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(71) Applicant: **Candy S.p.A.**
20900 Monza (MB) (IT)

(72) Inventor: **Fumagalli, Aldo**
20900 Monza MB (IT)

(74) Representative: **Perani & Partners S.p.A.**
Piazza Armando Diaz, 7
20123 Milano (IT)

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(54) **METHOD FOR AUTOMATICALLY ASSESSING THE DISPLACEMENT OF AN OBJECT IN A WASHING AREA OF A DISHWASHING MACHINE**

(57) The present disclosure relates a method of automatically assessing the displacement of an object (S, 5, 7) in a washing area (2) of a dishwashing machine (1) having optical means (8) and a user interface (9). The

method includes acquiring, processing and comparing various images to check whether the object (S, 5, 7) has moved, to indicate a change-of-operating-state condition (16A) through said user interface (9).

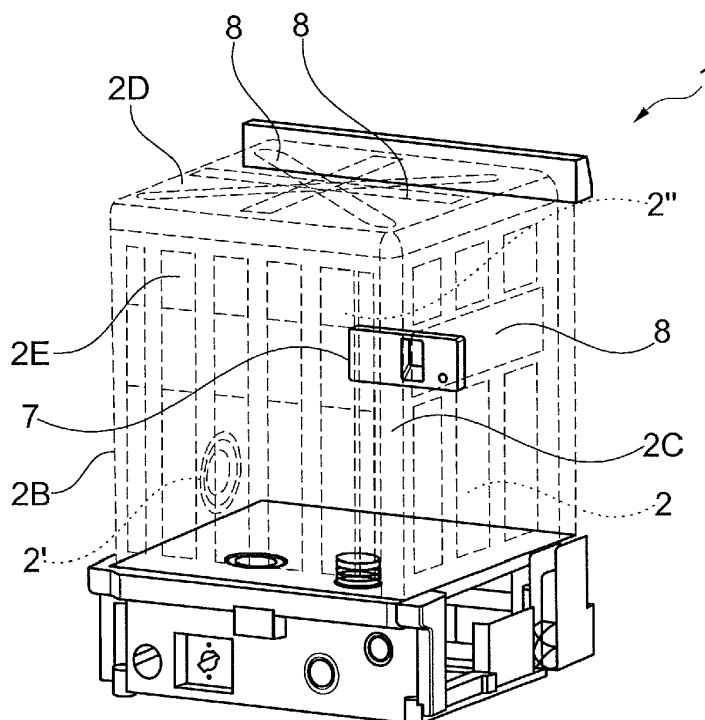


Fig. 3

Description

Field of The Invention

[0001] The present disclosure relates to a method of automatically assessing the displacement of an object in a washing area of a dishwashing machine, as defined in the preamble of claim 1.

[0002] The present disclosure also relates to a dishwashing machine configured to carry out the method of automatically assessing the displacement of an object in a washing area, as defined in the preamble of claim 10.

[0003] The present disclosure further relates to a system composed of a dishwashing machine and a user-handheld portable device configured to carry out the method of automatically assessing the displacement of an object in a washing area, as defined in the preamble of claim 13.

Discussion of the related art

[0004] Dishwashing machines are known in the art, which are equipped with optical devices such as still cameras, video cameras or camcorders, located in a fixed or moving position relative to the washing chamber to check the dishware load or degree of cleaning.

[0005] For example, WO2016008699 and US 2012/0138092 disclose such dishwashing machines.

Problem of the prior art

[0006] During operation of a dishwashing machine of the above-discussed type, conditions may occur that might degrade the washing and drying performance on the entire load and/or on part of the dishware loaded in the washing area.

[0007] This may be also caused by the fact that, in certain cases, the dishware loaded on the racks by a user might:

- be displaced due to unstable positioning thereof on the rack;
- be displaced due to the mechanical action of the washing fluid;
- be displaced due to water weight;
- block the rotation of the impellers used to distribute the fluid on the dishware;
- block the detergent dispenser door.

SUMMARY OF THE INVENTION

[0008] The object of the present invention is to provide a method, a dishwashing machine and a system for assessing whether the objects in the washing zone have changed their position, to avoid the above described prior art problems.

[0009] This object is fulfilled by a method, a dishwashing machine and a system for automatically assessing

the displacement of an object in a washing area of a dishwashing machine as defined in the following claims 10 and 13, respectively.

Advantages of the Invention

[0010] One embodiment of the present invention provides a method and a corresponding dishwashing machine as well as a system composed of a dishwashing machine and a user-handheld portable device that can be used to identify the displacement of objects inside the washing zone of a dishwashing machine, in view of taking actions and restoring the conditions for proper positioning of the objects, thereby reducing the need to wash part of the dishware and/or repeat the washing cycle, leading to water, detergent and power consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The characteristics and advantages of the present disclosure will appear from the following detailed description of a possible practical embodiment, illustrated as a nonlimiting example in the set of drawings, in which:

- Figure 1 shows a flowchart of the method of the present invention;
- Figure 2 shows a front perspective view of a built-in dishwashing machine with the omission of the finishing panels, which is configured to carry out the method of Figure 1;
- Figure 3 shows a rear perspective view of the dishwashing machine of Figure 2 with the omission of some of its parts and the dishware;
- Figure 4 shows a detail view of a zone proximate to the dispenser, when the latter is equipped with an optical device of the dishwashing machine of Figure 2, according to the present invention;
- Figure 5 shows a cross sectional view as taken along line V-V of Figure 4.

DETAILED DESCRIPTION

[0012] Even when this is not expressly stated, the individual features as described with reference to the particular embodiments shall be intended as auxiliary to and/or interchangeable with other features described with reference to other exemplary embodiments.

[0013] Referring to the accompanying figures 2 to 5, numeral 1 designates a dishwashing machine, e.g. of built-in type, located in a kitchen cabinet, the finishing panels being omitted for better illustration of the internal volumes.

[0014] This dishwashing machine 1 comprises a washing area 2 and a door 3 adapted to be closely associated with the washing area 2.

[0015] The dishwashing machine 1 identifies a base 1A, usually designed to accommodate the mecha-

nisms/devices required to carry out the specific operations of the machine 1.

