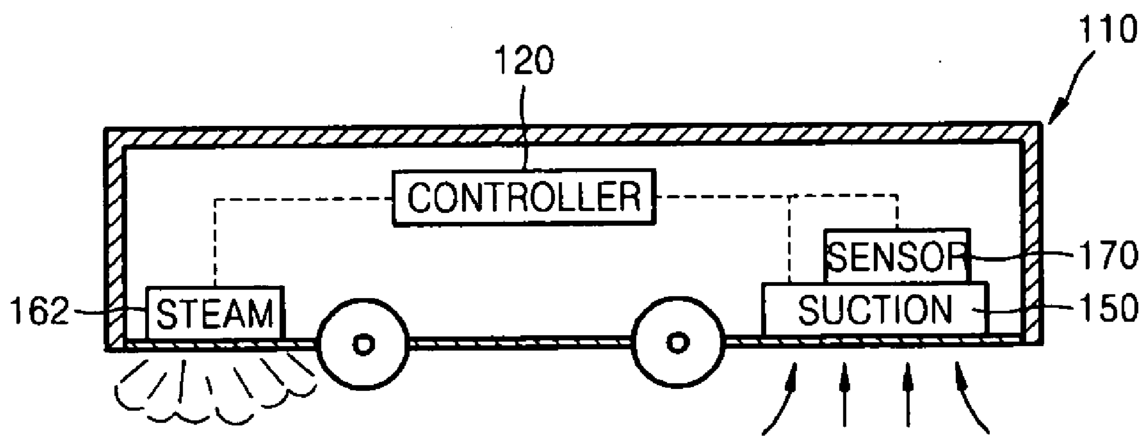


FIG. 1

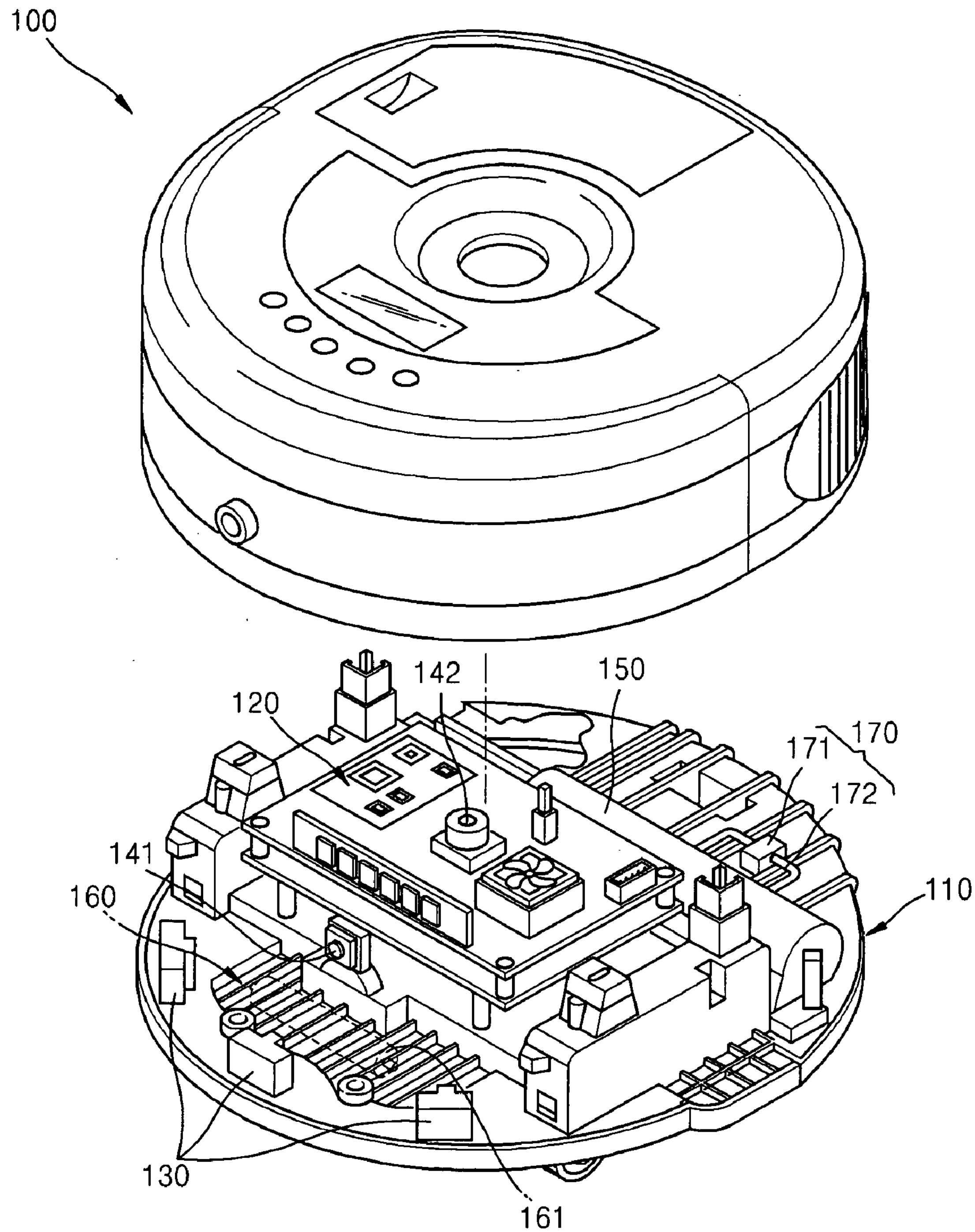


FIG. 2

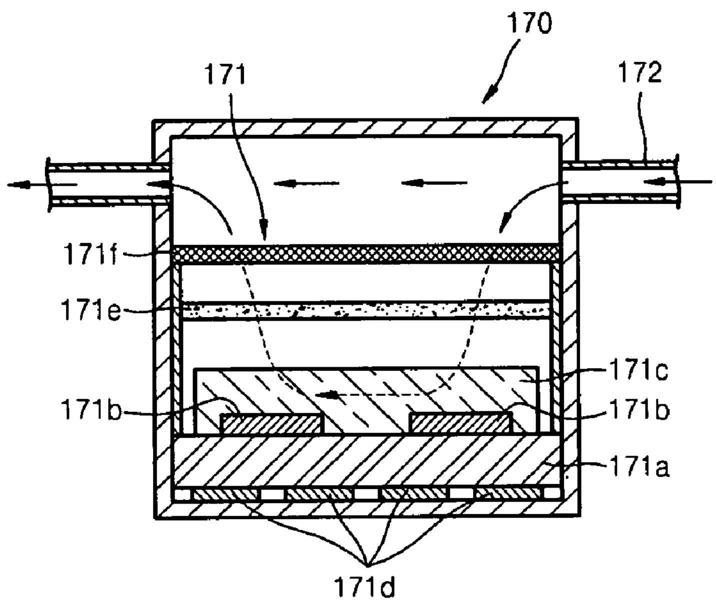
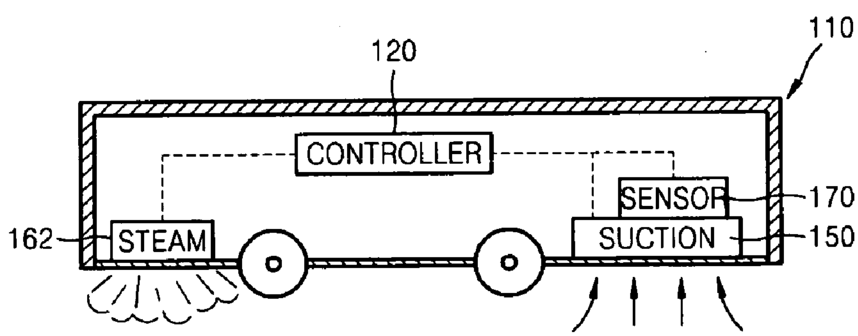

170
171
172
171f
171e
171c
171b
171b
171a
171d

FIG. 3


110
120
CONTROLLER
SENSOR
170
162
STEAM
SUCTION
150

ROBOT VACUUM CLEANER HAVING MICROBE SENSING FUNCTION

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 10-2006-0022325, filed on Mar. 9, 2006, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the invention

[0003] The present invention relates to a robot vacuum cleaner that automatically travels in an area to be cleaned in order to suck and thereby remove contaminants (i.e. dust) on the floor, and more particularly, to a robot vacuum cleaner having a microbe sensing function.

[0004] 2. Description of the Related Art

[0005] In general, a robot vacuum cleaner is an autonomous vacuum cleaner which can remove dust on the floor by suction while finding its own way around an area to be cleaned without a user's control. Such robot vacuum cleaner uses a sensor to avoid an obstacle that exists in the area to be cleaned, so that the robot vacuum cleaner can travel itself freely while changing directions without hitting into the obstacle. Thus, the robot vacuum cleaner can be conveniently used not only in a wide open space, but in a house filled with furniture, attracting a buyer.

