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DISH WASHER

Abstract

A dish washer includes a handle configured to protrude in a frontward direction from a door when opening or closing the door, thereby preventing accumulation of foreign substances such as dusts on the handle to keep the handle in a clean state, and improving user convenience. The handle is configured to retract to an inside of the door when the door is not being used.

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Background/Summary

TECHNICAL FILED

[0002] The present disclosure relates to a dish washer. More specifically, the present disclosure relates to a dish washer including a handle configured to reciprocate relative to a door.

BACKGROUND

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

[0004] For instance, a dish washer may include a washing tub having a washing space defined therein, a dish rack that accommodates therein a washing target inside the washing tub, a spraying arm that sprays the washing water into the dish rack, and a sump that stores therein water and supplies the washing water to the spraying arm.

[0005] Using the dish washer may reduce a time and effort for washing the dishes and other washing targets after a meal, thereby contributing to user convenience.

[0006] In some cases, the dish washer may perform a washing cycle for washing a washing target, a rinsing cycle for rinsing a washing target, and a drying cycle for drying a washing target that has been washed and rinsed.

[0007] In order to store dishes inside the dish washer before the cycle proceeds, and to withdraw the washed and dried dishes after the cycle has been completed, the user may open and close the door. In some cases, the door may include a handle that the user may grasp for facilitating the opening and closing of the door.

[0008] For instance, a dish washer may include a depressed type handle that is provided at the door for the user to grasp when opening and closing the door. The handle may have a grip groove depressed from a front surface of the door toward a rear surface thereof by a predetermined depth. The handle may have a depressed form from a portion of the front surface of the door toward an inside of the door. Since a separate cover, etc., is not disposed on the handle, the handle is always exposed to an outside. Therefore, the handle has a structure in which external foreign substances such as dusts may accumulate 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. Furthermore, the handle may deteriorate the aesthetics 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 have a protruding type handle. For instance, the handle may have a predetermined protruding height in a frontward direction from a front surface of the door and may maintain the protruding state in a 90 degrees-rotated U shape. In some cases, a user may not recognize the protruding portion from the front surface of the door and 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 there is a possibility of causing damage to the handle itself or items such as dishes.

[0010] In some cases, a dish washer may have a door (of a handless type) without a handle, where the user opens the door to a fully open state (by a large angle) by holding a portion (for example, a top portion) of the door. In this case, there is a risk that the user may get burned due to hot steam generated during or after the process of the dish washer.

SUMMARY

[0011] The present disclosure describes a dish washer including a handle that is configured to extend in a protruding manner in a frontward direction from the door for use, 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.

[0012] The present disclosure further describes a dish washer including a handle that is configured to at least partially retract into an inside of the door when the handle is not being used, and a front end surface of the handle and a front surface of the door are configured to be coplanar with each other in the retracted state such that 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.

[0013] The present disclosure further describes a dish washer including a handle that is configured to at least partially retract into the inside of the door when the handle is not being used, thereby reducing the possibility of user injury and handle damage that may occur due to collision of the user with the handle.

[0014] The present disclosure further describes a dish washer configured to detect the user's finger or an object between the handle and the door during a process of extending and retracting the handle, thereby reducing a possibility of injury to the user and damage to the handle, and thus, improving stability and reliability of the dish washer.

[0015] According to one aspect of the subject matter described in this application, a dish washer including 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 that is 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 a forward direction relative to the door and (ii) a retracted position in which the handle is at least partially accommodated within the door, and 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. The handle driver includes a pivot link having (i) a first end configured to rotate relative to the door and (ii) a second end that is connected to the handle and configured to rotate relative to the handle, a driving cam configured to (i) press the pivot link in a frontward direction based on the driving cam rotating in a first direction and (ii) press the pivot link in a rearward direction based on the driving cam rotating in a second direction opposite to the first direction, and a driving motor configured to generate a driving force for rotating the driving cam in the first direction or the second direction, the driving motor comprising a rotation shaft disposed below a vertical level of the handle.

[0016] Implementations according to this aspect can include one or more of the following features. For example, the door can be configured to pivot about a pivot axis relative to the tub to thereby open and close the open front surface of the tub, where a rotation direction of the door around the pivot axis to open the tub matches one of the first direction or the second direction of the drive motor to move the handle toward the extended position.