[0016] The washing area 2 defines the volume in which the objects S, 5 and 7 to be monitored are arranged.

[0017] Namely, the washing area 2 is defined by a plurality of walls, such as the base wall 2A, the side walls 2B and 2C, the ceiling 2D and the bottom wall 2E and identifies an upper portion 2' and a lower portion 2".

[0018] The terms upper/lower shall be intended to be related to a proper installation and operation condition of the dishwashing machine 1. Here, the term upper designates the portion that is farther from the base 1A, and the term lower designates the portion that is closer to the base 1A.

[0019] The door 3 can be manually operated by the user and/or be power-assisted and has the purpose of hermetically closing the washing area 2 to avoid leakage of washing liquids while the cleaning program is being executed.

[0020] The term object S, 5 and 7 shall be intended hereinafter as:

- a dishware item S, such as a dish, a piece of cutlery, a glass, a pot, or
- a part of the dishwashing machine itself, such as an impeller 5 for introducing washing liquid into the washing area or a door 7 of a detergent-containing dispenser 6.

[0021] The impellers 5 are well known in the art and will not be further described herein. It shall be simply noted that one or preferably two impellers may be located in the washing area. Namely, the first impeller is located in the lower area 2' proximate to the base 1A and the other is located in the upper area 2", preferably in the lower portion of the upper area.

[0022] A dish rack 21 is situated in the lower area 2' and/or the upper area 2", and has the purpose to accommodate the dishware S, in a manner that is known in the art and will not be further described herein.

[0023] The dishwashing machine 1 comprises a dispenser 6 whose shape defines a volume adapted to accommodate the products required to clean the objects, particularly the dishware.

[0024] For example, these products may be detergent powders or tabs, but also a gel.

[0025] The dispenser 6 may comprise one or more compartments, each designed to receive a particular washing product.

[0026] In one aspect, the dispenser 6 comprises a door 7 which is configured to move between a closed position and a position allowing free access to the internal volume of the dispenser 6.

[0027] For example, when the door 7 is in the closed position, products cannot come out of their respective compartments, and when the door 7 is in the open position, these washing products are allowed to come out.

[0028] The door 7 is moved between the closed posi-

tion and the open position by being mechanically and/or electrically controlled by the control unit 4, once the door 3 of the dishwashing machine 1 has been closed.

[0029] In one aspect, also referring to Figure 4, the dispenser 6 is placed on the door 3, and particularly on the side facing the washing area 2, at a predetermined height. More particularly, the dispenser 6 is housed within the thickness of the door 3.

[0030] The dishwashing machine 1 comprises a control unit 4, e.g. situated within the thickness of the door 3, which has a motherboard with the usual electrical and electronic devices located thereon, including a CPU, a number of I/O ports for receiving and transmitting data, a memory bank, a portion whereof being designed to permanently store at least one cleaning program.

[0031] The control unit 4 is a unit configured to control and supervise the operating functions of the dishwashing machine 1.

[0032] In one embodiment of the present invention, the memory of the control unit 4 is designed to also permanently store a database in which the contours of the objects S, 5 and 7 are identified by means of appropriate parameters.

[0033] The objects S, 5 and 7 are advantageously identified in the database by one or more digital parameters that can represent the contour of the objects S, 5 and 7. For example, for an impeller 5 or the door 7 of the dispenser 6, the so-called mathematics that represent these devices are already known to the manufacturer of the dishwashing machine 1, but the dishware S is designed to be identified using a particular imaging process.

[0034] In order to execute the selected cleaning program, the dishwashing machine 1 comprises a pump, for example arranged in the base 1A, which is adapted to be connected, in a manner that is known to a skilled person and will not be described herein, to a water mains supply.

[0035] For example, this pump is controlled by a solenoid valve and has the purpose of withdrawing water from the mains and supply it to the impellers 5 arranged in the washing area 2.

[0036] The dishwashing machine 1 comprises one or more optical devices 8 that can capture digital images of the washing area 2.

[0037] In one aspect, the optical devices 8 are arranged with their optical system facing the washing area 2.

[0038] Namely, each wall 2A, 2B, 2C, 2D and/or 2E of the washing area 2 can accommodate one or more of the aforementioned optical devices 8 in its thickness,

[0039] A housing 2F for each optical device 8 is provided for this purpose.

[0040] The housing 2F defines a volume adapted to accommodate its respective optical device and a light-transparent covering panel 8A preferably covers the optical system of the optical device.

[0041] This covering panel 8A is made, for example, of glass or plastic or materials having similar technical

properties.

[0042] The covering panel 8A is preferably arranged substantially flush with or slightly projecting out of the surface of the wall 2A, 2B, 2C, 2D or 2E.

[0043] Particularly referring to Figure 5, the housing 2F formed in the thickness of the door 3 of the dishwashing machine 2. As shown in this Figure 5, all the electrical and electronic parts required for the operation of the optical device 8 are accommodated in the housing 2F.

[0044] The purpose of the optical devices 8 in the dishwashing machine 1 is to capture still and/or sequential two-dimensional digital images at predetermined capturing speeds, usually in the visible range of the electromagnetic spectrum, such as a single frame, or a burst of images, or an seamless stream of images of the washing area 2 and particularly of the objects S, 5, 7 in this washing area.

[0045] For example, still referring to Figure 5, it may be appreciated that the optical device 8 has a field of view 8B, allowing acquisition of images of the objects S, 5 and/or 7 that fall within such field of view.

[0046] These optical devices 8 are in signal communication with the control unit 4 via the I/O ports of the latter to send the acquired data to the control unit 4.

[0047] The optical devices 8 are embodied, for example, by a still camera and/or a video camera. These devices are known in the art and will not be described in further detail herein.

[0048] Nevertheless, it shall be noted that the still camera and/or the video camera as used in the dishwashing machine 1 preferably comply with the technical specifications for operation with water, i.e. the still camera and/or the video camera comply with the standard IP x(1-8).

[0049] Instead of or in addition to these technical specifications, the housing 2F in which the optical devices 8 are placed, is configured to be watertight, e.g. using sealing techniques.

