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DISH WASHER

Abstract

A dish washer is configured to recognize when a user intends to open a door while a washing course in a tub is in progress. The dish washer includes a handle driver, a controller, and a handle configured to protrude in a frontward direction when the washing process has been stopped, thereby securing convenience and safety.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and benefit of Korean Patent Application No. 10-2024-0022964, filed on Feb. 16, 2024, which is hereby incorporated by reference as when fully set forth herein.

TECHNICAL FIELD

[0002] The present disclosure relates to a dish washer. More specifically, the present disclosure relates to a dish washer configured such that when a user's intention to open a door is identified as being present while a washing course is in progress, a handle extends to protrude in a frontward direction while the washing process in progress has been stopped, thereby securing convenience and safety simultaneously.

BACKGROUND

[0003] A dish washer is an apparatus that washes dishes and cooking utensils as washing targets stored therein by spraying washing water thereto. The washing water may contain washing detergent.

[0004] Using a dish washer may allow a time and effort for washing the dishes and other washing targets after a meal to be reduced, thereby contributing to user convenience.

[0005] In order to store dishes inside the dish washer before a washing cycle, and to withdraw the washed and dried dishes after the washing cycle, the user may open and close the door.

[0006] The dish washer may include a door with a handle that the user may grasp to open and close the door.

[0007] In some cases, a dish washer may include a depressed type handle provided in the door. For instance, the handle of the dish washer may be provided in a form of a grip groove configured to be depressed from a front surface of the door toward a rear surface thereof by a predetermined depth.

[0008] In some cases, the handle is provided in a depressed form from a portion of the front surface of the door toward an inside of the door. A separate cover, etc., may not be disposed on the handle, and thus the handle may be always exposed to an outside. In some cases, the handle structure may accumulate external foreign substances such as dusts in the depressed space into which the hand of the user is inserted. The user may frequently clean the handle, thereby causing inconvenience to the user. In some cases, the handle may deteriorate the aesthetic sense of the front surface appearance of the door because the portion of the front surface of the door is concavely depressed.

[0009] In some cases, a dish washer may include a protruding type handle disposed on the door. For instance, the handle of the dish washer may have a predetermined protruding height in a frontward direction from a front surface of the door, and may be always in a protruding state and have a 90 degrees-rotated U shape. In some cases, a user who does not recognize the protruding portion from the front surface of the door may collide with the protruding portion, thereby causing injury to the user. In some cases, the handle may collide with dishes and other kitchenware when the dishes are withdrawn from the dish washer, and thus causing damage to the handle itself or items such as dishes.

SUMMARY

[0010] The present disclosure describes a dish washer configured such that the handle is configured to extend in a protruding manner in a frontward direction from the door only when necessary, such as when opening or closing the door, so that external foreign substances such as dusts are prevented from accumulating on the handle, thereby maintaining a clean state of the handle and improving user convenience.

[0011] The present disclosure further describes a dish washer configured such that the handle is configured to at least partially retract into the inside of the door when the use of the handle is unnecessary, thereby reducing the possibility of user injury and handle damage that may occur due to collision of the user with the handle.

[0012] The present disclosure further describes a dish washer configured such that when a user's

intention to open a door is identified as being present while a washing course is in progress, a handle extends to protrude in a frontward direction while the washing process in progress has been stopped, thereby securing convenience and safety simultaneously.

[0013] According to one aspect of the subject matter described in this application, a dish washer includes a tub that defines a washing space configured to accommodate one or more objects to be washed therein, the tub having an open front surface in fluid communication with the washing space, a door configured to open and close the open front surface of the tub, a handle configured to reciprocate between (i) an extended position in which the handle protrudes forward from the door and (ii) a retracted position in which the handle is at least partially accommodated within the door, a handle driver disposed within the door and configured to move the handle from the retracted position toward the extended position or from the extended position toward the retracted position, and a controller configured to determine whether to operate the handle driver and to control power to be supplied to the handle driver. The controller is configured to determine whether a user intends to open the door, and based on determining that a user is to open the door, control the handle driver to move the handle forward from the retracted position toward the extended position.

[0014] Implementations according to this aspect can include one or more of the following features. For example, the controller may be further configured to control the handle driver to move the handle forward from the retracted position toward the extended position (i) before a washing course starts or (ii) after the washing course has been completed. In some examples, the controller may be further configured to determine whether the user intends to open the door before the washing course starts or after the washing course has been completed, and based on a determination that the user intends to open the door, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

[0015] In some implementations, the dish washer may further include a proximity sensor configured to detect whether the user is located at a position within a predetermined detection range from the door, where the controller may be further configured to receive an output signal from the proximity sensor, determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor, based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration, and based on a determination that the user has stayed at the position for the predetermined set time duration, determine that the user intends to open the door. In some examples, the predetermined set time duration is in a range from 0.9 seconds to 1.1 seconds.

[0016] In some examples, the door may have a sensor hole defined at a top surface of the door, where the proximity sensor includes a radar sensor disposed inside the door and configured to detect, through the sensor hole, whether the user is disposed within the predetermined detection range. The radar sensor may have a sensing surface that is tilted and faces the top surface of the door in a frontward and upward direction. In some examples, a tilting angle of the sensing surface of the radar sensor is in a range from 25 degrees to 35 degrees with respect to the top surface of the door.

[0017] In some examples, the controller may be further configured to, based on determining (i) that the user has a height greater than or equal to a minimum detection height of the proximity sensor in a vertical direction and (ii) that the user is disposed in a distance less than or equal to a maximum detection distance from the proximity sensor in a horizontal direction, determine that the user is disposed at the position within the predetermined detection range. In some examples, the minimum detection height is in a range from 100 cm to 110 cm. In some examples, the maximum detection distance is in a range from 75 cm to 85 cm.

[0018] In some implementations, the dish washer may further include a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, where the controller may be

further configured to, based on determining that the user intends to open the door, supply power to the light-source to thereby turn on the light-source before an operation of the handle driver is started or simultaneously with a start of the operation of the handle driver.

[0019] In some implementations, the controller may be further configured to control the handle driver to move the handle forward from the retracted position toward the extended position while a washing course is in progress. In some examples, the controller may be further configured to determine whether the user intends to open the door while the washing course is in progress, and based on a determination that the user intends to open the door while the washing course is in progress, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

[0020] In some implementations, the dish washer may further include a proximity sensor configured to detect whether the user is disposed at a position within a predetermined detection range from the door, and a first vibration sensor and a second vibration sensor that are respectively positioned at different locations inside the door and configured to detect a knock-on input of the user through the door. The controller may be further configured to receive an output signal from the proximity sensor, determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor, based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration, based on a determination that the user has stayed at the position for the predetermined set time duration, receive (i) a first vibration signal from the first vibration sensor and (ii) a second vibration signal from the second vibration sensor, determine (i) a maximum amplitude of the first vibration signal received from the first vibration sensor and (ii) a maximum amplitude of the second vibration signal received from the second vibration sensor, compare the maximum amplitude of the first vibration signal with the maximum amplitude of the second vibration signal, and based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, determine that the user intends to open the door.

[0021] In some examples, the first vibration sensor may be located closer to a front surface of the door than the second vibration sensor is. In some examples, the first vibration sensor may be configured to detect vibration in a first axial direction, and the second vibration sensor may be configured to detect vibration in a second axial direction orthogonal to the first axial direction. In some examples, the first vibration signal corresponds to vibration in a horizontal direction, and the second vibration signal corresponds to vibration in a vertical direction orthogonal to the horizontal direction.

[0022] In some implementations, the dish washer may further include a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, where the controller may be further configured to, based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, supply power to the light-source to thereby turn on the light-source before or simultaneously with a start of an operation of the handle driver.

[0023] In some examples, the controller may be further configured to, after the handle driver starts to operate, pause the washing course in progress, and based on a forward movement of the handle to the extended position having been completed after operating the handle driver, stop an operation of the handle driver. In some examples, the controller may be further configured to pause the washing course in progress before the operation of the handle driver is stopped or simultaneously with a stop of the operation of the handle driver.

[0024] In some implementations, external foreign substances such as dusts may be prevented from accumulating on the handle, thereby maintaining a clean state of the handle and improving user

convenience.

[0025] In some implementations, in the retracted state of the handle, the user feels a sense of unity of the handle and the door with each other, thereby improving the aesthetics of the appearance of the dish washer.

[0026] In some implementations, the dish washer may reduce the possibility of user injury and handle damage that may occur due to collision of the user with the handle.

[0027] In some implementations, when a user's intention to open the door is identified as being present while a washing course is in progress, the handle extends to protrude in a frontward direction while the washing process in progress has been stopped, thereby securing convenience and safety simultaneously.

[0028] In addition to the above-mentioned effects, the specific effects of the present disclosure as not mentioned will be described below along with the descriptions of the specific details for carrying out the present disclosure.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0029] FIG. 1 is a front perspective view showing an example of a dish washer.

[0030] FIG. 2 is a schematic cross-sectional view of the dish washer as shown in FIG. 1.

[0031] FIG. 3 is a front perspective view showing an example state of a handle of a dish washer that has been displaced to a retracted position.

[0032] FIG. 4 is a front perspective view showing an example state in which the handle as shown in FIG. 3 has been displaced to an extended position.

[0033] FIG. 5 is an enlarged side view of FIG. 3.

[0034] FIG. 6 is a rear perspective view of the door as shown in FIG. 3 and shows a state in which a rear panel of the door is removed.

[0035] FIG. 7 is a rear perspective view of a handle driver as shown in FIG. 5.

[0036] FIG. 8 is an exploded perspective view of the handle driver as shown in FIG. 7.

[0037] FIG. 9 is an exploded perspective view showing an example of a pivot link, a link connector, and a connection pin among components of the handle driver as shown in FIG. 8.

[0038] FIG. 10 is a side view illustrating an example operation of the handle driver to initiate movement from the retracted position to the extended position for the handle.

[0039] FIG. 11 is a side view illustrating an example state in which movement to the extended position of the handle has been completed.

[0040] FIG. 12 is a side view illustrating an example operation of the handle driver to initiate movement from the extended position to the retracted position of the handle.

[0041] FIG. 13 is an enlarged view of a portion of FIG. 11, and is a diagram illustrating an example structure that prevents the handle from being moved backwards under an external force applied to the handle.

[0042] FIG. 14 is a partial enlarged view showing an example state in which the handle and the handle driver have been removed from the door.

[0043] FIG. 15 is a rear perspective view illustrating an example of a handle frame on which the handle and the handle driver are installed which supports the handle and the handle driver.

[0044] FIG. 16 is an exploded perspective view illustrating an example configuration of the handle.

[0045] FIG. 17 is a side view showing an example state in which light is irradiated to an outside from the handle during a process in which the handle is moving to the extended position.

[0046] FIG. 18 is a schematic diagram illustrating an example configuration for recognizing a user and a pet in a distinguishing manner from each other using a proximity sensor disposed on a top surface of a door to determine absence or presence of the user's intention to open the door.

[0047] FIG. **19** and FIG. **20** are vertical cross-sectional views illustrating an example state in which the proximity sensor as shown in FIG. **18** is disposed inside the door.

[0048] FIG. **21** is a vertical cross-sectional view illustrating an example of relative positions of a first vibration sensor and a second vibration sensor that are configured to determine absence or presence of a user's intention to open the door are positioned, respectively.

[0049] FIG. **22** is a functional block diagram illustrating an example configuration of a controller and functional modules included in a dish washer.

[0050] FIG. **23** is a flow chart showing an example of a sequence of cycles performed in a dish washer.

[0051] FIGS. **24** to **26** are flow charts respectively showing steps of an example method for controlling a dish washer.

DETAILED DESCRIPTIONS

[0052] The above-mentioned purpose, features and advantages are described in detail below with reference to the attached drawings. Accordingly, a person skilled in the art in the technical field to which the present disclosure belongs will be able to easily implement the technical idea of the present disclosure. In describing the present disclosure, when it is determined that a detailed description of the known technology related to the present disclosure may unnecessarily obscure the gist of the present disclosure, the detailed description thereof is omitted. Hereinafter, one or more implementations will be described in detail with reference to the attached drawings. In the drawings, identical reference numerals are used to indicate identical or similar components.

[0053] Hereinafter, the present disclosure will be described with reference to the drawings.

[0054] Hereinafter, an overall structure of a dish washer **1** will be described in detail with reference to the attached drawings.

[0055] FIG. **1** is a front perspective view showing the dish washer **1**. FIG. **2** is a simplified cross-sectional view briefly showing an internal structure of the dish washer **1**.

[0056] As shown in FIG. **1** and FIG. **2**, the dish washer **1** may include a casing **10** that constitutes an exterior appearance, a tub **20** installed in an inner space of the casing **10** and having a washing space **21** defined therein where the washing target is washed, wherein a front surface of the tub is open, a door **30** that opens/closes the open front surface of the tub **20**, a driver **40** located under the tub **20** to supply, collect, circulate, and discharge the washing water for washing the washing target, a dish rack **50** removably provided in the inner washing space **21** of the tub **20** to receive therein the washing target, and a water sprayer installed adjacent to the dish rack **50** to spray the washing water for washing the washing target thereto.