[0017] In some implementations, the driving cam can include a cam body configured to rotate based on the driving force of the driving motor, and a driving pin that protrudes from one side surface of the cam body toward the pivot link, where the pivot link defines a guide groove between the first end and the second end and, the guide groove receiving the driving pin. The driving pin can be configured to, based on the cam body rotating in the first or second direction, move relative to and along the guide groove to thereby cause the pivot link to pivot in the frontward or rearward direction.

[0018] In some examples, the driving pin can be located at a position that defines, in a state in which the handle is located at the extended position, a predetermined intersection angle between (i) a virtual first extension line extending from a rotation center of the cam body to a center of the driving pin and (ii) a virtual second extension line that is parallel to a movement direction of the handle to the extended position and extends through the rotation center of the cam body. For instance, the predetermined intersection angle can be less than or equal to 5 degrees.

[0019] In some implementations, the dish washer can further include a handle housing disposed

inside the door and configured to receive the handle therein based on the handle moving to the retracted position, where the handle housing defines a rail groove configured to guide a reciprocating movement of the handle between the extended position and the retracted position. In some examples, the handle can include a guide protrusion that protrudes toward the rail groove and is inserted into the rail groove, where the guide protrusion is configured to move along the rail groove during the reciprocating movement of the handle.

[0020] In some implementations, the door can define an opening at a front surface thereof, where the handle is configured to reciprocate through the opening of the door during a reciprocating movement of the handle and configured to close the opening of the door based on the handle being disposed at the retracted position. In some examples, the opening is spaced apart from a top surface of the door by a vertical distance, and the opening is spaced apart from each of right and left side surfaces of the door by a left-right distance that is less than the vertical distance. In some implementations, the handle can have a front end surface that is configured to be coplanar with the front surface of the door based on the handle being disposed at the retracted position.

[0021] In some implementations, the handle can include a first handle body configured to be exposed out of the door based on the handle moving to the extended position, and a second handle body connected to a rear end of the first handle body and received inside the door. In some examples, a vertical width of the second handle body is greater than a vertical width of the first handle body. In some examples, a front surface of the second handle body can be configured to, based on the handle being disposed at the extended position, be disposed at a front surface of the door or rearward relative to the front surface of the door.

[0022] In some implementations, the dish washer can further include a controller configured to determine whether to move the handle driver and to control power to be supplied to the handle driver, where the controller is configured to control an operation of the handle driver to prevent an object or a hand of a user from being caught between the handle and the door while the handle moves from the extended position to the retracted position.

[0023] In some implementations, the dish washer can further include a first safety sensor configured to detect whether the hand of the user is present between the handle and the door, where the controller configured to, based on an output signal received from the first safety sensor, determine whether the hand of the user is present between the handle and the door for a first set time duration or longer, and based on a determination that the hand of the user is present between the handle and the door for a time duration greater than the first set time duration, initiate the operation of the handle driver to move the handle backwards toward the retracted position and decrease a movement speed of the handle after the operation of the handle driver has been initiated. In some examples, the first safety sensor can include a capacitive touch sensor or an infrared sensor.

[0024] In some implementations, the dish washer can further include a vibration element disposed at the handle and configured to generate a haptic vibration, where the controller is configured to turn on the vibration element to generate the haptic vibration based on the determination that the hand of the user is present between the handle and the door for the time duration greater than the first set time duration.

[0025] In some examples, the controller is configured to, after decreasing the movement speed of the handle, re-determine whether the hand of the user is still present between the handle and the door based on the output signal received from the first safety sensor. In some examples, the controller is further configured to, based on a determination that the hand of the user is still present between the handle and the door, stop the operation of the handle driver to stop a movement of the handle toward the retracted position.

[0026] In some implementations, the dish washer can further include a second safety sensor configured to detect whether the object or the hand of the user is present between the handle and the door, where the controller is further configured to, based on the output signal received from the

first safety sensor, determine that the hand of the user is absent between the handle and the door for a time duration greater than the first set time duration, based on a determination that the hand of the user is absent between the handle and the door for the time duration greater than the first set time duration, initiate the operation of the handle driver to move the handle backwards, after the operation of the handle driver has been initiated, determine whether the object or the hand of the user is present between the handle and the door based on an output signal received from the second safety sensor, based on determination that the object or the hand of the user is present between the handle and the door, stop the operation of the handle driver to stop a movement of the handle toward the retracted position, and after the handle has stopped, start an operation of the handle driver to move the handle forwards toward the extended position.