[0050] The dishwashing machine 1 comprises a user interface 9, i.e. the control and monitoring interface through which the user may control and manage the operation and functions of the dishwashing machine.

[0051] For this purpose, the user interface 9 is in signal communication with the control unit 4 via the I/O ports of the latter to receive the data processed by the CPU of the control unit.

[0052] In one embodiment, the user interface 9 is a screen 23 which is integrated in the dishwashing machine 1 to be visible by a user during normal operation and/or with the addition of a buzzer (not shown).

[0053] In one aspect, still referring to figures 1 and 2, the user interface 9 is integrated in the door 3 with such an orientation that the screen faces out of the washing area 2.

[0054] It shall be noted that the screen of the user interface 9 is configured to display light indications, text messages and/or single or continuous images. Namely, the images displayed on screen may be the images of

the washing area 2 and the objects therein provided acquired by the optical devices 8. Particularly, the screen may be a touch (i.e. touch sensitive) screen.

[0055] In another embodiment, the user interface 9 comprises one or more analog buttons and/or a combination of analog/digital controls and/or a combination of analog/digital controls and a screen, the latter being, for instance, a touchscreen.

[0056] The buzzer of the user interface 9 has the purpose of providing acoustic warnings of any situations or operating conditions to the user.

[0057] In one embodiment, the dishwashing machine 1 comprises a radio transmitting/receiving apparatus, which is configured to provide signal communication with a wired and/or wireless network. For instance, the wireless network may be an Internet protocol-based network that uses a WI-FI connection or a Bluetooth-based WPAN (Wireless Personal Area Network).

[0058] In this case, the user interface 9 also comprises a portable device (i.e. a device that can be carried and held in a user's hand) 22 such as a smartphone, a tablet, a PC or similar instruments.

[0059] In other words, the user interface 9 comprises both the usual control interface of the dishwashing machine 1 and the screen of a portable device 22.

[0060] Particularly, the portable device 22 has its own radio transmitting/receiving apparatus, which is configured to establish a signal communication with the radio transmitting/receiving apparatus of the dishwashing machine 1.

[0061] In one aspect, the portable device 22 is not only able to communicate with the control unit 4 of the dishwashing machine 1, but also to connect through the Internet network, for example via a GSM infrastructure, to one or more remote servers 24 to carry out storage, saving and/or data processing operations on the images that have been captured by the optical devices 8.

[0062] In other words, the portable device 22 is adapted to connect either directly with the dishwashing machine 1 and with the Internet network via the GSM infrastructure. Thus, a system 25 is provided which comprises the dishwashing machine 1, the portable device 22 which are in signal communication with each other via the GSM network, a WI-FI connection and/or a WPAN.

[0063] It shall be noted that the screen of the portable device 22 is configured to display light indications, text messages and/or images captured by the optical devices 8.

[0064] In one embodiment of the present invention, if the user interface 9 also includes the portable device 22, then the database in which the contours of the objects S, 5 and 7, are identified through appropriate parameters may be stored at least partially, preferably entirely, in the memory of the portable device 22, in a mass storage of the server and/or be distributed in the memories of the dishwashing machine 1, the portable device 22 and the server 23.

[0065] In one aspect, the control unit 4 is in signal com-

munication with the user interface 9 (provided either as the screen of the dishwashing machine 1 or as a screen of the portable device) to transmit changes of the operating state of the dishwashing machine 1.

[0066] As used herein, a change of the operating state is intended to designate any change of the function of the dishwashing machine 1 resulting from the displacement of one or more objects S, 5 or 7 to a position that cannot ensure proper operation, i.e. to a state in which one or more problems occur.

[0067] In one aspect, these problems particularly include:

- a component 5, 7 of the dishwashing machine that has not been displaced from its initial position, e.g. because it is blocked by a dishware item, and/or
- a dishware item S that has moved from its initial position, for instance to such a position in which it cannot be properly washed and/or dried or to a position in which it will block the movement of the components (for example the rotation of the impellers, or the movement of the door of the dispenser from the closed configuration to the open configuration) of the dishwashing machine.

[0068] In one embodiment, the identification of one or more of the aforementioned problems does not affect the execution of the cleaning program, i.e. the cleaning program that has been set will be completed in spite of the detected problem/s.

[0069] Alternatively, upon detection of one or more of the aforementioned problems, the cleaning program is designed to be stopped either automatically, i.e. by the control unit 4, or manually, i.e. by the user. This situation is restored as soon as the user solves the detected problems, for the initially selected program to be completed.

[0070] In a further alternative embodiment, upon detection of one or more of the aforementioned problems, the cleaning program may be designed to be changed, or modified automatically by the control unit 4, to account for the detected problem.

[0071] For example, in case of changes to the cleaning program, if for instance, the detected problem is a displacement of a dishware item S from its reference position (which affects the washing efficiency), the cleaning program being executed may be changed by the control unit 4 by increasing the water supply time (i.e. duration) to compensate for the detected problem.

[0072] Therefore, the visual indications that can be displayed on the screen of the user interface 9, in addition to the usual indications known in the art, can provide warning of possible changes of the operating states of the dishwashing machine 1.

[0073] Referring now to Figure 1, the method of automatically assessing the displacement of an object S, 5 and/or 7, i.e. a dishware item and/or of a component of the dishwashing machine 1 in a washing area 2, includes a step 10 of providing a plurality of objects S, 5, 7 in the

washing area 2.

[0074] It shall be noted that the method steps as described hereinbelow, i.e. the steps of acquiring, processing, filtering, comparing and dividing may be carried out either directly by the CPU of the control unit 4 or more preferably by the CPU of the portable user device via the Internet connection with the CPU of remote servers for analysis and data processing.

[0075] The method comprises a step of acquiring a first digital image 11 representative of the plurality of objects S, 5 and/or 7.

[0076] This acquisition step is carried out through the or optical device/s 8 located in the washing area 2.

[0077] The first digital image is preferably acquired after closing the door 3 but before starting the cleaning program.

[0078] For this purpose, the control unit 4 supervises the acquisition step by controlling the or optical device/s 8 once the door 3 has been closed before the start of the cleaning program.