[0057] In some examples, the washing target received in the dish rack **50** may be, for example, dishes such as bowls, plates, spoons, and chopsticks, and other cooking utensils. Hereinafter, unless otherwise specified, the washing target will be referred to as a dish.

[0058] The tub **20** may be formed in a box shape with an entirely open front surface, and have a configuration of a so-referred to as washing tub.

[0059] The washing space **21** may be defined inside the tub **20**. The open front surface of the tub **20** may be opened/closing by the door **30**.

[0060] The tub **20** may be formed via pressing of a metal plate resistant to high temperature and moisture, for example, a stainless steel plate.

[0061] Moreover, on an inner surface of the tub **20**, a plurality of brackets may be disposed for the purpose of supporting and installing functional components such as the dish rack **50** and the water sprayer which will be described later thereon within the tub **20**.

[0062] In one example, the driver **40** may include a sump **41** that stores therein washing water, a sump cover **42** that distinguishes the sump **41** from the tub **20**, a water supply **43** that supplies washing water from an external source to the sump **41**, a water discharger **44** that discharges the washing water of the sump **41** to an outside, and a washing pump **45** and a supply flow path **46** that supply the washing water of the sump **41** to the water sprayer. The sump cover **42** may be disposed

at a top of the sump **41** and may serve to distinguish the tub **20** and the sump **41** from each other. [0063] Moreover, the sump cover **42** may have a plurality of collecting holes defined therein for collecting washing water sprayed into the washing space **21** through the water sprayer into the sump **41**.

[0064] That is, the washing water sprayed from the water sprayer toward the dish may fall down to a bottom of the washing space **21**, and may be collected again through the sump cover **42** and into the sump **41**.

[0065] The washing pump **45** may be disposed at one side of the sump **41** and may serve to pressurize the washing water and supply the pressurized washing water to the water sprayer.

[0066] One end of the washing pump **45** may be connected to the sump **41** and the other end thereof may be connected to the supply flow path **46**. The washing pump **45** may be equipped with an impeller **451** and a motor **453**. When power is supplied to the motor **453**, the impeller **451** may rotate, and thus the washing water in the sump **41** may be pressurized, and then may be supplied to the water sprayer through the supply flow path **46**.

[0067] In some examples, a wash water heater may be provided in the washing pump **45** to heat the wash water supplied during a wash cycle or a heat rinse cycle.

[0068] In one example, the supply flow path **46** may serve to selectively supply the washing water supplied from the washing pump **45** to the water sprayer.

[0069] For example, the supply flow path **46** may include a first supply flow path **461** connected to a lower spraying arm **61**, and a second supply flow path **463** connected to an upper spraying arm **62** and a top nozzle **63**. The supply flow path **46** may be provided with a supply flow path switching valve **465** that selectively opens/closes the supply flow paths **461** and **463**.

[0070] In some examples, the supply flow path switching valve **465** may be controlled so that the supply flow paths **461** and **463** are opened sequentially or simultaneously.

[0071] In one example, the water sprayer may be configured to spray the washing water to the dishes stored in the dish rack **50**.

[0072] More specifically, the water sprayer may include the lower spraying arm **61** located under the tub **20** to spray the washing water to a lower rack **51**, the upper spraying arm **62** located between the lower rack **51** and an upper rack **52** to spray the washing water to the lower rack **51** and the upper rack **52**, and the top nozzle **63** located on top of the tub **20** to spray the washing water to a top rack **53** or the upper rack **52**.

[0073] In particular, the lower spraying arm **61** and the upper spraying arm **62** may be rotatably disposed in the washing space **21** of the tub **20** and may spray the washing water toward the dish of the dish rack **50** while being rotating.

[0074] The lower spraying arm **61** may be rotatably supported on a top of the sump cover **42** so as to spray the washing water toward the lower rack **51** while being rotating and being disposed under the lower rack **51**.

[0075] Moreover, the upper spraying arm **62** may be rotatably supported by a spraying arm holder **467** so as to spray the washing water on the dish while being rotating and being disposed between the lower rack **51** and the upper rack **52**.

[0076] In some examples, in order to increase washing efficiency, additional structure for diverting the washing water sprayed from the lower spraying arm **61** into an upward direction (diverting in a U-direction) may be provided at a lower surface **25** of the tub **20**.

[0077] A description of the specific configuration of the water sprayer will be omitted below.

[0078] The dish rack **50** for storing the dish therein may be disposed in the washing space **21**.

[0079] The dish rack **50** may be configured to extend or retract from or into the inner space of the tub **20** through the open front surface of the tub **20**.

[0080] For example, referring to FIG. 2, the dish rack **50** includes the lower rack **51** located at a lower portion of the tub **20** to accommodate therein relatively large dishes, the upper rack **5** located on top of the lower rack **51** to accommodate therein medium-sized dishes, and the top rack **53**

located at a top level of the tub **20** and capable of storing therein small dishes, etc. However, implementations of present disclosure are not limited thereto.

[0081] Hereinafter, an example in which the dish washer **1** includes the three dish racks **50** as shown is described.

[0082] In some implementations, each of the lower rack **51**, the upper rack **52**, and the top rack **53** may be configured to extend or retract from or into the inner space of the tub **20** through the open front surface of the tub **20**.

[0083] In some examples, guide rails may be respectively disposed on both opposing inner side surfaces constituting an inner surface of the tub **20**. By way of example, the guide rails may include an upper rail, a lower rail, and a top rail.

[0084] Wheels may be disposed on a bottom of each of the lower rack **51**, the upper rack **52**, and the top rack **53**. The user may extend the lower rack **51**, the upper rack **52**, and the top rack **53** from the inner space of the tub **20** through the open front surface of the tub **20** and may place the dishes thereon, or easily withdraw the dishes that have been washed out thereof.

[0085] The guide rail may be implemented as a simple rail-type fixed guide rail to guide the extending or the retracting of the rack **50**, or a telescopic guide rail capable of guiding the extending or the retracting of the rack **50** and at the same time, increasing an extension distance thereof as the rack **50** further extends from the inner space of the tub.

[0086] In one example, the door **30** is configured for opening/closing the open front surface of the tub **20** as described above.

[0087] A hinge around which the door **30** is closed or opened may be provided at a bottom of the open front surface. Thus, the door **30** may pivot around the hinge as a pivot axis.

[0088] In some examples, a handle **31** for opening the door **30** and a control panel **32** for controlling an operation of the dish washer **1** may be disposed on an outer side surface of the door **30**.

[0089] As shown, the control panel **32** may include a display **33** that visually displays information regarding a current operating status of the dish washer **1**, etc., and a button unit **34** including a selection button through which a user's course selection manipulation is input and a power button through which a user's manipulation for turning the dish washer on and off is input.

[0090] In one example, a rear panel **30b** constituting an inner side surface of the door **30** may constitute one surface of the tub **20** when the door **30** has been closed, and may constitute a seat surface on which the lower rack **51** of the dish rack **50** is supported when the door **30** is fully opened.

[0091] In some examples, when the door **30** is fully opened downwardly, the rear panel **30b** of the door **30** may constitute a horizontal plane extending in the same direction as a direction in which the guide rail guiding the displacement of the lower rack **51** extends.

[0092] In one example, unlike a conventional handle, the handle **31** of the dish washer **1** may be configured to be at least partially accommodated in an inside of the door **30** when the handle is not in use, and to automatically extend in a protruding manner in a frontward direction from the door **30** when it is necessary to open and close the door **30**.

[0093] In that the handle is configured to retract so as to be at least partially accommodated in the inside of the door **30** or extend in a protruding manner in a frontward direction from the door **30** out of the inside of the door **30**, the handle **31** may be referred to as various names such as a pop-up handle, a retractable handle, an extendable handle, etc.

[0094] Hereinafter, the handle **31** configured to retract into or extend from the door **30** of the dish washer **1** will be referred to as the pop-up handle **31**.

[0095] In some examples, a detergent supply device for automatically supplying detergent into the inside of the tub **20** may be further installed on an inner side surface of the door **30**.

[0096] Furthermore, a door position sensor **36** may be disposed on an outer top surface of the tub **20** and may be configured to detect whether the door **30** is in a closed or open state. For example,

the door position sensor **36** may include a door position sensor S_d or a latch sensor that detects a position of a door latch.

[0097] In one example, a drying air supply **80** may be disposed under the tub **20** and may be configured to generate and supply high-temperature or low-temperature drying air to the washing space inside the tub **20**.

[0098] As shown, the drying air supply **80** may be configured to include a filter member **883** for filtering outside air, a blower fan **825** for generating a drying air stream, a heater **84** for heating the drying air stream, and an air stream guide **83** disposed inside the tub **20** so as to guide the drying air stream.

[0099] A drying air supply hole may be defined in a lower surface of the tub **20** so that high-temperature drying air generated by the drying air supply **80** may be introduced into the inside of the tub **20** through the drying air supply hole.

[0100] Thus, the high-temperature drying air or low-temperature drying air may be supplied from the drying air supply **80** into the inside of the tub **20** during the drying cycle S5 such that the drying efficiency and sterilization effect on the dishes may be improved compared to a conventional dish washer.

[0101] In one example, the dish washer may be configured such that the air current supplied to the inside of the tub **20** and moistened while drying the dishes may be discharged to the outside, and the discharge of the air current may be accomplished via partial opening of the door **30** or via a separate air discharge device.

[0102] Hereinafter, with reference to FIGS. **3** to **5**, the appearance and the operation of the pop-up handle **31** disposed at the door **30** of the dish washer **1** will be described in detail.

[0103] As described above, the door **30** of the dish washer **1** may be provided with the pop-up handle **31** that may be reciprocally movable.

[0104] In some examples, as described above, the door **30** may be configured to be pivotable around the hinge connected to a lower end of the door.

[0105] In consideration of the position of the hinge, as shown in FIG. **3** and FIG. **4**, the pop-up handle **31** may be positioned at a position close to a top surface of the door **30** where the user may easily grasp the handle, and may be disposed at the front panel **30a** constituting the front surface of the door **30**.

[0106] Furthermore, the pop-up handle **31** may extend along an extension direction of a front edge of the top surface of the door **30** and along a left-right direction so that the user may easily grasp the handle. The handle **31** may be formed to have an approximate 90 degrees-rotated U shape.

[0107] In order to extend or retract the pop-up handle **31**, an elongate opening **30e** extending in a left-right direction and having a shape corresponding to an appearance of the pop-up handle **31** may be defined in the front panel **30a** of the door **30** and extend along the extension direction of the front edge of the top surface of the door **30**, and have a depth along a front-rear (F-R) direction

[0108] The pop-up handle **31** may be configured to reciprocate along the forward and backward directions through the opening **30e** of the front panel **30a** under an operation of a handle driver **35** as described below.

[0109] More specifically, the pop-up handle **31** may be disposed to reciprocate between the most forward position and the most rearward position under the operation of the handle driver **35**.

[0110] For convenience, the most forward position to which the pop-up handle **31** is displaced in a forward direction is defined as an extended position Pd. The most rearward position to which the pop-up handle **31** is displaced in a backward direction is defined as a retracted position Pa.

[0111] FIG. **3** illustrates a state where the pop-up handle **31** has been displaced to the most rearward position, that is, the retracted position Pa, and thus has been retracted into the inside of the door **30**.

[0112] As shown, when the pop-up handle **31** has been displaced to the retracted position Pa, the pop-up handle **31** has been at least partially retracted into the inside of the door **30**.

[0113] In some examples, preferably, the pop-up handle **31** may passing through an entirety of the opening **30e** of the door **30** and be retracted into the inside of the door **30**.

[0114] Furthermore, when the pop-up handle **31** has been displaced to the retracted position Pa, the pop-up handle **31** may be in a state where the pop-up handle **31** does not protrude from the front panel **30a** of the door **30** in a frontward direction.

[0115] Furthermore, when the pop-up handle **31** has been displaced to the retracted position Pa, a front end surface of the pop-up handle **31** may be coplanar with a front surface of the front panel **30a** of the door **30** so as to form a continuous surface.

[0116] That is, a state in which no step is formed between the front surface of the front panel **30a** of the door **30** and the front end surface of the pop-up handle **31** may be formed when the pop-up handle **31** has been displaced to the retracted position Pa.

[0117] Thus, when the pop-up handle **31** has been displaced to the retracted position Pa, the opening **30e** of the front panel **30a** is entirely blocked, and at the same time, no step is formed between the front surface of the front panel **30a** and the front end surface of the pop-up handle **31**, such that the phenomenon in which foreign substances such as dusts accumulate on a convex portion of the door **30** or on the handle itself as in the conventional approach may be fundamentally prevented.