[0006] Meanwhile, with a growing concern of respiratory ailments stemming from various bacteria and germs, there is a demand for a vacuum cleaner which can effectively eliminate not only dust but also microbe. To cope with such demand, a robot vacuum cleaner having a sterilizing function is disclosed in Korean Patent Application No. 2005-13866. The robot cleaner includes an ultraviolet ray lamp used for sterilizing, so that a sterilizing operation is performed through the ultraviolet ray lamp while a cleaning operation is carried out.

[0007] In this structure, however, it is difficult to expect that the sterilizing operation is carried out effectively. This is because the cleaning operation is carried out when a user selectively chooses on/off modes of the ultraviolet ray lamp, regardless of occurrence of a microbe contaminant in practice. The sterilizing operation can be rapidly and effectively carried out if an ultraviolet ray is intensively irradiated onto an area contaminated by a microbe, and as for other areas, the sterilizing operation is performed in a general manner. Therefore, if the cleaning operation is performed together with the sterilizing operation with respect to a whole area irrespective of the microbe contaminant, efficiency of the sterilizing operation decreases. Further, the sterilizing operation may be performed improperly because a sufficient time may not be ensured for an area required to be sterilized.

[0008] Accordingly, to solve the above mentioned problems, there is a need for a robot vacuum cleaner capable of detecting a microbe contamination.

SUMMARY OF THE INVENTION

[0009] The present invention provides an improved robot cleaner which can detect a microbe contamination to perform a sterilizing operation along with a cleaning operation.

[0010] According to an aspect of the present invention, there is provided a robot cleaner comprising: a cleaner body which automatically travels in an area to be cleaned; a suction unit which sucks dust in the area to be cleaned into a specific space included in the cleaner body; a microbe contamination sensor which detects a microbe contamination in the area to be cleaned; and a sterilizing unit which sterilizes a corresponding portion according to a microbe contamination measuring signal generated from the microbe contamination sensor.

[0011] In the aforementioned aspect of the present invention, the microbe contamination sensor may be a gas sensor which senses a particular smell component, such as 1-octen-3-ol, produced by a microbe.

[0012] In addition, the gas sensor may comprise: a substrate; a sensing layer which is laminated on the substrate and reacts with a particular smell component, thereby causing a resistance variation; an electrode which is buried on the sensing layer to measure the resistance variation; a heater which heats the sensing layer to a temperature suitable for measuring the resistance variation; a filter layer which filters a gas excluding the particular smell component so as not to be mixed into the sensing layer; and a mesh cap which prevents dust from mixing into the sensing layer.

[0013] In addition, as a main material, the sensing layer may comprise at least one main material selected from metal oxide materials of SnO2, In2O3, WO3, and SiO2, and in the sensing material, as for an additive material, at least one component selected from ZnO, Al2O3, NiO, and TiO2 may be added at the ratio of 5~15 wt % per unit weight of the main material, and as for a catalyst, at least one component of noble metals such as Pt, Pd, and Au may be added at the ratio of 0.1~1 wt % per unit weight of the main material.

[0014] In addition, the sterilizing unit may comprise an ultraviolet ray lamp and/or a steam generator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

[0016] FIG. **1** is a perspective view of a robot cleaner according to an embodiment of the present invention;

[0017] FIG. **2** is a cross-sectional view of a microbe contamination sensor used in the robot cleaner of FIG. **1**; and

[0018] FIG. **3** illustrates an example of an alternative sterilizing unit used in the robot cleaner of FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

[0019] FIG. **1** illustrates a robot cleaner **100** according to an embodiment of the present invention.

[0020] Referring to FIG. **1**, the robot cleaner **100** has a structure in which traveling, cleaning, and sterilizing operations are automatically carried out by a controller **120** included in a cleaner body **110**. Specifically, a position of the robot cleaner **100** and a position of an obstacle are detected by an obstacle sensor **130**, a front camera **141**, and an upper camera **142**, and then based on information obtained from the detection, the controller **120** allows the cleaner body **110** to automatically travel in an area to be cleaned. In this process, a suction unit **150** sucks dust, and a sterilizing unit

160 including an ultraviolet ray lamp 161 performs a sterilizing operation. The description so far is similar to that of a conventional robot cleaner disclosed in

[0021] Further, the robot cleaner **100** of the present invention includes a microbe contamination sensor **170** which detects a microbe contamination in an area to be cleaned. Specifically, unlike the conventional robot cleaner which performs a sterilizing operation using a uniform pattern in general according to on/off modes thereof, in the present invention, a feedback control is achieved in which the microbe contamination sensor **170** detects the microbe contamination, and based on the result thereof, the sterilizing operation is distinctively performed.