[0079] Once the first image has been acquired, the method comprises a step 12 of digitally processing the first acquired image 11 to obtain a first processed image 12A; wherein said first processed image 12A defines a first contour for each object of said plurality of objects S, 5 and/or 7.

[0080] In other words, the control unit 4 and/or the portable user device starts a process in which the first image 11 is processed to define the contour of each of the objects S, 5 and/or 7 in the washing area 2, which may be either dishware and/or components of the dishwashing machine.

[0081] It shall be noted that the first processed image 12A represents the initial image, i.e. an image of the initial arrangement of the objects S, 5 and/or 7 whose displacement is to be assessed.

[0082] The method comprises a filtering step 13 that, based on the first contour of each object, filters the first processed image 12a to obtain a first filtered image 13A. This first filtered image 13a defines a first group of objects 13B, this first group of objects representing the objects 5 and/or 7 of the plurality of objects S, 5 and/or 7 that are movable relative to the washing area 2.

[0083] In other words, by applying the filter 13, the contours of the objects in the first processed image 12A may be distinguished to obtain a first filtered image 13A that only contains the contours of the objects that are movable relative to the washing area 2.

[0084] Therefore, the first group of objects 13b comprises the objects that are expected to move relative to the washing area 2 during the cleaning program, being these objects components of the dishwashing machine 1. These objects of the first group of objects 13b are, for example, the impeller/s 5 and the door 7 of the dispenser 6.

[0085] The impeller/s 5 must move relative to the washing area to introduce an uniform flow of water and detergent products into the washing area 2 The movement is

a rotary movement about a central point, which is typically the center of gravity.

[0086] Likewise, for the detergent materials to be mixed with water, the door 7 of the dispenser 6 is required to move from the closed configuration to the open configuration.

[0087] The filtering step 13 may be implemented, for example, by comparing the contours that have been identified with the contours stored in a database that resides in the memory of the control unit 4 or in the memory of the portable user device or in a server remote from both the dishwashing machine 1 and the user hand-held device.

[0088] Namely, the contours of the impellers 5 and/or the door 7 of the dispenser 6 are known to the manufacturer of the dishwashing machine 1 and can be stored beforehand and directly compared with those in the first processed image 12A.

[0089] The other contours in the first processed image 12A, i.e. the contours that are not part of the first group 13B, belong to a second group of objects 13D which, as described below, defines the objects S that are stationary relative to the washing area 2.

[0090] As used herein, the term objects that are stationary relative to the washing area 2 or movable relative to the washing area 2 is intended to indicate that:

- in the former case, the spatial coordinates identifying one or more characteristic features of the objects (e.g. the edge of a dish, the bottom of a glass, etc.) will be unchanged with respect to the reference system represented by the washing area 2 during the cleaning program (i.e. the coordinates are time-invariant during the cycle of the cleaning program);
- in the latter case, the spatial coordinates identifying one or more characteristic features of the objects (e.g. the end of an impeller, the edge of the dispenser door, etc.) will change with respect to the reference system represented by the washing area 2 during the cleaning program (i.e. the coordinates are time-variant during the cycle of the cleaning program).

First group of objects 13B

[0091] The method comprises the step of acquiring a second image 14 representative of the first group of objects 13B once a first preset period of time T1 has elapsed from the start of a cleaning program.

[0092] Preferably, this first period of time T1 must be greater than a few seconds, affording a check on whether the objects of the first group 13b have moved or are moving in the washing area 2.

[0093] In a preferred embodiment, this first period of time T1 is greater than three seconds and not greater than four minutes. During this interval, a check may be made on whether the impeller/s 5 are rotating and that the door 7 of the dispenser 6 has been actually opened.

[0094] In one aspect, the optical devices 8 that are pref-

erably used to acquire the second image 14 are those placed in the lower portion 2' of the washing area 2.

[0095] The method comprises a step 15 of digitally processing the second acquired image 14 to obtain a second processed image 15A, wherein this second processed image 15A defines a second contour for each object of said first group of objects 13B.

[0096] The method comprises a step 16 of comparing the first filtered image 13A with the second processed image 15A to assess whether the first contour of each object of said first group of objects 13B coincides with the respective second contour and, if it does, notifying 16A a critical change-of-operating-state condition through the user interface 9.

[0097] In other words, once the period T1 after the start of the cleaning program has elapsed, the control unit 4 will actuate the optical device/s 8 to acquire the second image 15A to check whether the contour of the objects of the first group of objects 13b has been moved or is moving.

[0098] In the case of the impeller/s 5, the control unit 4 can check whether they are moved, to indicate a first critical condition 16A through the user interface 9, if an obstacle blocks their movement.

[0099] This also applies to the door 7 of the dispenser 6.

[0100] Therefore, the signal associated with the first critical condition 16A allows the user to learn through the interface 9 whether:

- the rotation of the impeller/s 5 is blocked or hindered,
- the door 7 of the dispenser has not been opened.

[0101] In one aspect, downstream from (or possibly at the same time as) the step of indicating the first critical condition 16A, the cleaning program is designed to proceed as expected, be changed in response to this first critical condition 16A that has been detected or stopped until the normal operating conditions will be restored.

Second group of objects 13D

[0102] The step of filtering 13 according to the first contour of each object can filter the first processed image 12a to additionally or alternatively obtain a second filtered image 13C, the second filtered image defining a second group of objects 13D.

[0103] This second group of objects 13D represents the objects S of the plurality of objects S, 5 and 7 that are stationary relative to the washing area 2.

[0104] As mentioned above, the objects that are required to be stationary relative to the washing area 2 are the dishware S.

[0105] The method comprises a step of acquiring a third image 18 representative of the second group of objects once a second preset period of time T2 has elapsed from the start of the cleaning program.

[0106] Preferably, this second period of time T2 must

be greater than a few seconds, affording a check on whether the objects of the second group are still, i.e. do not move in the washing area 2.

[0107] In one embodiment, this second period of time T2 is greater than one minute.

[0108] In one aspect, the optical devices 8 that are preferably used to acquire the third image 18 are those placed in the side walls 2B and 2C.