[0118] In one example, as described below, the front end surface of the pop-up handle **31** may be a front surface of a decoration panel **315** that is provided separately from a first handle body **311** that constitute the overall appearance of the pop-up handle **31**.

[0119] In some examples, the decoration panel **315** may include a material having the same texture as that of the front panel **30a** of the door **30**.

[0120] Thus, the user may feel a sense of unity the decoration panel **315** and the front panel **30a** of the door **30**, and thus the aesthetic sensibility of the outer appearance of the door **30** may be improved and the aesthetics of the door which the user perceives may be improved.

[0121] FIG. 4 and FIG. 5 illustrate a state in which the pop-up handle **31** has been displaced from the retracted position Pa to the extended position Pd as the most forward position.

[0122] As described above, the door **30** of the dish washer **1** should be opened and closed in order to store the dishes that need to be washed in the dish washer or to withdraw the dishes that have been washed out of the dish washer **1**.

[0123] When the user's intention to open the door **30** is identified as being present at a time when opening/closing of the door **30**, the pop-up handle **31** may be automatically moved from the retracted position Pa to the extended position Pd under the operation of the handle driver **35**.

[0124] In some examples, the dish washer **1** may further be provided with a device for detecting the user's intention to open the door **30**.

[0125] For example, the dish washer **1** may include a proximity sensor S_p as a first device for detecting absence or presence of a user's intention to open the door **30**.

[0126] The proximity sensor S_p may be a sensor that may detect whether the user approached so as to be located within a specific detection range from the door **30**.

[0127] For example, the proximity sensor S_p may include any one of a radar sensor, an image sensor, or an infrared sensor (IR) Sensor.

[0128] However, implementations of the present disclosure are not limited thereto, and the proximity sensor S_p may be applied without limitation in terms of the type thereof as long as the proximity sensor S_p is a device that may identify proximity of the user to the door. The following description will be based on an example in which the radar sensor is applied as the proximity sensor S_p.

[0129] As shown in FIG. 3 and FIG. 4, the radar sensor as the proximity sensor S_p may be disposed on the control panel **32** and at a location close to the existing display **33** so as to easily identify the proximity of the user to an area in front of the door, and to facilitate modularization thereof with the existing display **33**.

[0130] Furthermore, in order to distinguish between a user and a non-user such as a pet, the radar sensor functioning as the proximity sensor S_p may be disposed on the control panel **32** and at a location as close as possible to a center of the top surface of the door **30**.

[0131] However, the dish washer **1** is not configured to immediately move the pop-up handle **31** even when the radar sensor recognizes that the user is located within a predetermined detection range from the door **30**.

[0132] This is because there may be cases where the user simply passes by the dish washer **1** without any intention to open the door **30**.

[0133] In some implementations, the dish washer **1** may be further configured to add a time condition to identify absence or presence of the intention to open the door **30** through the proximity sensor S_p such as the radar sensor.

[0134] In some examples, when the dish washer **1** identifies that the user is present within a specific detection range from the door **30** through the radar sensor and continues to stay within the specific detection range for a specific time condition, the dish washer **1** may determine that the user has an intention to open the door **30**.

[0135] In some examples, the specific detection range and the specific time condition may be set to vary depending on the environment in which the dish washer **1** is disposed and a physical condition of the user.

[0136] When the specific detection range condition and the specific time condition are satisfied, a controller **100** as described below is configured to initiate the operation of the handle driver **35** to move the pop-up handle **31** in the frontward direction from the retracted position Pa to the extended position Pd.

[0137] Details regarding the configuration for identifying absence or presence of the user's intention to open the door **30** using the proximity sensor S_p, etc., will be described below with reference to FIG. **18**.

[0138] FIG. **4** and FIG. **5** illustrate the state in which the pop-up handle **31** has completed the forward movement to the extended position Pd.

[0139] When the pop-up handle **31** has completed its movement to the extended position Pd, the first handle body **311** of the pop-up handle **31** may be entirely exposed to the outside of the door **30** and may be grasped by the user.

[0140] In some examples, a stroke Ls by which the pop-up handle **31** is displaced from the retracted position Pa to the extended position Pd may be in a range of 40 mm inclusive to 50 mm inclusive, for example, 45 mm.

[0141] The stroke Ls of the pop-up handle **31** is determined in consideration of that when the stroke Ls is too small, such as smaller than 40 mm, it is not easy for the user to grasp the handle, while when the stroke Ls is too large, such as larger than 50 mm, a size of the pop-up handle **31** in the forward and backward direction increases, thereby causing a problem in that the pop-up handle **31** does not retract entirely into the door **30**.

[0142] However, the numerical value of the movement stroke Ls of the pop-up handle **31** is only an example and may be set to vary depending on the overall size of the dish washer **1** and the size in the forward and backward direction of the door **30**.

[0143] In one example, as the pop-up handle **31** moves to the extended position Pd, the first handle body **311** of the pop-up handle **31** comes out of the opening **30e** of the front panel **30a** of the door **30** and is exposed to the outside of the door **30**. Accordingly, the opening **30e** is not blocked with the first handle body **311**.

[0144] However, when the pop-up handle **31** moves to the extended position Pd as described below, a second handle body **312** connected to the first handle body **311** moves in the frontward direction together therewith, so that the opening **30e** of the front panel **30a** is blocked with the second handle body **312**.

[0145] Therefore, even when the pop-up handle **31** has been moved to the extended position Pd, the

opening **30e** of the front panel **30a** may be maintained in a blocked state, so that foreign substances such as dusts may be effectively prevented from entering the inside of the door **30**.

[0146] Furthermore, since the observation of the inside of the door **30** through the opening **30e** of the front panel **30a** blocked with the second handle body **312**, the deterioration of the aesthetic sense for the user may be effectively prevented.

[0147] Hereinafter, referring to FIG. **6** to FIG. **13**, the detailed configuration of the handle driver **35** that actuates the pop-up handle **31** so that the pop-up handle **31** moves back and forth between the extended position Pd and the retracted position Pa is described.

[0148] Referring to FIG. **6**, in consideration of a shape of each of the first handle body **311** and the second handle body **312** of the pop-up handle **31** that extends in an elongate manner in the left-right direction, a pair of handle drivers **35** may be disposed separately and respectively on a left end and a right end of the pop-up handle **31**.

[0149] That is, the pair of handle drivers **35** may be separated from each other and spaced from each other along the left-right direction and may be respectively on a left end and a right end of the pop-up handle **31** so as to respectively transmit a driving force for moving the pop-up handle **31** to the left end and the right end of the pop-up handle **31** which are accommodated inside a handle housing **30d4**.

[0150] In this way, the pair of handle drivers **35** are disposed in a state separated from each other and spaced from each other along the left-right direction, the driving force generated from each of the handle drivers **35** may be transmitted to each of the left and right ends of the pop-up handle **31**.

[0151] Accordingly, since driving loads applied to the handle drivers **35** are distributed, the miniaturization of each of the handle drivers **35** may be achieved, and thus, the manufacturing cost may be reduced.

[0152] However, this is only an example. Alternatively, the pop-up handle **31** may be driven using only a single handle driver. Hereinafter, an implementation in which the pair of handle drivers **35** are provided will be described. However, implementations of present disclosure are not limited thereto.

[0153] As illustrated, the left handle driver **35** and the right handle driver **35** may have shapes symmetrical with each other and may be arranged symmetrically with each other around the pop-up handle **31**, and may be fixedly installed on a handle frame **30d**.

[0154] Therefore, the right and left handle drivers **35** may be configured to be identical with each other except for the fact that the left handle driver **35** and the right handle driver **35** have shapes symmetrical with each other and are arranged symmetrically with each other around the pop-up handle **31**.

[0155] Therefore, the following description will be based on the handle driver **35** disposed at the left side. Unless otherwise described, the following content may be equally applied to the handle driver **35** disposed at the right side.

[0156] As shown in FIG. **7** to FIG. **9**, the handle driver **35** that generates the driving force for the reciprocating movement of the pop-up handle **31** may be configured to include a driving motor **351** that receives power and generates a rotational driving force, a driving cam **352** that spins under the rotational driving force of the driving motor **351**, a pivot link **353** that pivots around one end thereof in conjunction with the spin motion of the driving cam **352** so as to push or pull the pop-up handle **31**, a link connector **354** that connects the pivot link **353** and the pop-up handle **31** to each other, and a housing **355** that accommodates therein the driving motor **351**, the driving cam **352**, and the pivot link **353**.

[0157] The driving motor **351** is configured to receive power and generate a rotational driving force.

[0158] As described above, the pop-up handle **31** may be configured to repeatedly move forwards from the retracted position Pa toward the extended position Pd and move backwards from the extended position Pd toward the retracted position Pa and thus to reciprocate between the extended

position Pd and the retracted position Pa.

[0159] In order to easily implement such reciprocating movement, the driving motor **351** constituting the handle driver **35** may be configured to generate a bidirectional rotation driving force.

[0160] Accordingly, the driving motor **351** applied to the handle driver **35** may be applied without limitation in terms of the type thereof as long as the driving motor **351** is capable of generating the bidirectional rotation driving force.

[0161] Hereinafter, among the bidirectional rotation driving (forces), the driving (driving force) in the direction in which an output shaft **3512** of the driving motor **351** rotates to move the pop-up handle **31** in the frontward direction toward the extended position Pd is referred to as forward direction rotation driving (forward direction rotation driving force), while the driving (driving force) in the direction in which the output shaft **3512** of the driving motor **351** rotates to move the pop-up handle **31** backwards toward the retracted position Pa is referred to as reverse direction rotation driving (or reverse direction rotation driving force).

[0162] In one example, as shown in FIG. **8**, a motor body **3511** of the driving motor **351** may be accommodated in an accommodation space formed between a second housing **3552** and a third housing **3553**, and the output shaft **3512** of the driving motor **351** may extend thorough the second housing **3552** and be connected to the driving cam **352**.

[0163] As described below, the output shaft **3512** of the driving motor **351** may be inserted into a shaft hole **3522** of the driving cam **352**, and may be forcibly coupled to the shaft hole **3522**.

[0164] Thus, the output shaft **3512** of the driving motor **351** may rotate integrally with the driving cam **352**.

[0165] In one example, the driving cam **352** receives the rotation driving force from the output shaft **3512** of the driving motor **351** and transmits the received rotation driving force to the pivot link **353**.

[0166] More specifically, when the driving cam **352** rotates in the forward direction in conjunction with the rotation of the output shaft **3512** of the driving motor **351**, the driving cam **352** pressurizes the pivot link **353** so that the pivot link **353** pivots in the frontward direction. When the driving cam **352** rotates in the reverse direction in conjunction with the rotation of the output shaft **3512** of the driving motor **351**, the driving cam **352** pressurizes the pivot link **353** so that the pivot link **353** pivots in the backward direction.

[0167] In some examples, the driving cam **352** may be configured to include a cam body **3521** that spins under the rotation driving force transmitted from the output shaft **3512** of the driving motor **351**, and a driving pin **3523** that is disposed on one side surface of the cam body **3521** and protrudes toward the pivot link **353**.

[0168] The cam body **3521** may be provided in a form of a disk having an approximately uniform thickness, for example.

[0169] The shaft hole **3522** to which the output shaft **3512** of the driving motor **351** is forcibly inserted may extend through a center portion of the cam body **3521**.

[0170] In order to easily implement integral rotation of the cam body **3521** and the motor shaft **3512** via the forcible coupling between the output shaft **3512** and the shaft hole **3522**, the output shaft **3512** and the shaft hole **3522** may be connected to each other via a spline coupling, etc.

[0171] In one example, the driving pin **3523** plays a role of transmitting the rotation driving force of the cam body **3521** to the pivot link **353**.

[0172] As illustrated, the driving pin **3523** may be formed to protrude from one side surface facing the pivot link of the cam body **3521** toward the pivot link **353**, and may be positioned at a position spaced apart from the shaft hole **3522** by a predetermined distance in a radial direction.

[0173] Therefore, when the cam body **3521** spins around the shaft hole **3522**, the driving pin **3523** revolves around the shaft hole **3522**.

[0174] The driving pin **3523** is connected to the pivot link **353** while being inserted into a guide

groove **3533** of the pivot link **353** as described later.

[0175] Accordingly, while the driving pin **3523** revolves around the shaft hole of the cam body **3521**, the driving pin **3523** pressurizes the pivot link **353** so that the pivot link **353** pivots in a frontward or backward direction.

[0176] In one example, a revolve range of the driving pin **3523** or a spin range of the cam body **3521** needs to be smaller than an extension length of the guide groove **3533** provided in the pivot link **353**. This is because when the revolve range is larger than the extension length of the guide groove **3533**, there is a possibility that the driving pin **3523** or the guide groove **3533** may be damaged.

