The present disclosure relates to a dishwasher or other washing apparatus, a control method thereof, and a spin-dry control system therefor, including a sensor unit configured to detect a weight of one or more objects in a spin-dry tub, and an amount of eccentricity and a speed of the spin-dry tub; a driving unit configured to balance or rotate the spin-dry tub; and a control unit configured to determine an operation state of the driving unit according to information from the sensor unit. Accordingly, a separate spin-dry function can be added to the dishwasher or other washing apparatus to maximize spatial efficiency, and the dishwasher can control a spin-dry function with optimal efficiency by automatically detecting a change in weight of object(s) in the spin-dry tub and the speed of the spin-dry tub, thereby maximizing spin-dry efficiency.
Fig. 3

SPIN-DRY TUB 400

DRIVING MOTOR 210
STEP MOTOR 200

ALARM UNIT 500

CONTROL UNIT 300

WEIGHT SENSOR 110
TWO-AXIS SENSOR 120
SPEED SENSOR 130
Fig. 4

START

1. DISPLAY WEIGHT OF SPIN-DRY TUB
2. OPEN DOOR
3. PUT SPIN-DRY TARGET INTO SPIN-DRY TUB
4. DETECT WEIGHT OF SPIN-DRY TARGET
5. DETECT AMOUNT OF ECCENTRICITY OF SPIN-DRY TUB

IF AMOUNT OF ECCENTRICITY > AMOUNT OF REFERENCE ECCENTRICITY?

- YES: RE-DISPOSE SPIN-DRY TARGET
- NO: RE-DETECT AMOUNT OF ECCENTRICITY OF SPIN-DRY TUB

6. ROTATE SPIN-DRY TUB
7. MEASURE AMOUNT OF CHANGE IN WEIGHT AND SPEED
8. IF WEIGHT AND SPEED ARE EQUALLY MAINTAINED FOR PREDETERMINED TIME?
   - YES: STOP ROTATION OF SPIN-DRY TUB
   - NO: GENERATE ALARM

END
Fig. 7

Fig. 8
WASHING APPARATUS AND CONTROL SYSTEM AND METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and claims priority from Korean Patent Application No. 10-2013-0141924, filed on Nov. 22, 2013, the disclosure of which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a dishwasher or other washing apparatus and a control method thereof, and more particularly, to a dishwasher including a spin-dry tub for spin-drying objects, and a control method and system therefor.

BACKGROUND

[0003] A dishwasher is a home appliance for automatically washing food leftovers or other detritus on a surface of dishes by high pressure washing water sprayed from a washing nozzle.

[0004] FIG. 1 illustrates a configuration of a general dishwasher that includes a washing tub 10 therein providing a space for washing dishes. The washing tub 10 includes a plurality of dish baskets or racks 12 (e.g., an upper basket or rack and a lower basket or rack) for holding and/or accommodating dishes, slidable rails or brackets 14 supporting and enabling withdrawal and insertion of the plurality of dish baskets or racks 12, and nozzles 16 above and/or under each of the plurality of dish baskets or racks 12 to spray water onto the dishes.

[0005] Here, the plurality of nozzles 16 is connected to a sump 20 by supply tubes 22, to receive washing water from the sump 20.

[0006] However, the dishwasher, a main purpose of which is to wash dishes, does not include a spin-dry control system or a method for spin-drying certain objects, such as vegetables, fruits, or small amounts of laundry, so that addition of a particular spin-dry function for certain objects, in addition to washing dishes, is useful.

SUMMARY

[0007] The present disclosure has been made in an effort to provide a dishwasher, a main purpose of which is to wash dishes, having a separate spin-dry function, that automatically detects a change in weight of object(s) in and a speed of a spin-dry tub to control the spin-dry function from start to completion with optimal efficiency, and a control method thereof.

[0008] One or more embodiments of the present disclosure provide a dishwasher including a spin-dry tub inside a washing tub, a sensor unit configured to detect a weight of one or more objects in the spin-dry tub, and an amount of eccentricity and a speed of the spin-dry tub; a driving unit configured to balance or rotate the spin-dry tub; and a control unit configured to determine an operation state of the driving unit according to information from the sensor unit.