[0027] In some implementations, the second safety sensor can include a strain sensor disposed on the handle or the handle driver, or a current sensor configured to detect electric current supplied to the handle driver.

[0028] In some implementations, the controller is further configured to determine whether a second set time duration has elapsed after starting the operation of the handle driver to move the handle forwards toward the extended position, based on a determination that the second set time duration has elapsed, re-determine whether the object or the hand of the user is present between the handle and the door based on the output signal received from the second safety sensor, and based on a determination that the object or the hand of the user is absent between the handle and the door, operate the handle driver to move the handle backwards toward the retracted position.

[0029] 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.

[0030] 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.

[0031] In some implementations, the dish washer can reduce the possibility of user injury and handle damage that may occur due to collision of the user with the handle.

[0032] In some implementations, the dish washer may effectively detect the user's finger or an object being caught into between the handle and the door during a process of extending and retracting the handle, thereby reducing a possibility of injury to the user and damage to the handle.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0033] FIG. **1** is a front perspective view showing an example of a dish washer.

[0034] FIG. **2** is a schematic cross-sectional view of the dish washer as shown in FIG. **1**.

[0035] FIG. **3** is a front perspective view showing an example of a handle of the dish washer that is moved to a retracted position.

[0036] FIG. **4** is a front perspective view showing the handle in FIG. **3** that is moved to an extended position.

[0037] FIG. **5** is an enlarged side view of FIG. **3**.

[0038] 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.

[0039] FIG. **7** is a rear perspective view showing an example of a handle driver as shown in FIG. **5**.

[0040] FIG. **8** is an exploded perspective view of the handle driver as shown in FIG. **7**.

[0041] 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**.

[0042] 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.

[0043] FIG. **11** is a side view illustrating a state in which movement to the extended position of the handle has been completed.

[0044] 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.

[0045] FIG. **13** is an enlarged view of a portion of FIG. **11**, and illustrates an example structure that can restrict the handle from being moved backwards under an external force applied to the handle.

[0046] FIG. **14** is a partial enlarged view showing a state in which the handle and the handle driver have been removed from the door.

[0047] FIG. **15** is a rear perspective view illustrating an example of a handle frame on which the handle and the handle driver are installed, where the handle frame supports the handle and the handle driver.

[0048] FIG. **16** is an exploded perspective view illustrating an example configuration of the handle.

[0049] FIG. **17** is a side view showing a 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.

[0050] FIG. **18** is a functional block diagram illustrating an example configuration of a controller and functional modules included in a dish washer.

[0051] FIG. **19** is a flow chart showing an example of a sequence of cycles performed in a dish washer.

[0052] FIGS. **20** to **22** are flow charts respectively showing example steps of a method for controlling a dish washer.

DETAILED DESCRIPTIONS

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

[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** according to the present disclosure. FIG. **2** is a simplified cross-sectional view briefly showing an internal structure of the dish washer **1** according to the present disclosure.

[0056] As shown in FIG. **1** and FIG. **2**, the dish washer **1** according to the present disclosure 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 detailed configuration of the water sprayer has been already known in the art. Thus, 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, in FIG. **2**, an embodiment is shown in which 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, However, embodiments of present disclosure are not limited thereto. However, hereinafter, an example in which the dish washer **1** includes the three dish racks **50** as shown is described.

[0081] 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**.

[0082] For this purpose, 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.

[0083] 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.

[0084] The guide rail may be embodied 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.

[0085] In one example, the door **30** is configured for opening/closing the open front surface of the tub **20** as described above.

[0086] 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.

[0087] 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**.

[0088] 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.

[0089] In one example, a rear panel **30**b 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.

[0090] For this purpose, when the door **30** is fully opened downwardly, the rear panel **30**b 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.

[0091] In one example, unlike a conventional handle, the handle **31** of the dish washer **1** according to the present disclosure 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**.

[0092] 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.

[0093] 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**.