[0177] A stopper protrusion **3524** acting as a structure for limiting the revolve range of the driving pin **3523** or the spin range of the cam body **3521** may be disposed on an edge of the cam body **3521** and protrude along a radial direction thereof.

[0178] As illustrated, the stopper protrusion **3524** may be implemented as a predetermined step formed on the edge of the cam body **3521**.

[0179] The stopper protrusion **3524** implemented as the step may be provided as a pair of stopper protrusions spaced apart from each other along a circumferential direction of the cam body which may limit the revolve range of the driving pin **3523** or the spin range of the cam body **3521** in both opposing directions.

[0180] In this way, the stopper protrusion **3524** may limit the revolve range of the driving pin **3523** or the spin range of the cam body **3521** to a circumferential range defined between the pair of stopper protrusions **3524**.

[0181] As shown in FIG. **9**, a cam stopper **3552b** corresponding to the pair of stopper protrusions **3524** may be provided inside the second housing **3552** that accommodates the driving cam **352**.

[0182] In one example, the pivot link **353** receives the driving force from the driving pin **3523** of the driving cam **352** so as to push the pop-up handle **31** so that the pop-up handle **31** moves forwards or pull the pop-up handle **31** so that the pop-up handle **31** moves backwards.

[0183] As shown in FIG. **9**, the pivot link **353** may be, for example, a bar-type link extending from a first end **3531** toward a second end **3532** thereof in a bar shape.

[0184] In some examples, the first end **3531** of the pivot link **353** as the bar-type link may be supported by the first housing **3551** and the second housing **3552** such that the pivot link only relatively rotates with respect to the first housing **3551** and the second housing **3552**, that is, only pivots with respect to the first housing **3551** and the second housing **3552**.

[0185] Accordingly, the pivot link **353** may pivot around the first end **3531** when the pressing force of the driving pin **3523** of the driving cam **352** is applied thereto.

[0186] In some examples, a pair of shaft bosses **3531a** that serve as a pivot center of an entirety of the pivot link **353** may be provided at both opposing sides of the first end **3531** of the pivot link **353**, respectively.

[0187] The pair of shaft bosses **3531a** may be formed to protrude toward the first housing **3551** and the second housing **3552** so as to have a predetermined protrusion height from one side surface and the other side surface of the first end **3531** of the pivot link **353**, respectively.

[0188] A bushing **356** or a bearing may be fitted around each of the pair of shaft bosses **3531a** to reduce friction. The pair of shaft bosses **3531a** may be connected to the first housing **3551** and the second housing **3552**, respectively, while each bushing **356** is fitted around each of the pair of shaft bosses **3531a**.

[0189] Each of the first housing **3551** and the second housing **3552** may be formed to have each of cylindrical bushing receiving portions **3551a** and **3552a** into which each bushing **356** may be inserted.

[0190] The pivot link **353** may be formed to have the guide groove **3533** into which the driving pin **3523** of the driving cam **352** as described above is inserted.

[0191] As illustrated, the guide groove **3533** may be formed between the first end **3531** and the

second end **3532**, and may be defined in a first extension **353a** of the pivot link **353** as described below.

[0192] The guide groove **3533** may linearly extend along a length direction of the first extension **353a**. Movement of the driving pin **3523** may be guided along the extension direction of the guide groove **3533** so that the driving pin **3523** moves relative to the guide groove **3533** while being inserted into the guide groove **3533**.

[0193] In one example, the second end **3532** of the pivot link **353** may be connected to the second handle body **312** of the pop-up handle **31** so as to be relatively pivotable with respect thereto, and may be configured to move the pop-up handle **31** forwards or backwards by pushing or pulling the second handle body **312** when the pivot link **353** pivots.

[0194] The second end **3532** of the pivot link **353** may be connected to the second handle body **312** via a connection pin **3534** so that the second end **3532** of the pivot link **353** may be pivotable relative to the second handle body **312**.

[0195] In some examples, the link connector **354** may be further provided as a component for mutually connecting the second end **3532** of the pivot link **353** and the second handle body **312** to each other.

[0196] As illustrated, in one example, the link connector **354** may be configured to include a handle connection portion **3541** that is fastened to the second handle body **312** as described below, and a link connection portion **3542** that is indirectly connected to the second end **3532** via the connection pin **3534**.

[0197] The handle connection portion **3541** may be formed in a flat shape so as to make surface contact with the second handle body **312** in order to secure a maximum contact area with the second handle body **312**.

[0198] The handle connection portion **3541** may be formed to have a plurality of screw holes **3541h** defined therein so that a connecting device such as a screw bolt may pass through each screw hole.

[0199] The link connection portion **3542** may be indirectly connected to the second end **3532** of the pivot link **353** via the connection pin **3534**.

[0200] In some examples, a pin guide hole **3543** may be formed in the link connection portion **3542** and extend through the link connection portion along the left-right direction.

[0201] As illustrated, the pin guide hole **3543** may linearly extend along the vertical direction. The movement of the connection pin **3534** may be guided so that the connection pin moves relative to the pin guide hole **3543** in the vertical direction while being inserted into the pin guide hole **3543**.

[0202] Therefore, when the pivot link **353** pivots, the connection pin **3534** coupled to the second end **3532** of the pivot link **353** moves along the pin guide hole **3543**, thereby pushing the link connector **354** forwards or pulling the link connector backwards, thereby causing the pop-up handle **31** to move forwards or backwards.

[0203] In order to allow the connection pin **3534** to be connected in this way, left and right pin holes **3532h** through which the connection pin **3534** passes may extend through the second end **3532** of the pivot link **353** along the left-right direction and may be arranged along the left-right direction.

[0204] Furthermore, the second end **3532** of the pivot link **353** may be formed in a branched form as illustrated in order to prevent interference with the link connection portion **3542** that moves relative to the second end **3532**.

[0205] In one example, as described above, the pivot link **353** pivots around the first end **3531** to push or pull the link connector **354** and the second handle body **312** to generate the forward or backward movement stroke Ls of the pop-up handle **31**.

[0206] In order to minimize a pivot amount of the pivot link **353** and maximize the frontward-backward movement stroke Ls of the pop-up handle **31**, the second end **3532** of the pivot link **353** may extend in an inclined manner toward the second handle body **312** of the pop-up handle **31**.

[0207] That is, as shown in FIG. 9, the pivot link 353 may include a first extension 353a that extends radially from the first end 3531, and a second extension 353b that extends in a bent manner toward the pop-up handle 31 and between the first extension 353a and the second end 3532.

[0208] In this way, the second extension 353b is formed to be bent or curved toward the pop-up handle 31, thereby greatly increasing a frontward-rearward stroke Ls by which the second handle body 312 of the pop-up handle 31 is pushed or pulled.

Movement of the Pop-up Handle Under Operation of Handle Driver

[0209] Referring to FIG. 10 to FIG. 13, a process in which the pop-up handle 31 moves forwards to the extended position Pd or moves backwards to the retracted position Pa under the operation of the handle driver 35 will be described below.

[0210] FIG. 10 illustrates a situation in which the pop-up handle 31 automatically moves forwards along the forward direction Dfw from the retracted position Pa toward the extended position Pd.

[0211] Referring to FIG. 10, when the pop-up handle 31 has been displaced to the retracted position Pa, the power is supplied to the driving motor 351, such that the operation of the driving motor 351 is initiated, and the driving motor 351 generates the forward direction rotation driving force.

[0212] Accordingly, the forward direction rotation of the output shaft 3512 of the driving motor 351 may be initiated, and the forward direction spin of the driving cam 352 forcibly connected to the output shaft 3512 may be initiated.

[0213] At this time, when the forward direction rotation is initiated, the output shaft 3512 and the driving cam 352 may start to rotate counterclockwise based on the illustrated state.

[0214] In one example, as the forward direction spin of the driving cam 352 is initiated, a forward direction revolve of the driving pin 3523 may be initiated.

[0215] As shown in FIG. 10, the driving pin 3523 which has been located at a lower end of the guide groove 3533 of the pivot link 353 may start to move to a top of the guide groove 3533.

[0216] As the driving pin 3523 revolves in the forward direction, the driving pin moves to the top from the bottom of the guide groove 3533, such that the driving pin 3523 presses the pivot link 353 such that the pivot link pivots forwards around the first end 3531. That is, based on the illustrated state, the pivot link 353 pivots counterclockwise around the first end 3531.

[0217] At this time, as the pivot link 353 pivots around the first end 3531, the second end 3532 of the pivot link 353 also pivots forwards, and the connection pin 3534 connected to the second end 3532 pivots forwards.

[0218] Accordingly, the driving pin 3523 which has been located at the bottom of the guide hole 3543 of the link connector 354 moves to the top of the guide hole 3543.

[0219] As the connection pin 3534 moves to the top from the bottom of the guide hole 3543, the connection pin 3534 presses the link connector 354 and the second handle body 312 to push forwards. That is, while the connection pin 3534 moves relative to the guide hole 3543 and along the guide hole 3543, a pressure force is applied to the link connector 354 to push the link connector 354 forwards.

[0220] In this way, the operation of the handle driver 35 is initiated, such that the driving cam 352 has completely rotated along a preset rotation range. Then, the power supply to the driving motor 351 may be cut off, and the forward movement of the pop-up handle 31 to the extended position Pd may be completed.

[0221] FIG. 11 shows the state in which the pop-up handle 31 has completed the forward movement to the extended position Pd.

[0222] When the forward movement of the pop-up handle 31 to the extended position Pd has been completed in this way, an entirety of the first handle body 311 may be exposed to the outside of the door 30, and thus, the user may easily perform the action of opening or closing the door 30 while holding the first handle body 311.

[0223] In some examples, as shown in FIG. 13, when the pop-up handle 31 has been displaced to

the extended position Pd, the first extension **353a** of the pivot link **353** has stood upright, and the driving pin **3523** of the driving cam **352** has been moved to the bottom of the guide groove **3533**. [0224] Therefore, as shown, a predetermined intersection angle α may be defined between a virtual first extension line Lc1 connecting a center Cr of the driving pin **3523** and a rotation center Cc of the shaft hole **3522** as a rotation center of the cam body **3521** and a virtual second extension line Lc2 which is parallel to a moving direction Drw/Dfw of the pop-up handle **31** and passes through the rotation center Cc of the shaft hole **3522** of the cam body **3521**. However, the intersection angle α may be very small angle.

[0225] For example, the intersection angle α may be in a range of 0 degrees inclusive to 5 degrees inclusive.

[0226] The very small intersection angle α in a range of 5 degrees or smaller is defined in this way. Thus, a structure may be achieved in which the first handle body **311** is fixed at the extended position Pd without being removed from the extended position Pd even when a user's pressure to open or close the door **30** is applied to the first handle body **311** of the pop-up handle **31**.

[0227] That is, a structure in which the pop-up handle **31** may be effectively fixed at the extended position Pd may be achieved by a position arrangement of the pivot link **353** and the driving cam **352** while a separate removal-prevention structure or fixing structure is not disposed at the pop-up handle **31** and the handle frame **30d** as described below.

[0228] Thus, in the dish washer **1**, a structure of a combination of the pop-up handle **31**, the handle driver **35**, and the handle frame **30d** may be simplified, and a manufacturing cost thereof may be reduced.

[0229] FIG. **11** illustrates a situation in which the pop-up handle **31** automatically moves backwards along the backward direction Drw from the extended position Pd toward the retracted position Pa.

[0230] Referring to FIG. **11**, the pop-up handle **31** has moved to the extended position Pd. Then, after a predetermined waiting time has elapsed, the power is supplied to the driving motor **351**, the driving motor **351** starts operating, and the driving motor **351** generates the reverse rotation driving force. For example, the predetermined waiting time may be in a range of 2.5 seconds to 3.5 seconds.

[0231] Accordingly, the reverse rotation of the output shaft **3512** of the driving motor **351** starts, and the reverse spin of the driving cam **352** forcibly connected to the output shaft **3512** may start.

[0232] When the reverse rotation starts, the output shaft **3512** and the driving cam **352** may start to rotate clockwise based on the illustrated state.

[0233] Further, as the reverse spin of the driving cam **352** starts, the reverse revolution of the driving pin **3523** may start.

[0234] As shown in FIG. **11**, the driving pin **3523** which has been positioned at the bottom of the guide groove **3533** of the pivot link **353** may start to move relative to the guide groove **3533** and to the top of the guide groove **3533**.

[0235] As the driving pin **3523** revolves in the reverse direction, the driving pin moves relative to the guide groove **3533** and to the top from the bottom of the guide groove **3533**, the driving pin **3523** presses the pivot link **353** to pivot in the rearward direction around the first end **3531**. That is, based on the shown state, the pivot link **353** pivots clockwise around the first end **3531**.

[0236] In some examples, as the pivot link **353** pivots around the first end **3531**, the second end **3532** of the pivot link **353** also pivots in the rearward direction, and the connection pin **3534** connected to the second end **3532** pivots in the rearward direction.