[0009] The sensor unit may include a weight sensor configured to detect the weight of the object(s) in the spin-dry tub; a two-axis sensor configured to detect the amount of eccentricity of the spin-dry tub; and a speed sensor configured to detect a speed or a rotation rate of the spin-dry tub.

[0010] The control unit may operate the driving unit to balance the object(s) in the spin-dry tub when the amount of eccentricity of the spin-dry tub exceeds a reference amount of eccentricity, and operate the driving unit to rotate the spin-dry tub when the amount of eccentricity of the spin-dry tub is equal to or smaller than the reference amount of eccentricity.

[0011] When the weight of the object(s) and the speed of the spin-dry tub are maintained or stable for a predetermined time during a spin-dry operation, the control unit may stop the driving unit.

[0012] The dishwasher may further include an alarm unit configured to generate an alarm when the rotation of the spin-dry tub is stopped.

[0013] Other embodiments of the present disclosure provide a method of controlling a dishwasher including detecting a weight of one or more objects in the spin-dry tub; detecting an amount of eccentricity of the spin-dry tub; balancing the object(s) in the spin-dry tub or rotating the spin-dry tub according to a result of detecting the amount of eccentricity of the spin-dry tub; measuring a change in the weight of the object(s) and a speed of the spin-dry tub while rotating the spin-dry tub; and stopping rotation of the spin-dry tub according to a result of measuring the change in the weight of the object(s) and the speed of the spin-dry tub.

[0014] The object(s) are balanced when the amount of eccentricity exceeds the reference amount of eccentricity; and the spin-dry tub is rotated when the amount of eccentricity detected is equal to or smaller than the reference amount of eccentricity.

[0015] Balancing the object(s) may include re-disposing the object(s) by rotating the spin-dry tub on an axis; and re-detecting the amount of eccentricity of the spin-dry tub in which the object(s) have been re-disposed, and the spin-dry tub may be rotated when the re-detected amount of eccentricity is equal to or smaller than the reference amount of eccentricity.

[0016] The rotation of the spin-dry tub may be stopped when the weight of the object(s) and the speed of the spin-dry tub are maintained or stable for a predetermined time.

[0017] The method may further include generating an alarm when the rotation of the spin-dry tub is stopped.

[0018] According to the exemplary embodiments of the present disclosure, a separate spin-dry function capable of spin-drying vegetables, fruits, a small amount of laundry, and the like is added to a dishwasher, of which a main purpose is to wash dishes, to maximize spatial efficiency, and the dishwasher controls a start to a completion of the spin-dry with optimal efficiency by automatically detecting a change in weight of an object and a speed of the spin-dry tub, thereby maximizing spin-dry efficiency.

[0019] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 is a side cross-sectional view illustrating a configuration of a general dishwasher.

[0021] FIG. 2 is an exploded perspective view illustrating an exemplary configuration of a dishwasher according to one or more embodiments of the present disclosure.
[0022] FIG. 3 is a block diagram illustrating an exemplary spin-dry control system for a dishwasher according to embodiment(s) of the present disclosure.

[0023] FIG. 4 is a flowchart illustrating an exemplary spin-dry control method according to embodiment(s) of the present disclosure.

[0024] FIG. 5 is a graph illustrating a relationship between the weight of object(s) in the spin-dry tub and the torque of a spin-dry tub in an exemplary spin-dry control method according to embodiment(s) of the present disclosure.

[0025] FIG. 6 is a graph illustrating a relationship between the weight of object(s) in the spin-dry tub and the rotation rate in revolutions per minute (RPM) of the spin-dry tub in an exemplary spin-dry control method according to embodiment(s) of the present disclosure.

[0026] FIG. 7 is a graph illustrating a change in the weight of object(s) in the spin-dry tub as a function of spin-dry time in the exemplary spin-dry control method according to embodiment(s) of the present disclosure.