[0094] In some examples, a detergent supply device for automatically supplying detergent into the inside of the tub **20** may be further installed on the rear panel **30***b* constituting an inner side surface of the door **30**.

[0095] 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.

[0096] 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**.

[0097] 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.

[0098] 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.

[0099] 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 S**5** such that the drying efficiency and sterilization effect on the dishes may be improved compared to a conventional dish washer.

[0100] 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.

[0101] 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.

[0102] 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.

[0103] 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.

[0104] 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 **30***a* constituting the front surface of the door **30**.

[0105] 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.

[0106] In order to extend or retract the pop-up handle **31**, an elongate opening **30***e* having a shape corresponding to an appearance of the pop-up handle **31** may be defined in the front panel **30***a* 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

[0107] The pop-up handle **31** may be configured to reciprocate along the forward and backward directions through the opening **30***e* of the front panel **30***a* under an operation of a handle driver **35** as described below.

[0108] More specifically, in consideration of the opening and closing movement of the door **30** pivoting around a lower end thereof and the user's aesthetic sense, the opening **30***e* and the pop-up handle **31** can be disposed as close as possible to an upper end surface of the door **30**.

[0109] That is, as illustrated in FIG. **3**, the opening **30***e* may be defined in the front panel **30***a* in a

state in which a predetermined vertical distance D**1** is defined between the opening and the upper end surface of the door **30**.

[0110] In addition, a predetermined left-right directional distance D**2** may be defined between the opening **30***e* and each of the right and left side surfaces of the door **30**.

[0111] For example, as shown in FIG. **3**, the vertical distance D**1** between the opening **30***e* and the upper end surface of the door **30** can be greater than the left-right directional distance D**2** between the opening and each of the right side surface and the left side surface of the door **30**.

[0112] As described above, since the vertical distance D**1** is set to be greater than the left-right directional distance D**2**, a predetermined free space may be secured between the opening **30***e* and the upper end surface of the door **30**, and thus the user's accessibility to the button **34** disposed on the upper end surface of the door **30** and the convenience of manipulation thereof may be improved.

[0113] Further, 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**.

[0114] 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.

[0115] 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**.

[0116] 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**.

[0117] In some examples, the pop-up handle **31** may passing through an entirety of the opening **30***e* of the door **30** and be retracted into the inside of the door **30**.

[0118] 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 **30***a* of the door **30** in a frontward direction.

[0119] 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 **30***a* of the door **30** so as to form a continuous surface.

[0120] That is, a state in which no step is formed between the front surface of the front panel **30***a* 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.

[0121] Thus, when the pop-up handle **31** has been displaced to the retracted position Pa, the opening **30***e* of the front panel **30***a* is entirely blocked, and at the same time, no step is formed between the front surface of the front panel **30***a* and the front end surface of the pop-up handle **31**, such that the phenomenon in which foreign substances such as dusts accumulate on an convex portion of the door **30** or on the handle itself as in the conventional approach may be fundamentally prevented.

[0122] 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**.

[0123] In some examples, the decoration panel **315** may include a material having the same texture as that of the front panel **30***a* of the door **30**.

[0124] Thus, the user may feel a sense of unity the decoration panel **315** and the front panel **30***a* 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.

[0125] 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.

[0126] 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**.

[0127] 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** is performed, 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**.

[0128] For this purpose, the dish washer **1** may further be provided with a detector or sensor for detecting the user's intention to open the door **30**.

[0129] For example, a proximity sensor S_p may be embodied as the detector for detecting absence or presence of the user's intention to open the door **30**.

[0130] 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**.

[0131] For example, the proximity sensor S_p may include any one of a radar sensor, an image sensor, or an infrared sensor (IR) Sensor.

[0132] However, embodiments of the present disclosure are not limited thereto. The proximity sensor S_p may be applied without limitation in terms of the type thereof as long as the proximity sensor S_p can 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.

[0133] 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**.

[0134] In this way, the radar sensor functioning as the proximity sensor S_p may be disposed on the control panel **32** constituting the top surface of the door **30** and may be configured to distinguish a user and a non-user such as a pet from each other.

[0135] In some implementations, the dish washer **1** may configured not 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**.

[0136] 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**.

[0137] Therefore, in some examples, 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.

[0138] 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**.

[0139] 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.

[0140] 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.