[0237] Accordingly, the driving pin **3523** which has been located at the top of the guide hole **3543** of the link connector **354** moves relative to the guide hole **3543** and to the bottom of the guide hole **3543**.

[0238] As the connection pin **3534** moves relative to the guide hole **3543** and from the top to the bottom of the guide hole **3543**, the connection pin **3534** applies the pressure the link connector **354**

to pull the link connector **354** in the rearward direction. That is, while the connection pin **3534** moves relative to and along the guide hole **3543**, a pressure force is applied to the link connector **354** to pull the link connector **354** in the rearward direction.

[0239] In this way, the operation of the handle driver **35** has been initiated, and then, the driving cam **352** has completed the reverse pivot motion thereof along the preset rotation range. Then, the power supply to the driving motor **351** may be cut off, and the backward movement of the pop-up handle **31** to the retracted position Pa may have been completed.

Guide of Linear Movement of Pop-up Handle

[0240] As described above, the pop-up handle **31** is configured to move forwards or backwards under the forward direction driving force or the reverse direction driving force of the handle driver **35**.

[0241] However, as described above, the pop-up handle **31** may be configured to move horizontally or linearly along the forward direction Dfw or the backward direction Drw.

[0242] A structure for implementing the horizontal or linear movement may be provided in the pop-up handle **31** and the handle frame **30d** in which the pop-up handle **31** is accommodated.

[0243] As described above, the pop-up handle **31** may be configured to include the first handle body **311** that is exposed to the outside of the door **30** and can be gripped by the user when the handle has been moved to the extended position Pd, and the second handle body **312** that is connected to a rear end of the first handle body **311** and is disposed inside the door **30** when the handle has been moved to the extended position Pd.

[0244] As illustrated in FIG. **14**, the second handle body **312** may include a plate-shaped panel **3121** that serves to screen the opening **30e** formed in the front panel **30a** of the door **30** when the pop-up handle **31** has been moved to the extended position Pd, and an edge rib **3122** that extends along an edge of the panel **3121** and extends rearwardly so as to be away from the first handle body **311**.

[0245] As described above, the link connector **354** of the handle driver **35** may be attached to a rear surface of the panel **3121** constituting the second handle body **312**.

[0246] That is, the driving force of the handle driver **35** may be transmitted to the panel **3121** of the second handle body **312** via the link connector **354**, and may be transmitted to the first handle body **311** via the panel **3121**.

[0247] The edge rib **3122** extends along the edge of the panel **3121** and serves to reinforce rigidity of the panel **3121** and prevent the pop-up handle **31** from being removed from the door **30** when the handle is pulled by the user.

[0248] In order to perform the removal prevention function, the edge rib **3122** may be formed to have a width in the vertical direction and a width in the left-right direction larger than those of each of the opening **30e** of the front panel **30a** of the door **30** and an opening **30d2** of a handle frame **30d** described later.

[0249] Due to the size of the edge rib **3122**, when the first handle body **311** is pulled, a front surface of the edge rib **3122** may collide with an inner surface of the handle frame **30d**, thereby preventing the first handle body **311** and the second handle body **312** from being removed from the door.

[0250] In one example, a vertical extension **3122b** of the edge rib **3122** may have a guide protrusion **3123** that protrudes so as to be away from the edge rib **3122**.

[0251] As shown in FIG. **14**, the guide protrusion **3123** may have a shape having a constant thickness in the vertical direction and extending in an elongate manner along a direction parallel to the forward direction Dfw or the backward direction Drw of the pop-up handle **31**.

[0252] The guide protrusion **3123** may be inserted into a rail groove **30d45** of the handle housing **30d4** described below. As the guide protrusion **3123** moves along the rail groove **30d45**, the first handle body **311** and the second handle body **312** move horizontally or linearly.

[0253] Therefore, a combination of the guide protrusion **3123** of the second handle body **312** and

the rail groove **30d45** of the handle housing **30d4** may act as a first structure for implementing the horizontal or linear movement of the pop-up handle **31**.

[0254] FIG. **14** shows a configuration in which only a left portion of the edge rib **3122** is provided with the guide protrusion **3123**. However, implementations of the present disclosure are not limited thereto. A right portion of the edge rib **3122** opposite to the left portion thereof may also be provided with the guide protrusion **3123**.

[0255] Furthermore, as shown in FIG. **14**, the horizontal extension **3122a** of the second handle body **312** may have a notch **3122c** defined therein whose a left-right width is maintained to be constant.

[0256] A protruding surface portion **30d46** of the handle housing **30d4** described later may be inserted into the notch **3122c**.

[0257] A left-right width of the protruding surface portion **30d46** may be maintained to be constant in a corresponding manner to a shape of the notch **3122c**.

[0258] When the first handle body **311** and the second handle body **312** have been accommodated in the handle housing **30d4**, the protruding surface portion **30d46** may be inserted into the notch **3122c**. Therefore, when the pop-up handle **31** moves, the notch **3122c** moves along the protruding surface portion **30d46**, such that the first handle body **311** and the second handle body **312** move horizontally or linearly.

[0259] Therefore, a combination of the notch **3122c** of the second handle body **312** and the protruding surface portion **30d46** of the handle housing **30d4** may act as a second structure for implementing the horizontal or linear movement of the pop-up handle **31**.

[0260] FIG. **15** illustrates the handle frame **30d** including the handle housing **30d4** in which the first handle body **311** and the second handle body **312** are accommodated.

[0261] The handle frame **30d** supports the aforementioned handle driver **35** attached thereto and receives therein and supports the pop-up handle **31** so as to be movable therein.

[0262] The handle frame **30d** may include a panel portion **30d1** and an outer wall **30d3** that serve as a support surface or an attachment surface to support the handle driver **35**.

[0263] The panel portion **30d1** and the outer wall **30d3** of the handle frame **30d** may be attached to an inner surface of the front panel **30a** of the door **30**.

[0264] In one example, the handle frame **30d** may further include the handle housing **30d4** to accommodate therein and support the pop-up handle **31** so as to be movable therein.

[0265] As illustrated, the handle housing **30d4** may be provided in a box shape with open front and rear surfaces so that the first handle body **311** and the second handle body **312** may be entirely accommodated in the handle housing in a state where the pop-up handle **31** has been moved to the retracted position Pa.

[0266] The open front surface of the handle housing **30d4** may act as the opening **30d2** through which the first handle body **311** extends or retracts.

[0267] The opening **30d2** of the handle housing **30d4** may be formed at a position corresponding to a position of the opening **30e** of the front panel **30a** of the door **30** and may have a corresponding size to a size of the opening **30e**.

[0268] The handle housing **30d4** may be provided with the rail groove **30d45** and the protruding surface portion **30d46**, each serving as the structure for implementing the horizontal or linear movement of the pop-up handle **31** as described above.

[0269] The rail groove **30d45** may be formed in each of a left side surface and a right side surface of the handle housing **30d4**, and may be formed by partially protruding each of the left side and right side surfaces thereof toward the outer wall **30d3**.

[0270] The protruding surface portion **30d46** may be formed on an upper surface of the handle housing **30d4**, and may be formed by protruding a portion of the upper surface thereof downwards.

[0271] In one example, as illustrated, a cut-away **30d44** may be defined in a lower surface **30d42** of the handle housing **30d4** to provide a movement path of the pivot link **353** of the handle driver **35**.

[0272] FIG. 16 illustrates a detailed structure of the pop-up handle **31** disposed in front of the first handle body **311** as described above.

[0273] Referring to FIG. 16, the pop-up handle **31** provided in the dish washer **1** may further include a handle substrate **313** that is disposed on a front surface of the first handle body **311** and has at least one light-source element **3131** mounted thereon, a light-guide plate **314** that is disposed in front of the handle substrate **313** and diffuses visible light generated from the light-source element **3131**, and the decoration panel **315** that is disposed in front of the light-guide plate **314**.

[0274] The light-source element **3131** generates visible light or another type of light when the pop-up handle **31** moves, thereby visually notifying the user that the pop-up handle **31** is operating normally.

[0275] The light-source element **3131** may be applied without limitation in terms of the type thereof as the light-source element **3131** may receive power and generate predetermined visible light. In one example, the light-source element **3131** may be an LED (light emitting diode) element.

[0276] The following description will be based on an example in which the LED element is applied as the light-source element **3131**. However, implementations of the present disclosure are not limited thereto.

[0277] FIG. 16 illustrates a configuration in which a total of 7 LED elements are mounted on the handle substrate **313**. However, implementations of the present disclosure are not limited thereto, and the number of LED elements may be increased or decreased depending on a size and a shape of the first handle body **311**.

[0278] In one example, the light-guide plate **314** serves to diffuse the visible light generated from the light-source element **3131**.

[0279] More specifically, the visible light generated from the light-source element **3131** may be introduced into the light-guide plate **314** through a rear surface of the light-guide plate **314**. Then, the visible light received inside the light-guide plate **314** may be spread therein such that the visible light diffuses toward an edge of the light-guide plate **314**.

[0280] In some examples, the decoration panel **315** disposed in front of the light-guide plate **314** may be surface-treated to have the same texture as that of the front panel **30a** of the door **30** as described above.

[0281] Therefore, the visible light introduced into the light-guide plate **314** may not pass through the decoration panel **315** and may be projected to the outside through the edge of the light-guide plate **314**.

[0282] In order to project the visible light, the edge of the light-guide plate **314** may be exposed to the outside, as shown in FIG. 17.

[0283] That is, the light-guide plate **314** may be positioned so as to be sandwiched between the decoration panel **315** and the front surface of the first handle body **311**, while the edge of the light-guide plate **314** may not be covered with the decoration panel **315** and the front surface of the first handle body **311**.

[0284] Therefore, as illustrated, the light generated from the light-source element **3131** may travel through the inside of the light-guide plate **314** and then through the edge of the light-guide plate **314** and then may be effectively projected to the outside. Thus, the user may effectively identify an operating state of the pop-up handle **31** based on the optical light projected through the edge of the light-guide plate **314**. In order that information indicating that the pop-up handle **31** is operating normally or that the operation of the pop-up handle will soon commence may be effectively conveyed to the user, the power may be supplied to the light-source element **3131** before the operation of the handle driver **35** commences or at the same time as a time when the operation of the handle driver **35** commences, so that the visible light may be irradiated to the outside out of the pop-up handle **31**, as described below.

[0285] Furthermore, since the visible light is projected only through the edge of the light-guide plate **314**, a lighting effect similar to indirect lighting may be achieved, thereby improving aesthetic

sensibility for the user.

[0286] In one example, the pop-up handle **31** of the present disclosure is configured to automatically move forwards and automatically move backwards according to the operation of the handle driver **35**.

[0287] Therefore, during the automatic backward movement of the pop-up handle **31**, there is a possibility that the user's hand or an object may be caught into between the first handle body **311** and the door **30**, and a device for warning and preventing such "hand being caught" to the user may be provided.

[0288] A vibration element **3132** as one of the devices for warning such "hand being caught" may be provided in the pop-up handle **31**.

[0289] For example, the vibration element **3132** may be mounted on the handle substrate **313** and may be configured to generate a haptic vibration in the pop-up handle **31** when the "hand being caught" is detected.

[0290] As shown in FIG. **16**, the vibration element **3132** may be mounted on the handle substrate **313**.

[0291] In some examples, either a piezo element or a haptic motor may be selected as the vibration element **3132** that may generate the haptic vibration and may be effectively mounted on the handle substrate **313**.

[0292] In one example, the pop-up handle **31** may further be provided with a device for detecting the "hand being caught."

[0293] The device for detecting the "hand being caught" may be referred to as a first safety sensor **S_sf1** and a second safety sensor **S_sf2**.

[0294] The first safety sensor **S_sf1** detects whether the user's hand is caught with into between the first handle body **311** and the door **30**.

[0295] In one example, the first safety sensor **S_sf1** may include either a touch sensor **S_t** or an infrared sensor **S_if**.

[0296] The touch sensor **S_t** may be a capacitive touch sensor. In this case, a conductive sheet **316** constituting the capacitive touch sensor may be disposed on a rear surface of the first handle body **311** facing the door **30** so that contact of the user's finger therewith may be effectively detected by the sensor.

[0297] The infrared sensor **S_if** may be configured to project infrared rays from a transmitter **S_if1** toward a receiver **S_if2** and identify presence of the user's finger between the transmitter **S_if1** and the receiver **S_if2** based on whether the infrared rays are received by the receiver **S_if2**. In some examples, as illustrated in FIG. **16**, the transmitter **S_if1** and the receiver **S_if2** may be separately and respectively disposed at both opposing ends of the first handle body **311**.

[0298] However, the positions of the transmitter **S_if1** and receiver **S_if2** are only examples, and the transmitter **S_if1** and receiver **S_if2** may be installed in other positions than the positions on the first handle body **311**.