[0027] FIG. 8 is a graph illustrating a change in speed of the spin-dry tub as a function of spin-dry time in the exemplary spin-dry control method according to embodiment(s) of the present disclosure.

DETAILED DESCRIPTION

[0028] In the following detailed description, reference is made to the accompanying drawing, which form a part hereof. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here.

[0029] Hereinafter, an exemplary embodiment according to the present disclosure will be described in detail with reference to the accompanying drawings. In the process, thicknesses of lines or a size of a constituent element illustrated in the drawing, and the like, may be exaggerated for clarity and ease of description. The drawings are schematic and are not necessarily dimensionally illustrated. A predetermined size is just exemplary and not limiting. Further, terms may be defined considering the configurations and the effects of the present disclosure, but their meanings may vary depending on the intention or usual practice of a user or operator. Further, the spirit of the present disclosure is not limited to any suggested or exemplary embodiment, and those understanding the spirit of the present disclosure may easily carry out another exemplary embodiment within the scope of the same spirit, which also belongs to the scope of the present disclosure.

[0030] As those skilled in the art will realize, the described exemplary embodiments may be modified in various different ways, all without departing from the spirit or scope of the present disclosure, which is not limited to the exemplary embodiments described herein. Like reference numerals designate like elements throughout the specification and drawings. A detailed explanation of known related functions and constitutions may be omitted when the detailed explanation obscures the subject matter of the present disclosure.

[0031] The exemplary embodiments of the present disclosure illustrate ideal exemplary embodiments of the present disclosure in more detail. As a result, various modifications of the drawings are expected. Accordingly, the exemplary embodiments are not limited to a specific form of the illustrated region, and for example, include a modification of a form by manufacturing.

[0032] FIG. 2 is an exploded perspective view illustrating an exemplary configuration of a dishwasher according to embodiments of the present disclosure. The configuration of the dishwasher will be described in detail with reference to FIG. 2.

[0033] A main purpose of the dishwasher is to wash dishes. In addition, to improve spatial efficiency at home, and the like, a spin-dry function for other objects, such as vegetables, fruits, or small amounts of laundry, is added.

[0034] As illustrated in FIG. 2, a spin-dry tub 400, into which one or more objects are placed, is placed inside a washing tub of the dishwasher. The spin-dry tub 400 rotates with the rotation of a rotating member 410, to spin-dry the object(s) therein.

[0035] Here, the rotating member 410 rotates by rotational force from a supply tube 420 that supplies water into the washing tub. The supply tube 420 may be rotated by a motor. A fixing plate 430 is between the spin-dry tub 400 and the rotating member 410 to provide a sufficient contact area for the spin-dry tub 400 to maintain balance while being rotated.

[0036] In the meantime, according to embodiments of the present disclosure, a separate opening/closing valve and/or the like may be in the supply tube 420 to block or close the supply tube 420 during a spin-dry function or operation, and a driving unit or motor 210 (see FIG. 3) to be described below rotates the supply tube 420.

[0037] A detachable cover 440 is on or over an upper portion or opening of the spin-dry tub 400 to prevent the object(s) from being ejected or separated from the spin-dry tub 400 during the spin-dry function or operation.

[0038] As described above, the object(s) are spin-dried in the spin-dry tub 400, and residual water on the object(s) is discharged into the washing tub through a plurality of through-holes in the spin-dry tub 400, and then is discharged to the outside through a drainage structure (e.g., drain) of the dishwasher.

[0039] Hereinafter, a detailed spin-dry control system in a dishwasher to which the spin-dry function is added and in which the spin-dry tub is in the washing tub will be described in detail.

[0040] FIG. 3 is a block diagram illustrating an exemplary spin-dry control system for a dishwasher according to embodiments of the present disclosure. Referring to FIG. 3, the spin-dry control system includes a sensor unit 100, a driving unit 200, a control unit 300, and an alarm unit 500.