[0141] 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.

[0142] 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 out of the door **30** and may be grasped by the user.

[0143] 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, e.g., 45 mm.

[0144] 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**.

[0145] 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**.

[0146] 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 **30***e* of the front panel **30***a* of the door **30** and is exposed to the outside out of the door **30**. Accordingly, the opening **30***e* is not blocked with the first handle body **311**.

[0147] 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 **30***e* of the front panel **30***a* is blocked with the second handle body **312**.

[0148] In some examples, the vertical width of the second handle body **312** may be greater than the vertical width of the first handle body **311**, and may be greater than or equal to the vertical width of the opening **30***e* of the front panel **30***a*.

[0149] In addition, when the movement to the extended position Pd is completed, the front surface of the second handle body **312** and the front panel **30***a* constituting the front surface of the door **30** may be disposed at the same front-rear position, or the front surface of the second handle body **312** may be positioned in rear of the front panel **30***a* constituting the front surface of the door **30**.

[0150] Therefore, even when the pop-up handle **31** has been moved to the extended position Pd, the opening **30***e* of the front panel **30***a* 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**.

[0151] Furthermore, since the observation of the inside of the door **30** through the opening **30***e* of the front panel **30***a* blocked with the second handle body **312**, the deterioration of the aesthetic sense for the user may be effectively prevented.

[0152] 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.

[0153] First, 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**.

[0154] 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 **30***d***4**.

[0155] In this way, the pair of handle drivers **35** are disposed in a state separated from each other and spaced form 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**.

[0156] 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.

[0157] However, this is only an example. Alternatively, the pop-up handle **31** may be driven using

only a single handle driver. Hereinafter, an embodiment in which the pair of handle drivers **35** are provided will be described. However, embodiments of present disclosure are not limited thereto.

[0158] 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 **30***d*.

[0159] 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**.

[0160] 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.

[0161] In general, the door **30** of the dish washer **1** may have a small thickness to secure a wider washing space and for the user to easily open the door **30**.

[0162] Due to such a small thickness, the position of the driving motor **351** of the handle driver **35** that generates a driving force for automatically operating the pop-up handle **31** may be limited.

[0163] More specifically, when the handle driver **35** is disposed directly in rear of the pop-up handle **31**, there is a problem in that the thickness of the door **30** should be considerably increased.

[0164] In addition, when the handle driver **35** is disposed on top of the pop-up handle **31**, there is a possibility that the handle driver may be superposed with the controller **100** disposed at the upper end of the door **30**.

[0165] In addition, the vertical position of the pop-up handle **31** may be lowered to prevent the handle driver **35** from being superposed with the controller **100**. In this case, as the position of the pop-up handle **31** is lowered, thereby causing inconvenience in gripping the pop-up handle **31** and causing the pop-up handle **31** to be visible to the user's eyes, which may cause a problem in that aesthetic impression is not good.

[0166] In consideration of the above problems, a vertical level of the driving motor **351** constituting the handle driver **35** may be lower than a vertical level of each of the pop-up handle **31** and the opening **30***e* of the door **30**.

[0167] 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**.

[0168] The driving motor **351** is configured to receive power and generate a rotational driving force.

[0169] 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.

[0170] 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.

[0171] 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.

[0172] 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). In this case, as illustrated, the output shaft **3512** of the driving motor **351** extends, for example, in the left-right direction and in parallel to the front surface of the door **30**. Accordingly, a direction in which the door **30** pivots about the pivot axis when the tub **20** is opened and a direction in which the output shaft **3512** of the driving motor **351** rotates when the pop-up handle **31** moves toward the extended position may be the same as each other.

[0173] 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**.

[0174] 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**.

[0175] Thus, the output shaft **3512** of the driving motor **351** may rotate integrally with the driving cam **352**.

[0176] 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**.

[0177] 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.

[0178] For this purpose, 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**.

[0179] The cam body **3521** may be provided in a form of a disk having an approximately uniform thickness, for example.

[0180] 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**.

[0181] 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.

[0182] 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**.

[0183] 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.

[0184] Therefore, when the cam body **3521** spins around the shaft hole **3522**, the driving pin **3523** rotates around the shaft hole **3522**.

[0185] 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.

[0186] Accordingly, while the driving pin **3523** rotates 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.