[0299] The second safety sensor detects whether an object other than the user's hand is located between the pop-up handle **31** and the door **30**.

[0300] For example, the second safety sensor **S_sf2** may include one of a strain sensor that detects whether the pop-up handle **31** or the handle driver **35** is deformed when the pop-up handle **31** moves backwards, or a current sensor that detects an overload of the driving motor **351** when the pop-up handle **31** moves backwards.

[0301] In some examples, the strain sensor may be attached to the first handle body **311** or the second handle body **312** constituting the pop-up handle **31**, or may be attached to the pivot link **353** of the handle driver **35**.

[0302] Furthermore, in some examples, the current sensor may be provided in a power supply **48** as described below and configured to detect a current value supplied to the driving motor **351** through the power supply **48**.

[0303] As described above, the dish washer **1** may further include a device for detecting a user's intent to open the door **30**.

[0304] For example, the device for detecting the user's intent to open the door **30** may be the proximity sensor S_p and a knock-on sensor S_n .

[0305] FIG. **18** illustrates a configuration for detecting the user's intent to open the door **30** using a single radar sensor as the proximity sensor S_p .

[0306] In some implementations, the radar sensor may transmit the electromagnetic waves from a sensing surface thereof and may receive the electromagnetic waves reflected from the user or the object and may analyze the received electromagnetic waves and may perform a function of detecting the presence of the user or the object within a detection area as, a distance to the user or the object, and a moving speed of the user or the object based on the analysis result.

[0307] As illustrated, the detection area as of the radar sensor applied to the present disclosure may have an angular range of about 100 degrees along the frontward-backward direction and about 100 degrees along the left-right direction around the sensing surface S_{p1} .

[0308] In some examples, as described above, the radar sensor functioning as the proximity sensor S_p may be configured to be disposed at a position as close as possible to a center of a top surface of the front panel **30a** of the door **30** defining the inside of the door **30** so as to easily identify whether the user is approaching an area in front of the door **30** and to distinguish between the user and a non-user such as a pet from each other.

[0309] At a position corresponding to the position where the radar sensor is disposed, a sensor hole **30a1** through which electromagnetic waves of the radar sensor may enter and exit may extend through the top surface of the front panel **30a**. The sensor hole **30a1** may be closed with a glass panel **30a2**.

[0310] In some examples, in order to minimize interference with the detection area as of the radar sensor, each of predetermined left and right second clearances **D2** extending in the left-right direction should be secured between the radar sensor S_p and the front panel **30a** in an area of the sensor hole **30a1**, as shown in FIG. **20**. Further, each of predetermined first left and right clearance **D1** extending in the vertical direction should be secured between the sensor substrate **120** on which the radar sensor is mounted and the front panel **30a**, as shown in FIG. **20**.

[0311] For example, a size of each of the first clearance **D1** and the second clearance **D2** may be set to be 5 mm or greater.

[0312] In one example, as shown in FIG. **19**, the radar sensor S_p is disposed inside the door **30** and at a position closer to the top surface of the front panel **30a** of the door **30**, such that the sensing surface S_{p1} of the radar sensor may generally face upwardly of the door **30**.

[0313] Furthermore, the sensing surface S_{p1} of the radar sensor may be oriented in a tilted manner at a predetermined angle in the frontward direction of door **30**.

[0314] Therefore, the sensing surface S_{p1} of the radar sensor may be oriented in a state facing in the frontward and upward direction of the door **30**.

[0315] In this way, the sensing surface S_{p1} of the radar sensor is oriented in a state facing in the frontward and upward direction of the door **30** rather than in the frontward and downward direction of door **30**, the detection area as of the radar sensor may be formed in a tilted manner so as to face in the frontward and upward direction of the door **30**.

[0316] More specifically, referring to FIG. **19**, a substrate frame **30f** to support the aforementioned control panel **32** and a main substrate **110** constituting the control panel **32** may be disposed between the front panel **30a** and the rear panel **30b** and in an upper end of an inner space of the door **30**.

[0317] As illustrated, the substrate frame **30f** may be disposed on top of the handle frame **30d** and may be supported on the handle frame **30d**.

[0318] In some examples, as illustrated, the substrate frame **30f** may be provided as a combination of upper and lower portions stacked along the vertical direction, and may be composed of a first

frame **30f1** constituting the upper portion and a second frame **30f2** constituting the lower portion. [0319] As illustrated, a tilting holder **30f3** for supporting the radar sensor in the tilted state may be disposed on an inner bottom surface of the first frame **30f1** constituting the upper portion and may be integrally or separately formed with or from the first frame **30f1**.

[0320] The radar sensor may be mounted on the main substrate **110**, or may be mounted on the sensor substrate **120** provided separately from the main substrate **110** and adjacent to the main substrate **110**, and may be supported on the tilting holder **30f3** as illustrated.

[0321] In this way, the sensing surface S_p1 of the radar sensor is disposed on the tilting holder **30f3** in a tilted manner so that the sensing surface faces in the frontward and upward direction of the door **30**. Thus, even when an object that may not be expected to use the dish washer **1**, such as a pet or an infant with a height smaller than at least a height of the dish washer **1**, approaches the area in front of the door **30**, the radar sensor may be configured not to detect the object such as the pet or the infant. Accordingly, the pop-up handle **31** may be prevented from operating meaninglessly upon detecting the pet or the infant, and thus power loss may be minimized.

[0322] In some implementations, the tilting angle at of the sensing surface S_p1 of the radar sensor with respect to the horizontal direction may be, for example, in a range of 25 degrees inclusive to 35 degrees inclusive, for example, 30 degrees. For instance, the tilting angle may range from 25 degrees to 35 degrees with respect to the top surface of the door where the sensor hole **30a1** is defined.

[0323] However, the tilting angle at of the sensing surface S_p1 of the radar sensor provided in the present disclosure with respect to the horizontal direction may be adjusted according to the physical condition of the user who is expected to use the dish washer **1**.

[0324] For example, when the tilting angle at of the sensing surface S_p1 of the radar sensor with respect to the horizontal direction is set to 30 degrees, a minimum vertical detection height H_min of the radar sensor may be in a range of 100 cm inclusive to 110 cm inclusive, for example, 105 cm, and a maximum detection distance L_max based on the horizontal direction may be in a range of 75 cm inclusive to 85 cm inclusive, for example, 80 cm.

[0325] That is, when the tilting angle at is set to 30 degrees, a user with a height of 105 cm or larger may be recognized as approaching the door when he or she enters the detection range within 80 cm from the radar sensor based on the horizontal direction.

[0326] Alternatively, for example, when the tilt angle at is set to 15 degrees, a user with a height of 127 cm or more may be recognized as approaching to the door when he or she enters the detection range within 50 cm of the radar sensor in the horizontal direction.

[0327] In some examples, the tilting angle at may be changed by adjusting the inclination angle of the aforementioned tilting holder **30f3**.

[0328] In this way, the dish washer **1** is configured so that the tilting angle at of the sensing surface S_p1 of the radar sensor may be adjusted. Thus, the vertical minimum detection height H_min of the detection range and the horizontal maximum detection distance L_max of the detection range that can be detected by a single radar sensor and may be easily changed and set.

[0329] In some examples, the dish washer **1** may not be configured to immediately move the pop-up handle **31** even when the radar sensor recognizes that the user is located within a predetermined distance range from the door **30**.

[0330] This is because, for example, a situation in which while the user simply passes by the dish washer **1** without the intention of opening the door **30**, the user approaching the door is detected by the proximity sensor S_p may occur.

[0331] Therefore, the dish washer **1** may be further configured to add a time condition to identify absence or presence of the intention to open the door **30** using the proximity sensor S_p such as the radar sensor.

[0332] In some examples, when the dish washer **1** identifies that the user is present within a set distance range from the door **30** using the radar sensor and continues to stay within the set distance

range for a set time condition, the dish washer **1** may determine that the user has the intention to open the door **30**.

[0333] In some examples, the set time condition may be in a range of 0.9 seconds inclusive to 1.1 seconds inclusive, for example, 1 second.

[0334] When the detection range condition and the time condition set in this way are satisfied, as described below, the controller **100** may be configured to initiate the operation of the handle driver **35** to move the pop-up handle **31** forwards from the retracted position Pa to the extended position Pd before the washing course starts or after the washing course has been completed.

[0335] However, when the door **30** is opened while the dish washer **1** is performing the washing course, there is a very high possibility that the washing water will leak from the tub **20** or the user will be burned by the high-temperature washing water or the high-temperature airflow.

[0336] That is, while the washing cycle S2 is in progress using high-temperature washing water inside the tub **20**, or the heating and rinsing cycle S4 is in progress using high-temperature washing water inside the tub **20**, or the drying cycle S5 of drying the dishes is in progress using high-temperature airflow inside the tub **20**, the door **30** may be opened momentarily, such that there is a very high possibility that the user will be burned by the high-temperature washing water or high-temperature airflow.

[0337] However, in some cases, even when the washing course is in progress, a situation may arise where the washing course in progress should be temporarily stopped and the dishes should be added to the inside of the tub **20** or some of the dishes should be withdrawn from the inside of the tub **20**.

[0338] For example, a knock-on sensor S_n may be provided as an additional device for detecting absence or presence of the user's intention to open the door **30** while the washing course is in progress. That is, the knock-on sensor S can detect a motion of the user to thereby determine the user's intention.

[0339] When the user knocks on the door **30** with the intention of opening the door **30**, the knock-on sensor S_n detects the knock-on, and transmits an output signal corresponding to the detected knock-on to the controller **100** described below.

[0340] As described below, the controller **100** may be configured to determine absence or presence of the user's intention to open the door based on a vibration signal received as the output signal from the knock-on sensor S_n.

[0341] The knock-on sensor S_n may be a vibration sensor to effectively detect the user's knock-on input, and may be configured to include a first vibration sensor S_{n1} and a second vibration sensor S_{n2} which are positioned at different locations.

[0342] For example, a combination of the first vibration sensor S_{n1} and the second vibration sensor S_{n2} may act as a single-axis directional vibration detection sensor that may detect a single-axis directional vibration component among three-axes directional vibration components. the first vibration sensor S_{n1} and the second vibration sensor S_{n2} may be configured to have the same appearance and size. The knock-on sensor S_n may be composed of the two vibration sensors having the same appearance and size, the manufacturing cost and assembly cost may be reduced.

[0343] In some examples, the positions at which the first vibration sensor S_{n1} and the second vibration sensor S_{n2} are respectively positioned, and a direction in which the first vibration sensor S_{n1} and the second vibration sensor S_{n2} are arranged may vary according to implementations.

[0344] More specifically, as illustrated in FIG. **21**, the first vibration sensor S_{n1} may be attached to an inner surface of a front portion **30f21** of the second frame **30f2** of the substrate frame **30f** having a cross-section shape of a turned-upside down U shape.

[0345] As illustrated, the front portion **30f21** of the second frame **30f2** may be in direct contact with the front panel **30a** constituting the front portion of the door **30**.

[0346] Therefore, the first vibration sensor S_{n1} may be configured to directly receive the user's knock-on input from the front panel **30a**.

[0347] A rear portion **30f22** of the second frame **30f2** may directly contact the rear panel **30b** of the door **30**.

[0348] In one example, the second vibration sensor **S_n2** may be mounted on the main substrate **110** which is received in a space formed between an upper portion **30f13** of the first frame **30f1** and an upper portion **30f23** of the second frame **30f2**.

[0349] As shown, the main substrate **110** may be supported on the first frame **30f1** and the second frame **30f2** in a state where a contact area thereof with the first frame **30f1** and the second frame **30f2** is minimized to prevent a short circuit.

[0350] Therefore, the vibration generated by the user's knock-on input may be indirectly attenuated through the first frame **30f1**, the second frame **30f2**, and the main substrate **110** and then transmitted to the second vibration sensor **S_n2**.

[0351] Like the second frame **30f2**, the front portion **30f11** of the first frame **30f1** may directly contact the front panel **30a** of the door **30**, and the rear portion **30f22** of the second frame **30f2** may directly contact the rear panel **30b** of the door **30**.

[0352] In one example, as described above, each of the first vibration sensor **S_n1** and the second vibration sensor **S_n2** may act as a single-axis directional vibration sensor, such that directions in which the first vibration sensor **S_n1** and the second vibration sensor **S_n2** are oriented may be different from each other.

[0353] In an example, as shown in FIG. **21**, the first vibration sensor **S_n1** may be disposed on the second frame **30f2** so as to detect front-rear directional vibration **V1**, and the second vibration sensor **S_n2** may be disposed on the main substrate **110** so as to detect vertical vibration **V2**. That is, the first vibration sensor **S_n1** and the second vibration sensor **S_n2** may be configured to detect vibrations in directions orthogonal to each other, respectively.