[0041] The sensor unit 100 detects weights of various objects in the spin-dry tub 400, the amount of eccentricity of the spin-dry tub 400, a speed of the tub (e.g., a speed, a rotation rate, or a rotational, translational or angular speed), and the like. In particular, the sensor unit 100 includes a weight sensor 101 for detecting the weight of the object(s), a two-axis sensor 120 for detecting the amount of eccentricity of the spin-dry tub 400, and a speed sensor 130 for detecting the speed or a rotation rate of the spin-dry tub 400.

[0042] According to various embodiments of the present disclosure, the weight sensor 110 is in the aforementioned rotating member 410 or the fixing plate 430 (e.g., to detect the weight of the object(s)), and the two-axis sensor 120 may also be in the aforementioned rotating member 410 or fixing plate 430 (e.g., to detect the amount of eccentricity of the spin-dry
The two-axis sensor 120 may set a virtual X-axis and a virtual Y-axis based on a rotation axis of the spin-dry tub 400. The speed sensor 130 is at, on or in an internal wall or wall surface of the washing tub, near or adjacent to the spin-dry tub 400, so that it can detect a speed and/or rotation rate of the spin-dry tub 400 during its rotation.

The driving unit 200 balances or rotates the spin-dry tub 400, and includes a driving motor 210 and a step motor 220.

Hereinafter, a spin-dry control method using the aforementioned spin-dry control system will be described in detail.

FIG. 4 is a flowchart illustrating the spin-dry control method according to one or more embodiments of the present disclosure. The spin-dry control method will be described in detail with reference to FIG. 4.

First, in order to perform the spin-dry cycle or operation on objects using the dishwasher, in use preparation step S10, a user presses a power button, such as one labeled “Start,” and the weight of the spin-dry tub is displayed on a display of the dishwasher (S12).

The user opens the door of the dishwasher to which power is applied (S14), and puts one or more objects, such as vegetables, fruits, or a small amount of laundry, into the spin-dry tub inside the washing tub of the dishwasher (S16).

Next, the weight sensor 110 detects the weight of the object(s) put into the spin-dry tub (S100). Particularly, in usage preparation step S10, the weight of only the spin-dry tub is detected, and in weight detection step S100, the weight of both the spin-dry tub and the object(s) is detected, so that it is possible to detect the weight of only the object(s) in the spin-dry tub by subtracting the weight detected in the usage preparation step S10 from the weight detected in weight detection step S100.

First control step S300 comprises a step of determining whether to perform a balancing step S310 to balance the object(s) in the spin-dry tub, or to perform driving step S400 to rotate the spin-dry tub for the spin-dry cycle or operation, depending upon the amount of eccentricity of the spin-dry tub.

That is, when the amount of eccentricity of the spin-dry tub detected by the two-axis sensor 120 in eccentricity amount detection step S200 exceeds a reference amount of eccentricity, driving step S400 is performed after balancing step S310 is performed.

As described above, when the object(s) in the spin-dry tub is/are eccentrically disposed to one side so that the amount of eccentricity of the spin-dry tub exceeds the reference amount of eccentricity, the spin-dry operation may not be smoothly performed due to shaking or vibrations of the spin-dry tub during the spin-dry cycle or operation. As a result, the method enters balancing step S310.
[0064] Alternatively, when the amount of eccentricity of the spin-dry tub is equal to or smaller than the reference amount of eccentricity, driving step S400 is performed directly, and the spin-dry tub is rotated by the driving motor 210.

[0065] According to exemplary embodiments of the present disclosure, the weight of the rotating member 410 itself may be 120 g, and an error range of eccentricity is 5% to 5% is defined as the reference amount of eccentricity.

[0066] Balancing step S310 may comprise re-disposing a position of the object(s) so that the spin-dry tub has a smaller amount of eccentricity than the reference amount of eccentricity described above, and includes balance adjusting step S312 and eccentricity amount re-detection step S314.

[0067] When the amount of eccentricity of the spin-dry tub exceeds the reference amount of eccentricity, balance adjusting step S312 comprising re-disposing the position of the objects (e.g., by rotating the spin-dry tub using the step motor 220) is performed.