[0022] The microbe contamination sensor **170** is installed in a bypass pipe **172**, which is divided from the suction unit **150** so that a portion of air absorbed from the suction unit **150** can be collected and measured, and includes a gas sensor **171** which can detect a particular smell component of a microbe included in the absorbed air. If contamination occurs due to the microbe, a particular smell is produced. Here, although it is slightly different according to a microbe type, there is a common component producing the smell. The microbe contamination sensor **170** is composed of the gas sensor **171** which can sense the level of microbe contamination by sensing the particular common smell component. Thus, if a large portion of the particular smell component is sensed from an air that enters through the suction unit **150**, a signal indicating the fact is transmitted to the controller **120**, and the controller **120** then performs a distinctive sterilizing operation, for example, more time is spent to perform the sterilizing operation by using the ultraviolet ray lamp **161** for a portion that deems to be contaminated severely. The common smell component included in most microbes may be 1-octen-3-ol. Although not all strains contain such component, since a microbe found in everyday life exists in a multi-type form, it is expected that the component will be found commonly in an environment contaminated by several types of microbes.

[0023] The gas sensor **171** which senses the 1-octen-3-ol may be a semiconductor type of FIG. **2**. To measure variation in electrical resistance of a sensing layer **171***c* in response to the 1-octen-3-ol, the sensing layer **171***c* has a structure in which an electrode **171***b* and the sensing layer **171***c* are laminated on an alumina substrate **171***a*, and the variation in electrical resistance of the sensing layer **171***c* can be measured from the electrode **171***b*. A heater **171***d* heats the sensing layer **171***c* to a temperature suitable for measurement. A mesh cap **171***f* filters dust sucked from the air. A filter layer **171***e* filters other smell components except for the 1-octen-3-ol.

[0024] The semiconductor type gas sensor **171** operates by the following principles.

[0025] First, the sensing layer **171***c* includes a metal oxide material (i.e. SnO2, In2O3, WO3, or SiO2) as a main material. As for an additive material, ZnO, Al2O3, NiO, or TiO2 is added at the ratio of 5~15 wt % per unit weight of the main material. As for a catalyst, a noble metal (i.e. Pt, Pd, or Au) is added at the ratio of 0.1~1 wt % per unit weight of the main material. The metal oxide material, that is, the main material of the sensing layer **171***c*, shows absorption characteristics of oxygen when it is heated to a specific temperature in the air. The absorbed oxygen forms a potential barrier in a grain boundary of the metal oxide material, thereby hindering a carrier such as an electron from freely moving. In other words, the absorbed oxygen functions as an electrical resistance. When a reductive gas of 1-octen-3-ol comes in contact therewith, the absorbed oxygen reacts with the 1-octen-3-ol, and thus density decreases and resistance varies. The resistance variation is measured through the electrode **171***b*, and a quantity of contained 1-octen-3-ol is calculated therefrom. When the quantity of contained 1-octen-3-ol is large, it means that a microbe contaminant is severe. Whereas, when the quantity of contained 1-octen-3-ol is small, it means that a microbe contaminant is not severe.

[0026] The robot cleaner **100** including the microbe contamination sensor **170** having the above structure operates as follows.

[0027] First, when a cleaning operation begins, the cleaner body **110** travels in an area to be cleaned under the control of the controller **120**. Next, the suction unit **150** and the sterilizing unit **160** perform cleaning and sterilizing operations under the control of the controller **120**. Here, unlike the conventional case, the sterilizing operation of the sterilizing unit **160** is not performed unilaterally in the whole area to be cleaned. Instead, the sterilizing operation is selectively performed in response to a sensing signal from the microbe contamination sensor **170**. For this, the gas sensor **171** of the microbe contamination sensor **170** recognizes a quantity of contained microbe from the air entering into the bypass tube **172**, that is, a quantity of contained 1-octen-3-ol, through the following processes.

[0028] Referring to FIG. **2**, an air that enters through the bypass pipe **172** enters inside the gas sensor **171** via a mesh cap **171***f*. Here, dust in the air is filtered through the mesh cap **171***f*. The mesh cap **171***f* may include a Teflon net having a hole with a diameter of 2 μm suitable for filtering a tiny dust.

[0029] Besides the 1-octen-3-ol to be detected, ammonia and hydrogen sulfide series gases, which can function as a noise, are filtered through the filter layer **171***e* inside the mesh cap **171***f*. The filter layer **171***e* has to be non-reactive with the 1-octen-3-ol but reactive with the aforementioned ammonia and hydrogen sulfide series gases. For this reason, an active carbon or a zeolite-series material may be used.