[0354] In this way, the positions where the first vibration sensor **S_n1** and the second vibration sensor **S_n2** are positioned from each other and the directions of the vibrations which may be detected thereby are different from each other. Thus, using the first vibration sensor **S_n1** and the second vibration sensor **S_n2**, the dish washer may be configured to easily distinguish the vibration that occurs during the operation of the dish washer **1** from the vibration caused by the user's knock-on input.

[0355] That is, the user's knock-on input is generally made through the front panel **30a** that constitutes the front portion of the door **30**.

[0356] Furthermore, the front panel **30a** has the vertical length and the left-right directional width much larger than a thickness thereof.

[0357] Therefore, the vibration generated in the front panel **30a** of the door **30** due to the knock-on input may be generated so that a front-rear directional amplitude thereof is much larger than each of a left-right directional amplitude and a vertical amplitude thereof.

[0358] Therefore, when the user's knock-on is input to the door, the amplitude of the vibration detected by the first vibration sensor **S_n1** may be much larger than the amplitude detected by the second vibration sensor **S_n2**. However, when the vibration is simply generated during the washing course of the dish washer **1**, there is no significant difference between the amplitude detected by the first vibration sensor **S_n1** and the amplitude detected by the second vibration sensor **S_n2**.

[0359] As described below, when there is a significant difference between an amplitude of a first vibration signal output from the first vibration sensor **S_n1** and an amplitude of a second vibration signal output from the second vibration sensor **S_n2**, the controller **100** may be configured to determine that the user's knock-on is input to the door. However, when there is substantially no difference between an amplitude of a first vibration signal output from the first vibration sensor **S_n1** and an amplitude of a second vibration signal output from the second vibration sensor **S_n2**, the controller **100** may be configured to easily determine that the vibration is not a vibration caused by the user's knock-on.

[0360] Hereinafter, referring to FIG. **22**, the configuration of the controller **100** included in the dish

washer **1** will be described.

[0361] As shown in FIG. **22**, the dish washer **1** may include the controller **100** for controlling each of the functional modules of the dish washer.

[0362] For example, the controller **100** may be configured to be implemented in various forms such as an electric circuit, a computer, a microcontroller, a microcomputer, or a microprocessor that may be mounted on the aforementioned main substrate **110**.

[0363] In some implementations, the controller **100** may be configured to be electrically connected to the driving motor **351** of the handle driver **35**. The controller **100** may be configured to start or stop the operation of the driving motor **351** by controlling the power supplied to the driving motor **351** from the power supply **48** as described below. The controller **100** may be configured to supply the power to the driving motor **351** to rotate in a forward direction to move the pop-up handle **31** in the frontward direction, or supply the power to the driving motor **351** to rotate in a reverse direction to move the pop-up handle **31** in the backward direction.

[0364] When the user's intention to open the door **30** is identified as being present using the proximity sensor S_p and the knock-on sensor S_n , the controller **100** may be configured to supply the power to the driving motor **351** of the handle driver **35** through the power supply **48** to drive the driving motor **351** in the forward direction to move the pop-up handle **31** in the frontward direction to the extended position P_d .

[0365] Furthermore, when a predetermined waiting time has elapsed after the pop-up handle **31** has moved to the extended position P_d , the controller **100** may be configured to supply the power to the driving motor **351** to drive the driving motor **351** in the reverse direction to move the pop-up handle **31** backward to the retracted position.

[0366] Furthermore, the controller **100** may be configured to be electrically connected to the button unit **34** for inputting a user's manipulation command. When the user's power on-off manipulation input, washing course selection manipulation, or option selection manipulation is input through the button unit **34**, the button unit **34** may transmit a corresponding electrical signal thereto to the controller **100**.

[0367] When the electrical signal has been transmitted from the button unit **34** to the controller, the controller **100** may be configured to turn on/off the power of the dish washer **1** or to control the dish washer **1** to perform an individual cycle of the dish washer **1** according to the selected washing course and the selected operation mode.

[0368] In some examples, the user's manipulation command may be input through other input devices such as a user's wireless terminal, etc. in addition to the button unit **34**.

[0369] Furthermore, the controller **100** may be configured to be electrically connected to the door position sensor S_d . The controller **100** may be configured to determine whether the door **30** is currently closed or opened based on the signal received from the door position sensor S_d , and to identify absence or presence of the user's intention to open the door **30** in a state in which the door **30** is closed, and to operate the handle driver **35** to move the pop-up handle **31** in the frontward direction to the extended position P_d when the door **30** needs to be opened.

[0370] Furthermore, the controller **100** may be configured to be electrically connected to the proximity sensor S_p . The controller **100** may be configured to determine whether the user is approaching a position within a specific detection range from door **30** based on the signal received from the proximity sensor S_p .

[0371] As described above, the proximity sensor S_p may include one of a radar sensor, an image sensor, or an infrared sensor.

[0372] Furthermore, the controller **100** may be configured to be electrically connected to the first vibration sensor S_{n1} and the second vibration sensor S_{n2} constituting the knock-on sensor S_n . As described above, the first vibration sensor S_{n1} and the second vibration sensor S_{n2} detect the vibrations generated from the dish washer **1**. The controller **100** may be configured to determine whether the user's intention to open the door **30** is input during the washing course based on a

comparing result between the amplitude of the first vibration signal and the amplitude of the second vibration signal respectively received from the first vibration sensor **S_{n1}** and the second vibration sensor **S_{n2}**. In some examples, the controller **100** may be configured to further include a device (e.g., amplifier) for amplifying each of the amplitude of the first vibration signal and the amplitude of the second vibration signal in order to clearly detect the user's knock-on input.

[0373] Furthermore, the controller **100** may be configured to be electrically connected to the light-source element **3131** and the vibration element **3132** mounted on the handle substrate **313**.

[0374] The controller **100** may be configured to provide the power to the light-source element **3131** to generate the visible light or other types of light at the same time as a time when the forward movement of the pop-up handle **31** is initiated or before the forward movement of the pop-up handle **31** is initiated, thereby visually indicating to the user that the pop-up handle **31** is being operating normally and that the pop-up handle **31** will be moved forwards toward the extended position Pd.

[0375] As described above, the light-source element **3131** may be implemented as the LED element that may receive the power to emit predetermined visible light.

[0376] Furthermore, the controller **100** may be configured to be electrically connected to an audio output unit that generates voice output or sound output.

[0377] When the controller **100** has identified that the user's intention to open the door **30** is present using the proximity sensor **S_p** and the knock-on sensor **S_n**, the controller **100** may be configured to generate a voice alarm or a sound alarm through the audio output unit to preliminarily notify that the pop-up handle **31** will move forwards.

[0378] For example, the voice alarm may include guidance information such as “I will extend the handle.”

[0379] In one example, the controller **100** may be configured to be electrically connected to a memory and a timer. The controller **100** may be configured to retrieve an operation condition and a time condition related to each of the cycles that are pre-stored in the memory for each washing course and to generate a control signal for controlling a progress and an end of the cycle according to the washing course based on the operation condition and the time condition.

[0380] In addition, as described later, information about a set time that serves as a reference time used to determine absence or presence of the user's intention to open the door **30** may be further stored in the memory.

[0381] Furthermore, the controller **100** may be configured to measure an elapsed time of each of the cycles using the timer and determine whether each of the cycles has been completed based on a comparing result of the measured time with the pre-stored time condition related to each of the cycles.

[0382] In some examples, the cycles may include a pre-washing cycle **S1**, a washing cycle **S2**, a rinsing cycle **S3**, a heating and rinsing cycle **S4**, and a drying cycle **S5** as shown in FIG. 23. The controller **100** may be configured to control the dish washer **1** so that the washing course including a combination of at least one of the above listed cycles according to the user's selection is performed.

[0383] Hereinafter, a method for controlling the dish washer **1** will be described with reference to FIG. 23 to FIG. 26.

[0384] As illustrated in FIG. 23, the controller **100** may be configured to generally control progress of the washing course of the dish washer **1** including, for example, at least one of the pre-washing cycle **S1**, the washing cycle **S2**, the rinsing cycle **S3**, the heating and rinsing cycle **S4**, and the drying cycle **S5**.

[0385] The pre-washing cycle **S1** refers to a cycle in which the washing water is circulated under an operation of the washing pump **45** without injecting the detergent through the detergent supply device and an amount of contamination is measured using a turbidity sensor provided in the sump **41**. The washing cycle **S2** refers to a cycle in which dishes are washed by circulating the washing

water while injecting the detergent through the detergent supply device.

[0386] Each of the rinsing cycle **S3** and the heating and rinsing cycle **S4** refers to a cycle in which rinse is injected from the detergent supply device and the washing water is circulated to remove the detergent remaining on the dishes.

[0387] During the heating and rinsing cycle **S4**, the heated washing water is supplied so that the dishes may be heated to a predetermined temperature. Thus, the drying efficiency of the dishes may be improved and the drying time may be shortened in the drying cycle **S5** that is performed after the completion of the rinsing cycle **S3** and heating and rinsing cycle **S4**.

[0388] The above detailed cycles may be controlled to be omitted or to be combined with each other so as to be performed repeatedly depending on the selected washing course settings and options.

[0389] In some examples, a water discharge cycle of the washing water used in each of the cycles and a water supply cycle that supplies new washing water may be included between temporally adjacent ones of the cycles.

[0390] The water supply cycle may be included before the pre-washing cycle **S1**.

[0391] The water discharge cycle and the water supply cycle may be performed between the pre-washing cycle **S1** and the washing cycle **S2**, between the washing cycle **S2** and the rinsing cycle **S3**, and between the heating and rinsing cycle **S4** and the rinsing cycle **S3**. The water discharge cycle may be performed between the heating and rinsing cycle **S4** and the drying cycle **S5**.

[0392] The water supply cycle may be performed by controlling an aqua stop device included in the water supply **43** to supply the washing water to the sump **41** through a water supply path. The water discharge cycle may be performed by controlling the water discharger **44** connected to the sump **41** to discharge the washing water to the outside out of the dish washer **1** through a water discharge path.

[0393] In some examples, when the user's intention to open the door **30** is identified as being present using the proximity sensor **S_p** before the washing course that is performed in the above order of the cycles is started or after the washing course has been completed, the controller **100** may be configured to drive the handle driver **35** in the forward direction to drive the pop-up handle **31** to automatically move forwards from the retracted position **Pa** to the extended position **Pd**.

[0394] Furthermore, after a predetermined waiting time has elapsed after the pop-up handle **31** has moved to the extended position **Pd**, the controller **100** may be configured to drive the handle driver **35** in the reverse direction, so that the pop-up handle **31** automatically moves backwards from the extended position **Pd** to the retracted position **Pa**.

[0395] Furthermore, when the user's intention to open the door **30** is additionally identified as being present using the aforementioned knock-on sensor **S_n**, the controller **100** may be configured to control the pop-up handle **31** to move forwards from the retracted position **Pa** toward the extended position **Pd** even during the washing cycle.

[0396] This is to deal with a case where the door **30** is opened while the washing cycle is in progress, for example, in order to add the dishes to be washed into the washing space in the tub

[0397] When the forward movement of the pop-up handle **31** is initiated during the progress of the washing course, the controller **100** may be configured to temporarily stop the progress of the washing course in consideration of water leakage prevention and user safety.

[0398] FIG. **24** illustrates an example of a control method of the dish washer **1**, in which the method includes operations **S10** and **S20** of moving the pop-up handle **31** in the frontward direction from the retracted position to the extended position, based on a combination of a determination result of whether the washing course of the dish washer **1** is in progress, and a determination result of whether the user intends to open the door **30**.

[0399] FIG. **25** illustrates detailed operations of operation **S10**.

[0400] Referring to FIG. **25**, the controller **100** may be configured to receive an output signal from the proximity sensor **S_p** before the start of the selected washing course and after the completion of

the selected washing course in **S101**.

[0401] When the output signal has been received from the proximity sensor **S_p** in operation **S101**, the controller **100** is configured to identify whether a user's approaching a position within the detection range of the proximity sensor **S_p** is detected in **S102**.

[0402] In some examples, as described above, the vertical minimum detection height **H_{min}** of the proximity sensor **S_p** may be in a range of 100 cm inclusive to 110 cm inclusive, for example, 105 cm.

[0403] Furthermore, the maximum horizontal detection distance **L_{max}** of the proximity sensor **S_p** may be in a range of 75 cm inclusive to 85 cm inclusive, for example, 80 cm.

[0404] When it is determined that the proximity of the user to the position within the detection range of the proximity sensor **S_p** has been detected in operation **S102**, the controller **100** may be configured to determine whether the proximity state of the user to the position in the detection range lasts for a predetermined set time duration after the proximity of the user to the position has been detected in **S103**.

[0405] In some examples, the set time duration may be in a range of 0.9 seconds inclusive to 1.1 seconds inclusive, for example, 1 second.

[0406] Upon determination that the proximity state of the user to the position in the detection range has lasted for the predetermined set time duration in operation **S103**, the controller **100** may be configured to determine that the user has the intention to open the door **30**.