[0068] After balance adjusting step S312, eccentricity amount re-detection step S314 comprising re-detecting the amount of eccentricity of the spin-dry tub containing the re-disposed object(s) using the two-axis sensor 120 is performed.

[0069] When the amount of eccentricity detected in eccentricity amount re-detection step S314 is equal to or smaller than the reference amount of eccentricity, driving step S400 comprising rotating the spin-dry tub and/or operating the driving motor 210 by the control unit 300 is performed (S300).

[0070] When the amount of eccentricity detected in eccentricity amount re-detection step S314 exceeds the reference amount of eccentricity, the repeating balance maintaining step S312 and eccentricity amount re-detection step S314 (S300) are repeated, and the driving step S400 is performed only after the amount of eccentricity of the spin-dry tub is equal to or smaller than the reference amount of eccentricity.

[0071] Driving step S400 comprises performing the spin-dry cycle or operation on the object(s) by rotating the spin-dry tub. Referring to FIGS. 5 and 6, in one embodiment, the control unit 300 may control a rotation torque of the driving motor 210 to be in proportion to the weight of the object(s) in the spin-dry tub, and controls a rotation rate (e.g., RPM) of the driving motor 210 to be in inverse proportion to the weight of the object(s).

[0072] When the weight of the object(s) is relatively large, the driving motor 210 generates a rotational force having a large rotational torque and a low RPM, and when the weight of the object(s) is relatively small, the driving motor 210 generates a rotational force having a small rotational torque and a high RPM.

[0073] According to exemplary embodiments of the present disclosure, the maximum total object weight of 2,500 g may be put into the spin-dry tub, and as illustrated in FIG. 5, when the weight of the object(s) is 500 g, 1,000 g, or 2,000 g, the driving motor 210 generates a torque of 0.2 kgf·cm, 0.4 kgf·cm, and 0.6 kgf, respectively.

[0074] Referring to FIG. 6, when the weight of the object(s) is 500 g, 1,000 g, or 2,000 g, the driving motor 210 rotates at 65 rpm, 55 rpm, and 30 rpm, respectively.

[0075] When the method enters driving step S400, monitoring step S500 comprising measuring the change in the weight of the object(s) in the spin-dry tub and the speed during rotation of the spin-dry tub is performed.

[0076] That is, the weight sensor 110 and the speed sensor 130 detect the weight of the object(s) on which the spin-dry cycle or operation is performed and the speed of the spin-dry tub, respectively, and measure the amount of change in the weight of the object and in the speed of the spin-dry tub.

[0077] After monitoring step S500, the method enters a second control step S600, which controls whether to stop the spin-dry operation (e.g., spin-dry completion step S700) according to the measurement(s) of the amount of change in the weight and in the speed in monitoring step S500.

[0078] When the weight of the object(s) and the speed during the rotation of the spin-dry tub measured in monitoring step S500 are maintained or stable for a predetermined time, it is determined that the spin-dry operation is complete, and the rotation of the spin-dry tub is stopped (e.g., spin-dry completion step S700).

[0079] However, when the weight of the object(s) and/or the speed during the rotation of the spin-dry tub measured in monitoring step S500 continuously change, driving step S400 and monitoring step S500 are continuously performed, and when a change in the weight and/or the speed is below a threshold amount for the predetermined time, the method enters spin-dry completion step S700.

[0080] According to embodiments of the present disclosure, as illustrated in FIGS. 7 and 8, the total spin-dry time may be 130 seconds, and the predetermined time may be 30 seconds, which may change according to the size(s) and weight(s) of the spin-dry tub, the weight, shape and/or size of the object, and the like.

[0081] Particularly, when the weight of the objects in the spin-dry tub is 1,400 g, and the weight of the objects and the speed of the spin-dry tub 20 seconds after start of the spin-dry operation is 2,200 g and 1.3 m/s, respectively, the weight of the objects and the speed of the spin-dry tub 50 seconds after start of the spin-dry operation are 1,800 g and 1.0 m/s, respectively, and the weight of the objects and the speed of the spin-dry tub 80 seconds after start of the spin-dry operation are 1,500 g and 0.7 m/s, respectively.