[0187] In one example, a rotation 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 rotation 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.

[0188] A stopper protrusion **3524** acting as a structure for limiting the rotation 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.

[0189] As illustrated, the stopper protrusion **3524** may be embodied as a predetermined step formed on the edge of the cam body **3521**.

[0190] The stopper protrusion **3524** embodied 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 rotation range of the driving pin **3523** or the spin range of the cam body **3521** in both opposing directions.

[0191] In this way, the stopper protrusion **3524** may limit the rotation 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**.

[0192] As shown in FIG. **9**, a cam stopper **3552***b* corresponding to the pair of stopper protrusions **3524** may be provided inside the second housing **3552** that accommodates the driving cam **352**.

[0193] 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.

[0194] 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.

[0195] 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**.

[0196] 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.

[0197] For this purpose, a pair of shaft bosses **3531***a* 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.

[0198] The pair of shaft bosses **3531***a* 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.

[0199] A bushing **356** or a bearing may be fitted around each of the pair of shaft bosses **3531***a* to reduce friction. The pair of shaft bosses **3531***a* 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 **3531***a*.

[0200] Each of the first housing **3551** and the second housing **3552** may be formed to have each of cylindrical bushing receiving portions **3551***a* and **3552***a* into which each bushing **356** may be inserted.

[0201] 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.

[0202] 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 **353***a* of the pivot link **353** as described below.

[0203] The guide groove **3533** may linearly extend along a length direction of the first extension

353*a*. 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 and along the guide groove **3533** while being inserted into the guide groove **3533**.

[0204] 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.

[0205] 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**.

[0206] 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.

[0207] 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**.

[0208] 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**.

[0209] The handle connection portion **3541** may be formed to have a plurality of screw holes **3541***h* defined therein so that a connecting apparatus such as a screw bolt may pass through each screw hole.

[0210] The link connection portion **3542** may be indirectly connected to the second end **3532** of the pivot link **353** via the connection pin **3534**.

[0211] For this purpose, 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.

[0212] 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 and along the pin guide hole **3543** in the vertical direction while being inserted into the pin guide hole **3543**.

[0213] 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.

[0214] In order to allow the connection pin **3534** to be connected in this way, left and right pin holes **3532***h* 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.

[0215] 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**.

[0216] 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**.

[0217] 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**.

[0218] That is, as shown in FIG. **9**, the pivot link **353** may include a first extension **353***a* that extends radially from the first end **3531**, and a second extension **353***b* that extends in a bent manner

toward the pop-up handle **31** and between the first extension **353***a* and the second end **3532**.

[0219] In this way, the second extension **353***b* is formed to be bent or curved toward the pop-up handle **31**, thereby greatly increasing a 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

[0220] 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.

[0221] First, 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.

[0222] 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.

[0223] 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.

[0224] 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.

[0225] In one example, as the forward direction spin of the driving cam **352** is initiated, a forward direction rotation of the driving pin **3523** may be initiated.

[0226] 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**.

[0227] As the driving pin **3523** rotates 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**.

[0228] 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.

[0229] 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**.

[0230] 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.

[0231] 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.

[0232] FIG. **11** shows the state in which the pop-up handle **31** has completed the forward movement to the extended position Pd and has stopped.

[0233] 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 out 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**.

[0234] 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 **353***a* 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**.

[0235] Therefore, as shown, a predetermined intersection angle a may be defined between a virtual first extension line Lc**1** 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 Lc**2** 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**. In some examples, the intersection angle "a" may be a small angle. For example, the intersection angle "a" may be in a range of 0 degrees inclusive to 5 degrees inclusive.

[0236] The small intersection angle "a" 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**.

[0237] 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 device is not disposed at the pop-up handle **31** and the handle frame **30***d* as described below.

[0238] 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 **30***d* may be simplified, and a manufacturing cost thereof may be reduced.

[0239] FIG. **12** 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.

[0240] Referring to FIG. **12**, the pop-up handle **31** has moved to the extended position Pd and has stopped. 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. As will be described below, the predetermined waiting time may be in a range of 2.5 seconds to 3.5 seconds.

[0241] 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.

[0242] When the reverse rotation starts, the output shaft **3512** and the driving cam **352** may start to rotate clockwise based on the illustrated state.