[0109] The method comprises the step 19 of digitally processing the third acquired image 18 to obtain a third processed image 19A, wherein this third processed image 19A defines a second contour for each object of said second group of objects 13D.

[0110] The method comprises a step 20 of comparing the second filtered image 13C with the third processed image 19A to assess whether the first contour of each object of the second group of objects 13B coincides with the respective second contour and, if it doesn't, notifying 20A a critical change-of-operating-state condition through the user interface 9.

[0111] In order to make sure that the first group of objects is movable during the cleaning program, or more particularly when the cleaning program requires the impellers to be movable, the method includes repeating the steps 14, 15 and 16, namely acquiring the second image representative of the first group of objects 13B, once the first preset period of time T1 from the start of the cleaning program has elapsed, at regular or random intervals, to thereby provide a plurality of second images, spaced in time, representative of the position of the first group of objects 13B relative to the washing area 2.

[0112] By this repetition of the steps 14, 15 and 16, a comparison may be made with the first filtered image 13A, to assess whether the first contour of each object of the first group of objects 13B coincides with the respective second contour and, if it does, notifying 16A the change-of-operating-state condition through the user interface 9.

[0113] In other words, the control unit 4 instructs the optical device/s 8 to acquire additional second images 14, the acquisition occurring at regular or random intervals. These second images 14 are processed to define the new contours of the objects. These new contours are compared with the respective contours of the first filtered image 13A to assess whether a displacement has occurred. If the contours coincide, a change of the operating state is notified through the user interface 9.

[0114] *Mutatis mutandis*, the method comprises the same procedure for the second group of objects 13D, with the exception that a change of the operating state is notified if the new contours do not coincide with those of the second filtered image.

[0115] Particularly, the method includes repeating the steps 18, 19 and 20 to assess, by a comparison with the second filtered image 13C, whether the first contour of each object of the second group of objects 13D coincides with the respective second contour and, if it doesn't, notifying 20A a second critical change-of-operating-state

condition through the user interface 9.

[0116] Therefore, the signal associated with the second critical condition 20A allows the user to learn through the interface 9 whether the dishware S have changed their position.

[0117] In one aspect, downstream from (or possibly at the same time as) the step of indicating the second critical condition 20A, the cleaning program is designed to proceed as expected, be changed in response to this second critical condition 20A that has been detected or stopped until the normal operating conditions will be restored.

[0118] In one aspect, i.e. the processing steps 12, 15 and 19 comprise a process through which the images 13A, 13C are divided, with a reference grid being placed thereon, to compare the grid with the respective grid of the images 15A and 19A acquired at later times.

[0119] Particularly, by comparing the spatial position of the contours of the acquired objects S, 5 and 7 in the images 13A, 13C, with the respective grids as a reference, with the contours of the objects S, 5 and 7 of the images 15a and 19A acquired at later times, with the new respective grids as a reference, an assessment may be made of whether the objects of the first group 13b have moved or the objects of the second group are still stationary relative to the washing area 2. The comparison of the contour of an object that lies within a grid of the initial image with the corresponding grid of the next image in time allows appreciation of a possible displacement (or non-displacement) of the object being captured.

[0120] As mentioned above, the method and the dishwashing machine 1 allow a change of the operating state of the machine to be notified through the user interface 9, allowing actions to be taken to restore the proper installation conditions of the object. This will reduce the need to wash part of the dishware and/or repeat the washing cycle, leading the water, detergent and power consumption.

[0121] Those skilled in the art will obviously appreciate that a number of changes and variants as described above may be made to fulfill particular requirements, without departure from the scope of the invention, as defined in the following claims.

Claims

1. Method of automatically assessing the displacement of an object (S, 5, 7) in a washing area (2) of a dishwashing machine (1), said dishwashing machine comprising a door (3), designed to be associated with said washing area (2) to close it, and being configured to implement a cleaning program and to be in signal communication with a user interface (9), the method comprising the steps of:

- providing (10) a plurality of objects (S, 5, 7) in said washing area (2);
- acquiring a first digital image (11) representa-

tive of said plurality of objects (S, 5, 7);

- digitally processing (12) said first acquired image (11) to obtain a first processed image (12A); wherein said first processed image (12A) defines a first contour for each object of said plurality of objects (S, 5, 7);

- according to said first contour of each object, filtering (13) said first processed image (12A) to obtain a first filtered image (13A), wherein said first filtered image (13A) defines a first group of objects (13B), wherein said first group of objects (13B) represents the objects (5, 7) of said plurality of objects (S, 5, 7) that are movable relative to the washing area (2) during said cleaning program, said first group of objects (13B) comprising at least one component of said dishwashing machine (1);

- acquiring a second digital image (14) representative of said first group of objects (13B) once a first preset period (T1) has elapsed from the start of a cleaning program;

- digitally processing (15) said second acquired image (14) to obtain a second processed image (15A), wherein said second processed image (15A) defines a second contour for each object of said first group of objects (13B);

- comparing (16) said first filtered image (13A) with said second processed image (15A) to assess whether the first contour of each object of said first group of objects (13B) coincides with the respective second contour and, if it does, notifying a first critical change-of-operating-state condition (16A) through said user interface (9);

- said method **being characterized by the steps of:**

- according to said first contour of each object, filtering said first processed image (12A) to obtain a second filtered image (13C), wherein said second filtered image (13C) defines a second group of objects (13D), wherein said second group of objects (13D) represents the objects of said plurality of objects (S, 5, 7) that are fixed relative to the washing area (2) during said cleaning program;

- acquiring a third image (18) representative of said second group of objects once a second preset period (T2) has elapsed from the start of a cleaning program;

- digitally processing (19) said third acquired image (18) to obtain a third processed image (19A), wherein said third processed image (19A) defines a second contour for each object of said second group of objects (13D);

- comparing (20) said second filtered image

(13C) with said third processed image (19A) to assess whether the first contour of each object of said second group of objects (13D) coincides with the respective second contour and, if it does not, notifying a second critical change-of-operating-state condition (20A) through said user interface (9).

2. A method as claimed in claim 1, wherein said step of acquiring said first digital image (12) occurs once said door (3) has been closed and when said cleaning program has not been started yet.