[0082] As described above, the weight of the objects and the speed of the spin-dry tub decrease in inverse proportion to the spin-dry time, and when a predetermined weight value and a predetermined speed value are maintained for about 30 seconds (e.g., beginning up to after 100 seconds after the start of the spin-dry operation), the control unit 300 determines that the spin-dry is completed.

[0083] Finally, after spin-dry completion step S700, the method performs alarm step S800 to notify the user that the rotation of the spin-dry tub is stopped. The alarm may comprise a sound, a light, a flashing light, a message displayed on the dishwasher, a combination thereof, etc.

[0084] From the foregoing, it will be appreciated that various embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various embodiments disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

1. A dishwasher, comprising:
   a spin-dry tub inside a washing tub;
   a sensor unit configured to detect or determine a weight of one or more objects in the spin-dry tub, and an amount of eccentricity and a speed of the spin-dry tub;
a driving unit configured to balance or drive the spin-dry tub; and
a control unit configured to determine an operation state of
the driving unit according to information from the sensor
unit.
2. The dishwasher of claim 1, wherein the sensor unit
includes:
a weight sensor configured to detect or determine the
weight of the object(s) in the spin-dry tub;
a two-axis sensor configured to detect the amount of eccen-
tricity of the spin-dry tub; and
a speed sensor configured to detect the speed and/or rota-
tion rate of the spin-dry tub.
3. The dishwasher of claim 1, wherein the control unit
operates the driving unit to balance the object(s) in the spin-
dry tub when the amount of eccentricity of the spin-dry tub
exceeds a reference amount of eccentricity, and operates the
driving unit to rotate the spin-dry tub when the amount of
eccentricity is equal to or smaller than the reference amount
of eccentricity.
4. The dishwasher of claim 1, wherein when the weight of
the object(s) and the speed of the spin-dry tub are maintained
or stable for a predetermined time during a spin-dry op-
eration, the control unit stops the driving unit.
5. The dishwasher of claim 1, further comprising an alarm
unit configured to generate an alarm when rotation of the
spin-dry tub is stopped.
6. The dishwasher of claim 1, wherein the speed of the
spin-dry tub is a speed or a rotational, translational or angular
speed of the spin-dry tub.
7. A method of controlling a dishwasher, comprising:
detecting a weight of one or more objects in a spin-dry tub;
detecting an amount of eccentricity of the spin-dry tub;
balancing the object(s) in the spin-dry tub or rotating the
spin-dry tub according to a result of detecting the
amount of eccentricity of the spin-dry tub;
measuring a change in the weight of the object(s) and a
speed of the spin-dry tub while rotating the spin-dry tub;
and
stopping rotation of the spin-dry tub according to a result of
measuring the change in the weight of the object(s) and
the speed of the spin-dry tub.
8. The method of claim 7, wherein:
the spin-dry tub is rotated when the amount of eccentricity
is equal to or smaller than a reference amount of eccen-
tricity; and
the object(s) are balanced in the spin-dry tub when the
amount of eccentricity detected in the eccentricity
amount detection step exceeds the reference amount of
eccentricity.
9. The method of claim 8, wherein balancing includes:
re-disposing the object(s) by rotating the spin-dry tub on an
axis; and
re-detecting the amount of eccentricity of the spin-dry tub
in which the object(s) have been re-disposed.
10. The method of claim 9, wherein the spin-dry tub is
rotated when the re-detected amount of eccentricity is equal
to or smaller than the reference amount of eccentricity.
11. The method of claim 7, wherein the rotation of the
spin-dry tub is stopped when the weight of the object(s) and
the speed of the spin-dry tub are maintained or stable for a
predetermined time.
12. The method of claim 11, further comprising generating
an alarm when the rotation of the spin-dry tub is stopped.