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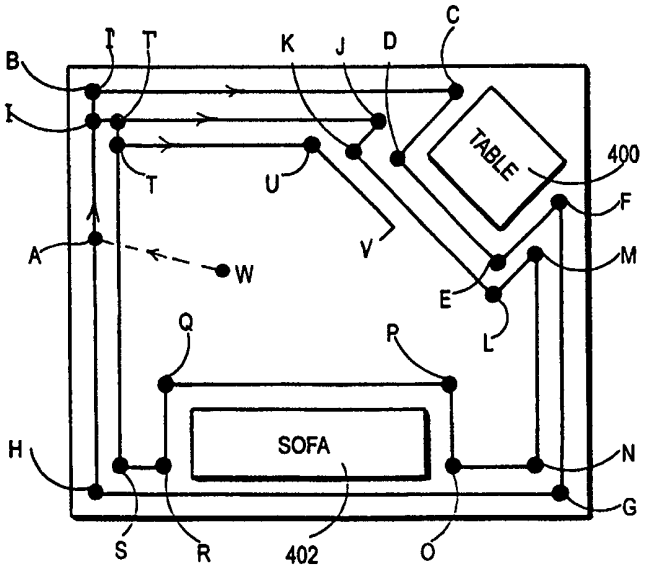

(57) Abstract

A robotic floor cleaning device is arranged so that it firstly completes a traverse around the edge of a room (A–I), avoiding any obstacles in its path, and then moves inwards (at I) and completes a second traverse of the room. The cleaning device continues to move inwards after each traverse (e.g. at T) so as to travel in a generally inwardly spiral manner until the floor of the room, apart from areas occupied by obstacles (400, 402), has been cleaned. Preferably, the distance by which the cleaning device moves inwardly after each traverse of the room is substantially the width of the cleaning head of the cleaning device, or a distance set by the user. The cleaning device seeks a wall of the room if it is started from a position (W) away from a wall. The cleaning device can determine when it has completely traversed a room.

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IMPROVEMENTS IN OR RELATING TO FLOOR CLEANING DEVICES

This invention relates to a robotic floor cleaning device, a method of operating a robotic floor cleaning device, and to software and a control apparatus for performing the method. The invention can be used in a robotic vacuum cleaning device.

There have been a number of proposals to provide robotic or autonomous vacuum cleaning devices which can clean a floor area without the need for a human user to push or drag the cleaning device along the floor. It is known to provide vacuum cleaners which are fed a detailed map of a room and which are then trained to reciprocate to and fro from one side or one end of a room to the other side or other end of the room. It is also known to provide a robotic vacuum cleaner which is lead around a room in a training cycle and which will then repeat the cycle from information stored in memory. A robotic vacuum cleaner has also been proposed which travels round the edge of a room and then moves about the room in a random fashion deflecting off obstacles as it moves around.

DE 35 36 974 A1 shows a floor cleaning device which performs a spiralling path over a surface to be cleaned. It requires a wet or dust trail to be deposited on the surface to be cleaned in order that the machine can follow this spiral path.

The present invention seeks to provide a robotic vacuum cleaner which minimises or overcomes disadvantages with the prior art. In particular, the present invention seeks to provide a robotic vacuum cleaner that can cover a floor area without the need for advance knowledge of the layout of the floor area and which does not leave a trail on the floor.

A first aspect of the present invention provides method of operating a robotic floor cleaning device so that the floor cleaning device:

(a) firstly completes a traverse around the edge of a room (or around a feature of the

room or an object in the room) avoiding any obstacles in its path, monitoring and storing information from detectors during the traverse, and

(b) when it is determined that monitored information from detectors is the same or substantially the same as previously stored information, the floor cleaning device moves inwards (or outwards) and completes a second traverse, the cleaning device continuing to move inwards (or outwards) after each traverse so as to travel in a generally inwardly (or outwardly) spiral manner until the floor of the room, apart from areas occupied by obstacles, has been cleaned.

Another aspect of the invention provides a robotic floor cleaning device comprising: power operated means for moving the cleaning device along the floor, and a navigation system, including sensors and a memory means, for navigating the cleaning device around the room, the navigation system being arranged to: (a) firstly cause the cleaning device to complete a traverse around the edge of a room (or around a feature of the room or an object in the room) avoiding any obstacles in its path, monitoring and storing information from the sensors in the memory during the traverse, and (b) when it is determined that monitored information from the sensors is the same or substantially the same as previously stored information, cause the device to move inwards (or outwards) and complete a second traverse, the device continuing to move inwards (or outwards) after each completed traverse so as to travel in a generally inwardly (or outwardly) spiral manner until the floor of the room, apart from areas occupied by obstacles, has been cleaned.

By following a spiralling pattern, the floor cleaning device can cover the complete floor area in an efficient manner. This method has the advantage that the floor cleaning device does not need to be programmed with advance knowledge of the layout of the floor area, or the need to maintain a cartesian map of the floor area. This can simplify the processing requirements of the controller of the cleaning device and avoids the need for a user to train the device or to load and update a map of the floor area that the device is to clean. Thus, the cleaning device can easily cope with different room layouts. It also does not require the cleaning device to leave a trail on the floor during the cleaning operation so that the

device can determine where it has previously travelled within the room.

Each further step inwards (or outwards) occurs when a comparison of monitored information from the sensors with previously stored information indicates that the present position of the cleaning device is the same, or almost the same, as a position that the cleaning device has visited on the same circuit.

A further problem with known robotic floor cleaning devices that have no advance knowledge of the layout of the floor area that they are cleaning is that they are incapable of determining when they have completely traversed the floor area. By performing an inwardly spiralling coverage pattern of the floor area, the cleaning device progresses methodically towards the centre of the room. The cleaning device can determine when it has reached the middle of the room. One way for determining when the cleaning device has completely traversed a floor area is to associate stored information from each traverse, or circuit, of the floor area into strands and to determine when the strands converge, indicating that the floor area has been completely traversed. Any stored data which is not part of a strand that has converged is indicative of a part of the floor area that has not been completely traversed.

The navigation system of the cleaning device can store information about the direction at which the cleaning device turns at each of the points where it stores sensor information. This can be used on later circuits to help the cleaning device in deciding which way to turn.

The floor cleaning device carries a cleaner head or other cleaning mechanism that is generally of the same or similar width as the cleaning device. It will be appreciated that the stepping inwardly or outwardly during the spiralling method is based upon the effective width of the cleaning mechanism carried by the cleaning device so that the floor area is properly covered. Preferably the stepping distance is substantially one width of the cleaner head, or slightly less than one width of the cleaner head so that each traverse slightly overlaps with the previous traverse. This ensures full coverage of the floor area

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