[0030] After being filtered through the filter layer **171***e*, the gases come in contact with the sensing layer **171***c*, with the 1-octen-3-ol component being left, in general. Here, the sensing layer **171***c* is heated by the heater **171***d* to about 200~300° C., and thus a large amount of oxygen is absorbed in the grain boundary. In this state, when the oxygen reacts with the 1-octen-3-ol, an oxygen density drops, causing a resistance variation. The resistance variation is delivered to the controller **120** as an electrical signal through the electrode **171***b*. According to the signal, if it is determined that a microbe contamination occurs severely, the controller **120** controls a motion speed so that the ultraviolet ray lamp **161** of the sterilizing unit **160** can irradiate light onto a corresponding area. In some cases, intensity of the ultraviolet ray may be increased so as to enforce a sterilizing power. As for an area where the 1-octen-3-ol is rarely detected, since the microbe contamination is low, the sterilizing operation is performed in a general manner, thereby achieving fast cleaning.

[0031] Accordingly, in an area severely contaminated by the microbe, the sterilizing operation is sufficiently carried out for a longer time. Whereas, in an area rarely contaminated by the microbe, the sterilizing and cleaning operations can be both effectively carried out.

[0032] For example, the sensing layer **171***c* of the gas sensor **171** may be formed through patterning and baking by using a powder in which the aforementioned main material, additive material, and catalyst are mixed. Specifically, the electrode **171***b* and the heater **171***d* are respectively subject to patterning on the alumina substrate **171***a* which is cleaned and dried, the powder mentioned above is then subject to the patterning, and the sensing layer **171***c* is then baked. Thereafter, as described above, a sensor capable of measuring resistance is formed. When the mesh cap **171***f* including the filter layer **171***e* is covered on the sensor, the gas sensor **171** of FIG. **2** is obtained. This is only example of forming the gas sensor **171**, and various methods thereof may be used.

[0033] In addition, although the ultraviolet ray lamp **161** is used as the sterilizing unit **160** in the present embodiment, the sterilizing operation may be carried out using stream generated from a stream generator **162** shown in FIG. **3**.

[0034] Accordingly, in the present invention, a robot cleaner directly measures a level of microbe contamination to perform a sterilizing operation according to the result obtained from measurement. By doing so, the sterilizing operation is performed sufficiently in a severely contaminated area, the sterilizing operation is performed in a general manner in other areas, and thus a cleaning operation can be rapidly carried out. Therefore, efficiency of the cleaning and sterilizing operations are both improved.

What is claimed is:

1. A robot cleaner comprising:
- a cleaner body which automatically travels in an area to be cleaned;
- a suction unit which sucks dust in the area to be cleaned into a specific space included in the cleaner body;
- a microbe contamination sensor which detects a microbe contamination in the area to be cleaned; and
- a sterilizing unit which sterilizes a corresponding portion according to a microbe contamination measuring signal generated from the microbe contamination sensor.

2. The robot vacuum cleaner of claim **1**, wherein the microbe contamination sensor comprises
- a gas sensor which senses a particular smell component produced by a microbe to be detected.

3. The robot cleaner of claim **2**, wherein the particular smell component is 1-octen-3-ol.

4. The robot cleaner of claim **2**, wherein the gas sensor comprises:
- a substrate;
- a sensing layer which is laminated on the substrate and reacts with a particular smell component, thereby causing a resistance variation;
- an electrode which is buried on the sensing layer to measure the resistance variation;
- a heater which heats the sensing layer to a temperature suitable for measuring the resistance variation;
- a filter layer which filters a gas excluding the particular smell component so as not to be mixed into the sensing layer; and
- a mesh cap which prevents dust from mixing into the sensing layer.

5. The robot cleaner of claim **4**, wherein, as a main material, the sensing layer comprises at least one main material selected from metal oxide materials of SnO2, In2O3, WO3, and SiO2.

6. The robot vacuum cleaner of claim **5**, wherein, in the sensing material, as for an additive material, at least one component selected from ZnO, Al2O3, NiO, and TiO2 is added at a ratio of 5~15 wt % per unit weight of the main material, and as for a catalyst, at least one component of noble metals such as Pt, Pd, and Au is added at a ratio of 0.1~1 wt % per unit weight of the main material.

7. The robot vacuum cleaner of claim **1**, wherein the sterilizing unit comprises an ultraviolet ray lamp and/or a steam generator.

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