[0407] When the user's intention to open the door **30** has been identified as being present before the start of the washing course or after the completion of the washing course, the controller **100** may be configured to supply the power to the handle driver **35** to drive the handle driver **35** in the forward direction, thereby automatically moving the pop-up handle **31** in the frontward direction from the retracted position **Pa** to the extended position **Pd** in **S105**.

[0408] In one example, when the user's intention to open the door **30** has been identified as being present, the controller **100** may be configured to supply the power to the light-source element **3131** disposed inside the pop-up handle **31** to turn on the light-source element **3131** in **S104**.

[0409] In some examples, the controller **100** may be configured to turn on the light-source element **3131** before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**. Thus, the user may intuitively and visually recognize that the pop-up handle **31** will begin moving forwards before or simultaneously with the start of the movement of the handle.

[0410] In some examples, the controller **100** may be configured to control the sound output unit to generate an audio alarm or an acoustic alarm including information indicating that the forward movement of the pop-up handle **31** will be initiated, before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**.

[0411] In one example, when the pop-up handle **31** has completed the forward movement to the extended position **Pd** after the operation of the handle driver **35** has been initiated in operation **S105**, the controller **100** may be configured to cut off the power supply to the handle driver **35** to stop the position of the pop-up handle **31** at the extended position **Pd** in **S106**.

[0412] Furthermore, in some examples, when the forward movement of the pop-up handle **31** has been completed, the controller **100** may be configured to turn off the light-source element **3131** by cutting off the power supply to the light-source element **3131** or to keep the light-source element **3131** in the turned-on state by maintaining the power supply thereto.

[0413] When the forward movement of the pop-up handle **31** to the extended position **Pd** has been completed, the user may easily open the door **30** while holding the pop-up handle **31**. FIG. 26 shows detailed operations of operation **S20**.

[0414] Referring to FIG. 26, the controller **100** may be configured to receive the output signal from the proximity sensor **S_p** during the progress of the selected washing course in **S201**.

[0415] When the output signal has been received from the proximity sensor **S_p** in operation **S201**,

the controller **100** may be configured to determine whether the user's approaching the position within the detection range of the proximity sensor S_p is detected **S202**.

[0416] In some examples, as described above, the vertical minimum detection height H_{min} of the proximity sensor S_p may be in a range of 100 cm inclusive to 110 cm inclusive, for example, 105 cm.

[0417] Furthermore, the maximum horizontal detection distance L_{max} of the proximity sensor S_p may be in a range of 75 cm inclusive to 85 cm inclusive, for example, 80 cm.

[0418] When it is determined that the proximity of the user to the position within the detection range of the proximity sensor S_p has been detected in operation **S202**, the controller **100** may be configured to determine whether the proximity state of the user to the position in the detection range lasts for a predetermined set time duration after the proximity of the user to the position has been detected in **S203**.

[0419] In some examples, the set time duration may be in a range of 0.9 seconds inclusive to 1.1 seconds inclusive, for example, 1 second.

[0420] Upon determination that the proximity state of the user to the position in the detection range has lasted for the predetermined set time duration in operation **S203**, the controller **100** may be configured to receive the output signals from the first vibration sensor S_{n1} and the second vibration sensor S_{n2} constituting the knock-on sensor S_n in **S204**.

[0421] In some examples, the output signal of the first vibration sensor S_{n1} may be the first vibration signal, and the output signal of the second vibration sensor S_{n2} may be the second vibration signal.

[0422] When the first vibration signal has been received from the first vibration sensor S_{n1} and the second vibration signal has been received from the second vibration sensor S_{n2} in operation **S204**, the controller **100** may be configured to calculate a maximum amplitude of the first vibration signal and a maximum amplitude of the second vibration signal in **S205**.

[0423] In some examples, in order to facilitate the calculation of and the comparison between the maximum amplitudes thereof, each of the first vibration signal and the second vibration signal may be amplified at a predetermined ratio after having been received by the controller **100**.

[0424] When the maximum amplitude of the first vibration signal and the maximum amplitude of the second vibration signal have been calculated in operation **S205**, the controller **100** may be configured to compare the maximum amplitude of the first vibration signal with the maximum amplitude of the second vibration signal in **S206**.

[0425] When the controller **100** determines that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal based on a result of the comparison in operation **S206**, the controller **100** may be configured to determine that the user's knock-on input is input into the door **30** and to determine that the user has the intention to open the door **30**.

[0426] In some examples, when the controller **100** determines that the maximum amplitude of the first vibration signal is smaller than or equal to the maximum amplitude of the second vibration signal based on a result of the comparison in operation **S206**, the controller **100** may be configured to determine that the received first vibration signal and second vibration signal are not generated due to the user's knock-on input. Thus, the process returns to the aforementioned operation **S201** and following operations are repeated.

[0427] In one example, when it is determined that the user intends to open the door **30** during the progress of the washing cycle, the controller **100** may be configured to supply the power to the handle driver **35** to drive the handle driver **35** in the forward direction, thereby automatically moving the pop-up handle **31** in the frontward direction from the retracted position P_a to the extended position P_d in **S208**.

[0428] In one example, when the user's intention to open the door **30** has been identified as being present, the controller **100** may be configured to supply the power to the light-source element **3131**

disposed inside the pop-up handle **31** to turn on the light-source element **3131** in **S207**.

[0429] In some examples, the controller **100** may be configured to turn on the light-source element **3131** before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**. Thus, the user may intuitively and visually recognize that the pop-up handle **31** will begin moving forwards before or simultaneously with the start of the forward movement of the handle.

[0430] In some examples, the controller **100** may be configured to control the sound output unit to generate an audio alarm or an acoustic alarm including information indicating that the forward movement of the pop-up handle **31** will be initiated before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**.

[0431] In one example, when the pop-up handle **31** has completed the forward movement to the extended position Pd after the operation of the handle driver **35** has been initiated in operation **S206**, the controller **100** may be configured to cut off the power supply to the handle driver **35** to stop the position of the pop-up handle **31** at the extended position Pd in **S209**.

[0432] Furthermore, in some examples, when the forward movement of the pop-up handle **31** has been completed, the controller **100** may be configured to turn off the light-source element **3131** by cutting off the power supply to the light-source element **3131** or to keep the light-source element **3131** in the turned-on state by maintaining the power supply thereto.

[0433] When the forward movement of the pop-up handle **31** to the extended position Pd has been completed, the user may open the door **30** while holding the pop-up handle **31**. However, since the dish washer **1** is currently in the washing process, it can be necessary to stop the washing process for the safety reason as described above.

[0434] Therefore, the controller **100** may be configured to control the dish washer **1** so that after the forward movement of the pop-up handle **31** is initiated by starting to operate the handle driver **35** in operation **S208**, the washing course currently in progress in the dish washer **1** is temporarily stopped in **S210**.

[0435] In some examples, the controller **100** may be configured to control the washing course so as to be temporarily stopped at least before the operation of the handle driver **35** is stopped in operation **S209** or at the same time as a time when the operation of the handle driver **35** is stopped in operation **S209**.

[0436] Thus, the user may be effectively prevented from being burned by high-temperature washing water or high-temperature airflow flowing out from the tub **20** due to the door **30** being opened while the washing course is in progress.

[0437] Although the implementations of the present disclosure have been described in more detail with reference to the accompanying drawings, the present disclosure is not necessarily limited to these implementations, and may be modified in a various manner within the scope of the technical spirit of the present disclosure. Accordingly, the implementations as disclosed in the present disclosure are intended to describe rather than limit the technical idea of the present disclosure, and the scope of the technical idea of the present disclosure is not limited by these implementations. Therefore, it should be understood that the implementations described above are not restrictive but illustrative in all respects. In addition, even though an effect of a configuration of the present disclosure is not explicitly described in describing the implementation of the present disclosure above, it is obvious that the predictable effect from the configuration should be recognized.

Claims

1. A dish washer comprising: a tub that defines a washing space configured to accommodate one or more objects to be washed therein, the tub having an open front surface in fluid communication with the washing space; a door configured to open and close the open front surface of the tub; a handle configured to reciprocate between (i) an extended position in which the handle protrudes

forward from the door and (ii) a retracted position in which the handle is at least partially accommodated within the door; a handle driver disposed within the door and configured to move the handle from the retracted position toward the extended position or from the extended position toward the retracted position; and a controller configured to determine whether to operate the handle driver and to control power to be supplied to the handle driver, wherein the controller is configured to, based on a position or a motion of a user, control the handle driver to move the handle forward from the retracted position toward the extended position.

2. The dish washer of claim 1, wherein the controller is further configured to: control the handle driver to move the handle forward from the retracted position toward the extended position (i) before a washing course starts or (ii) after the washing course has been completed.

3. The dish washer of claim 2, wherein the controller is further configured to: based on the position or the motion of the user, determine whether the user intends to open the door before the washing course starts or after the washing course has been completed; and based on a determination that the user intends to open the door, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

4. The dish washer of claim 3, further comprising a proximity sensor configured to detect whether the user is located at a position within a predetermined detection range from the door, wherein the controller is further configured to: receive an output signal from the proximity sensor; determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor; based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration; and based on a determination that the user has stayed at the position for the predetermined set time duration, determine that the user intends to open the door.

5. The dish washer of claim 4, wherein the door has a sensor hole defined at a top surface of the door, wherein the proximity sensor comprises a radar sensor disposed inside the door and configured to detect, through the sensor hole, whether the user is disposed within the predetermined detection range, and wherein the radar sensor has a sensing surface that is tilted and faces the top surface of the door in a frontward and upward direction.

6. The dish washer of claim 5, wherein a tilting angle of the sensing surface of the radar sensor is in a range from 25 degrees to 35 degrees with respect to the top surface of the door.

7. The dish washer of claim 4, wherein the controller is further configured to: based on determining (i) that the user has a height greater than or equal to a minimum detection height of the proximity sensor in a vertical direction and (ii) that the user is disposed in a distance less than or equal to a maximum detection distance from the proximity sensor in a horizontal direction, determine that the user is disposed at the position within the predetermined detection range.

8. The dish washer of claim 7, wherein the minimum detection height is in a range from 100 cm to 110 cm.

9. The dish washer of claim 7, wherein the maximum detection distance is in a range from 75 cm to 85 cm.

10. The dish washer of claim 4, wherein the predetermined set time duration is in a range from 0.9 seconds to 1.1 seconds.

11. The dish washer of claim 3, further comprising a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, and wherein the controller is further configured to, based on determining that the user intends to open the door, supply power to the light-source to thereby turn on the light-source before an operation of the handle driver is started or simultaneously with a start of the operation of the handle driver.

12. The dish washer of claim 1, wherein the controller is further configured to control the handle driver to move the handle forward from the retracted position toward the extended position while a

washing course is in progress.

13. The dish washer of claim 12, wherein the controller is further configured to: based on the position or the motion of the user, determine whether the user intends to open the door while the washing course is in progress; and based on a determination that the user intends to open the door while the washing course is in progress, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

14. The dish washer of claim 13, further comprising: a proximity sensor configured to detect whether the user is disposed at a position within a predetermined detection range from the door; and a first vibration sensor and a second vibration sensor that are respectively positioned at different locations inside the door and configured to detect a knock-on input of the user through the door, wherein the controller is further configured to: receive an output signal from the proximity sensor, determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor, based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration, based on a determination that the user has stayed at the position for the predetermined set time duration, receive (i) a first vibration signal from the first vibration sensor and (ii) a second vibration signal from the second vibration sensor, determine (i) a maximum amplitude of the first vibration signal received from the first vibration sensor and (ii) a maximum amplitude of the second vibration signal received from the second vibration sensor, compare the maximum amplitude of the first vibration signal with the maximum amplitude of the second vibration signal, and based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, determine that the user intends to open the door.

15. The dish washer of claim 14, wherein the first vibration sensor is located closer to a front surface of the door than the second vibration sensor is.

16. The dish washer of claim 14, wherein the first vibration sensor is configured to detect vibration in a first axial direction, and the second vibration sensor is configured to detect vibration in a second axial direction orthogonal to the first axial direction.

17. The dish washer of claim 14, wherein the first vibration signal corresponds to vibration in a horizontal direction, and the second vibration signal corresponds to vibration in a vertical direction orthogonal to the horizontal direction.

18. The dish washer of claim 14, further comprising a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, wherein the controller is further configured to: based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, supply power to the light-source to thereby turn on the light-source before or simultaneously with a start of an operation of the handle driver.

19. The dish washer of claim 13, wherein the controller is further configured to: after the handle driver starts to operate, pause the washing course in progress; and based on a forward movement of the handle to the extended position having been completed after operating the handle driver, stop an operation of the handle driver.

20. The dish washer of claim 19, wherein the controller is further configured to pause the washing course in progress before the operation of the handle driver is stopped or simultaneously with a stop of the operation of the handle driver.