3. A method as claimed in claim 1, which comprises repeating at regular or random intervals, once the first preset period of time (T1) has elapsed from the start of a cleaning program, the step of acquiring a second digital image (14), digitally processing (15) said second acquired image (14) to obtain a second processed image (15A) and comparing (16) said first filtered image (13A) with said second processed image (15A) to obtain a plurality of second images, spaced over time, representative of the position of the first group of objects (13B) relative to the washing area (2).

4. A method as claimed in claim 1, which comprises repeating at regular or random intervals, once the second preset period of time (T2) has elapsed from the start of a cleaning program, the step of acquiring a third digital image (18), digitally processing (19) said third acquired image (18) to obtain a third processed image (19A) and comparing (20) said second filtered image (13C) with said third processed image (19A) to obtain a plurality of third images, spaced over time, representative of the position of the second group of objects (13D) relative to the washing area (2).

5. A method as claimed in claim 1, wherein said first group (13B) comprises a component (5, 7) of the dishwashing machine which is movable between first and second operating positions.

6. A method as claimed in claim 1, wherein said second group (13D) comprises a plurality of dishware items (S).

7. A method as claimed in any of the preceding claims 1, wherein said steps of processing (12, 15 and 19) comprise a process through which said first or second filtered images (13A, 13C) are placed on a reference grid to compare such grid with the respective grid of the second or the third processed image (15A and 19A).

8. A method as claimed in claim 1, wherein, downstream from said step of notifying said first critical

condition (16A) or said second critical condition (20A), said cleaning program is changed, according to said first critical condition (16A) or second critical condition (20A) that has been notified, or stopped.

9. A dishwashing machine comprising a washing area (2) and a door (3) designed to be associated with said washing area (2) to close it, a control unit (4) having a memory with a cleaning program stored therein, a pump adapted to be connected to a water mains supply connection to withdraw water from the mains, one or more impellers (5) in fluid communication with such pump, a dispenser (6) having a door (7) configured to move between a closed position to an open position, one or more optical devices (8) that can acquire digital images of said washing area (2) and a user interface (9), said one or more optical devices (8) and user interface (9) being in signal communication with said control unit (4) as well as said pump, **characterized in that** it comprises a program residing in another portion of said memory, which is configured to carry out the steps as claimed in any of the preceding claims 1 to 8.
10. A dishwashing machine as claimed in claim 9, wherein said user interface is a screen (23) integrated in said dishwashing machine, said screen (23) being configured to display a first critical condition (16A) and/or a second critical condition (20A) due to a change of the operating state, through warning lights, texts and/or images.
11. A dishwashing machine as claimed in claim 9, wherein said dishwashing machine comprises a radio transmitting apparatus and said user interface is a portable device (22) having its own radio transmitting apparatus configured to establish a signal communication with said radio transmitting apparatus of said dishwashing machine (2) to thereby receive data representative of said change of the operating state, said portable device having its own screen, which is configured to display said change of the operating state through warning lights, messages and/or images.
12. A system for automatically assessing the displacement of an object (S, 5, 7) in a washing area (2) of a dishwashing machine (1), comprising:

a dishwashing machine (1) comprising a washing area (2) and a door (3) designed to be associated with said washing area (2) to close it, a control unit (4) having a memory with a cleaning program stored therein, a pump adapted to be connected to a water mains supply connection to withdraw water from the mains, one or more impellers (5) in fluid communication with such pump, a dispenser (6) having a door (7)

configured to move between a closed position to an open position, one or more optical devices (8) that can acquire digital images of said washing area (2) and a user interface (9), said one or more optical devices (8) and user interface (9) being in signal communication with said control unit (4) as well as said pump, and a transmitting/receiving radio apparatus;

- a portable device (22) designed to be handheld by a user, having its own radio transmitting/receiving apparatus configured to establish a signal communication with said radio transmitting/receiving apparatus of said dishwashing machine, a screen configured to display warning lights, messages and/or images and a memory,

characterized in that it comprises a program residing in a portion of said memory of the user-handheld portable device (22), said program being configured to carry out the steps as claimed in any of the preceding claims 1 to 8, for a first or second critical change-of-operating-state condition (16A, 20A) to be displayed on said interface (9) and/or said screen of said user-handheld portable device.

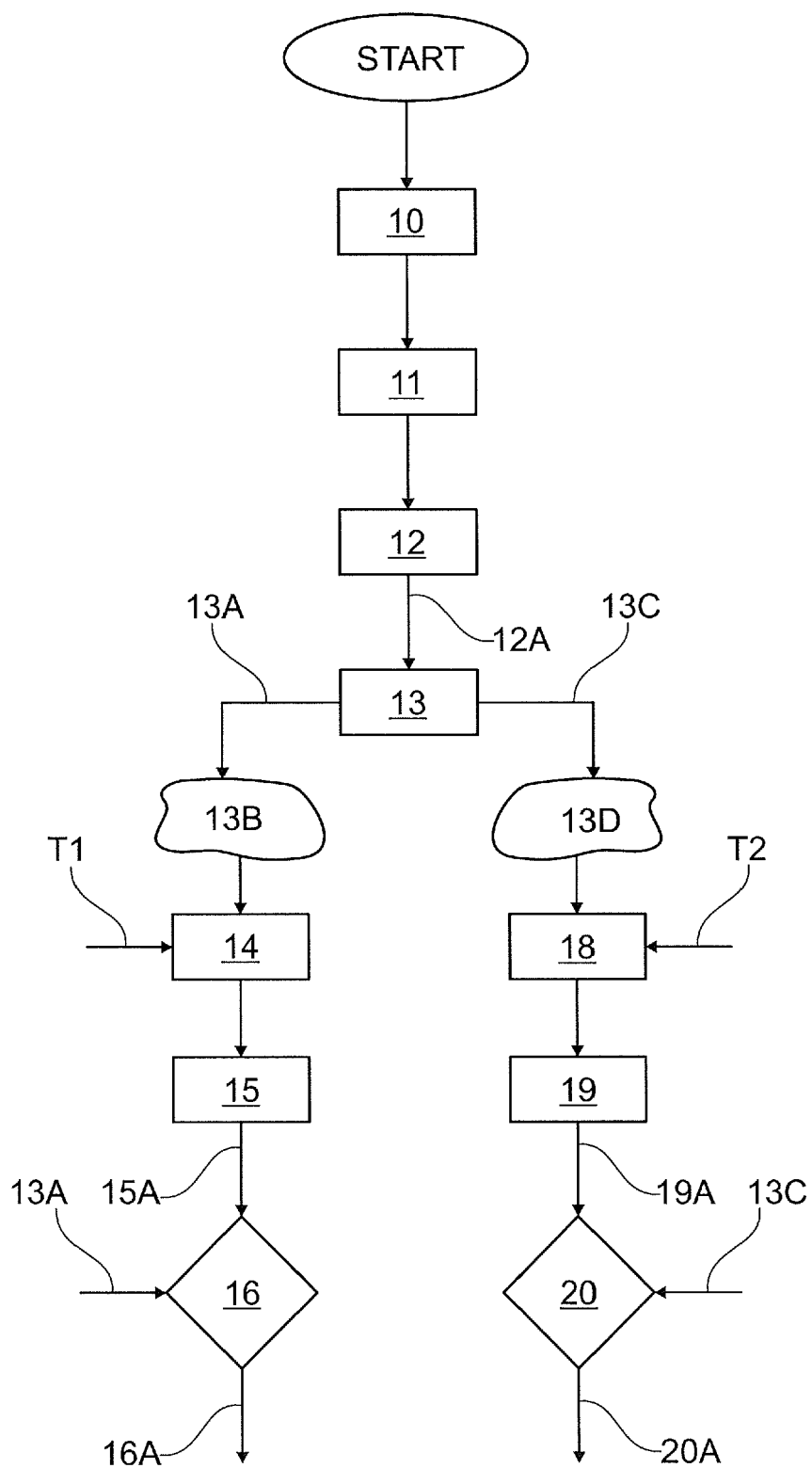
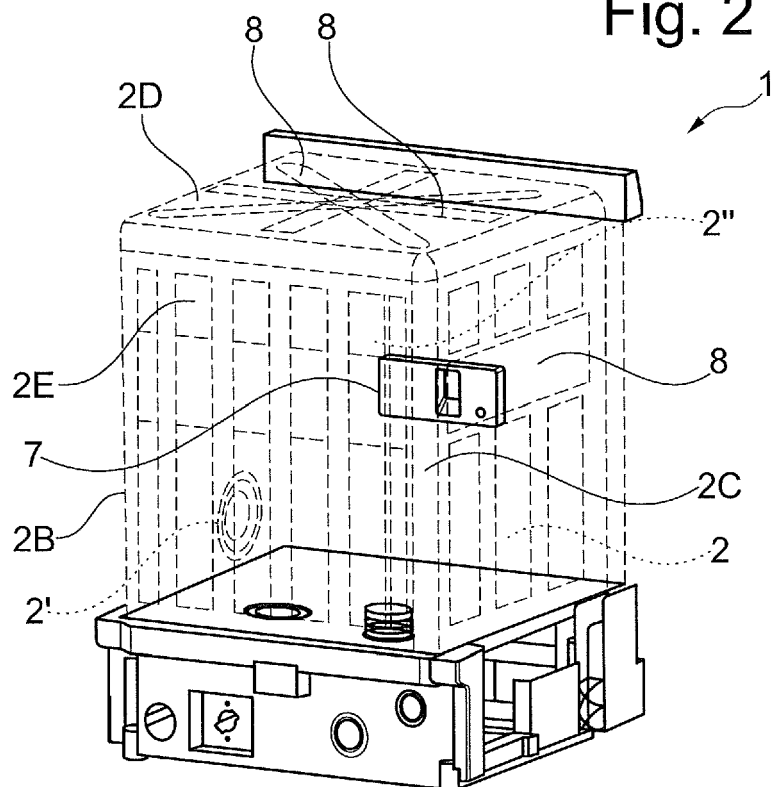
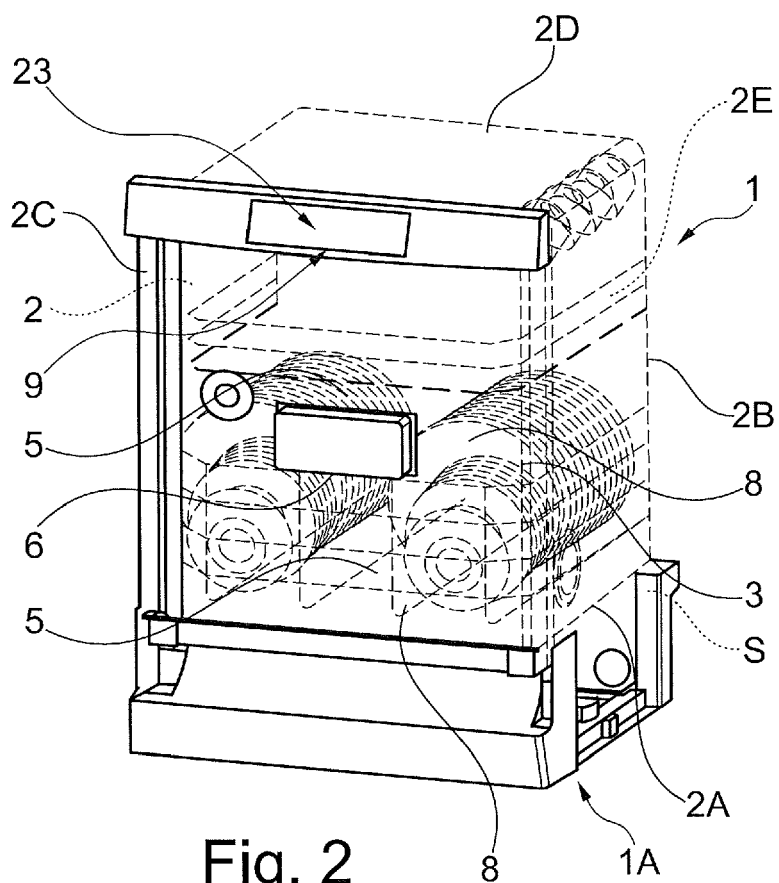


Fig. 1



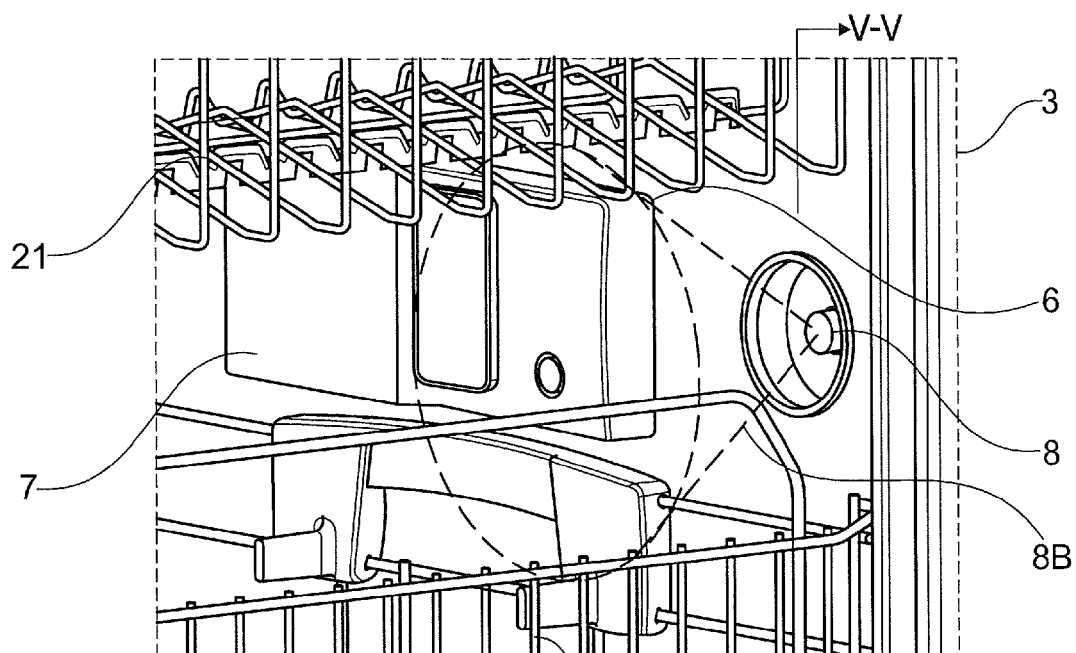


Fig. 4

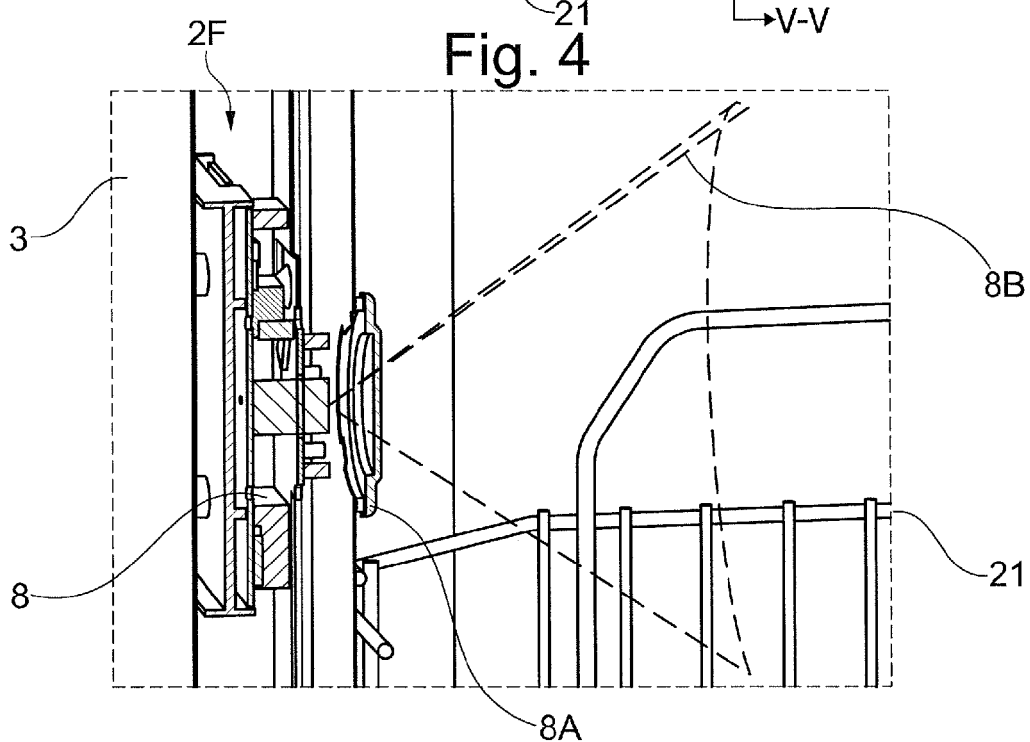


Fig. 5

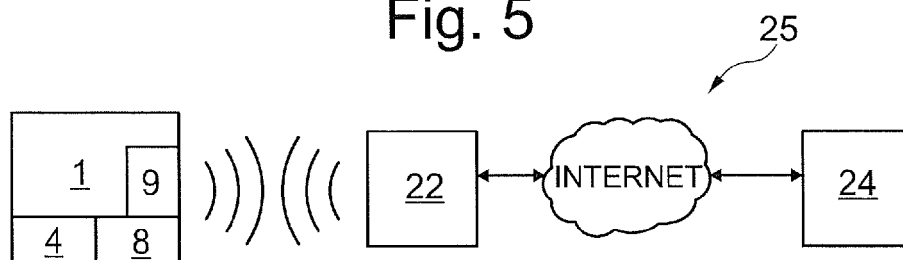


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 18 18 2619

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 10 2015 102694 A1 (MIELE & CIE [DE]) 25 August 2016 (2016-08-25) * paragraphs [0060] - [0081]; claims; figure 14 * -----	1-12	INV. A47L15/4295
			TECHNICAL FIELDS SEARCHED (IPC)
			A47L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 November 2018	Examiner Lopez Vega, Javier
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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