[0243] Further, as the reverse spin of the driving cam **352** starts, the reverse revolution of the driving pin **3523** may start.

[0244] 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**.

[0245] As the driving pin **3523** rotates 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**.

[0246] 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.

[0247] 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**.

[0248] 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.

[0249] 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 the Pop-Up Handle

[0250] 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**.

[0251] 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.

[0252] A structure for implementing the horizontal or linear movement may be provided in the pop-up handle **31** and the handle frame **30***d* in which the pop-up handle **31** is accommodated.

[0253] As described above, the pop-up handle **31** may be configured to include the first handle body **311** that is exposed to the outside out of the door **30** and may 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 and the retracted position Pa.

[0254] As illustrated in FIG. **14**, the second handle body **312** may include a plate-shaped panel **3121** that serves to screen the opening **30***e* formed in the front panel **30***a* 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**.

[0255] 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**.

[0256] 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**.

[0257] 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.

[0258] 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 **30***e* of the front panel **30***a* of the door **30** and an opening **30***d***2** of a handle frame **30***d* described later.

[0259] 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 **30***d*, thereby preventing the first handle body **311** and the second handle body **312** from being removed from the door.

[0260] In one example, a vertical extension **3122***b* of the edge rib **3122** may have a guide protrusion **3123** that protrudes so as to be away from the edge rib **3122**.

[0261] 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**.

[0262] The guide protrusion **3123** may be inserted into a rail groove **30***d***45** of the handle housing **30***d***4** described below. As the guide protrusion **3123** moves along the rail groove **30***d***45**, the first handle body **311** and the second handle body **312** move horizontally or linearly.

[0263] Therefore, a combination of the guide protrusion **3123** of the second handle body **312** and the rail groove **30***d***45** of the handle housing **30***d***4** may be an example structure for implementing the horizontal or linear movement of the pop-up handle **31**.

[0264] FIG. **14** shows a configuration in which only a left portion of the edge rib **3122** is provided with the guide protrusion **3123**. However, embodiments 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**.

[0265] Furthermore, as shown in FIG. **14**, the horizontal extension **3122***a* of the second handle body **312** may have a notch **3122***c* defined therein whose left-right width is maintained to be constant.

[0266] A protruding surface portion **30***d***46** of the handle housing **30***d***4** described later may be inserted into the notch **3122***c*.

[0267] A left-right width of the protruding surface portion **30***d***46** may be maintained to be constant in a corresponding manner to a shape of the notch **3122***c*.

[0268] When the first handle body **311** and the second handle body **312** have been accommodated in the handle housing **30***d***4**, the protruding surface portion **30***d***46** may be inserted into the notch **3122***c*. Therefore, when the pop-up handle **31** moves, the notch **3122***c* moves along the protruding surface portion **30***d***46**, such that the first handle body **311** and the second handle body **312** move horizontally or linearly.

[0269] Therefore, a combination of the notch **3122***c* of the second handle body **312** and the protruding surface portion **30***d***46** of the handle housing **30***d***4** may be an example structure for implementing the horizontal or linear movement of the pop-up handle **31**.

[0270] FIG. **15** illustrates the handle frame **30***d* including the handle housing **30***d***4** in which the first handle body **311** and the second handle body **312** are accommodated.

[0271] The handle frame **30***d* supports the aforementioned handle driver **35** attached thereto and receives therein and supports the pop-up handle **31** so as to be movable therein.

[0272] The handle frame **30***d* may include a panel portion **30***d***1** and an outer wall **30***d***3** that serve as a support surface or an attachment surface to support the handle driver **35**.

[0273] The panel portion **30***d***1** and the outer wall **30***d***3** of the handle frame **30***d* may be fixed to an inner surface of the front panel **30***a* or the rear panel **30***b* of the door **30**.

[0274] In one example, the handle frame **30***d* may further include the handle housing **30***d***4** to accommodate therein and support the pop-up handle **31** so as to be movable therein.

[0275] As illustrated, the handle housing **30***d***4** 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.

[0276] The open front surface of the handle housing **30***d***4** may act as the opening **30***d***2** through which the first handle body **311** extends or retracts.

[0277] The opening **30***d***2** of the handle housing **30***d***4** may be formed at a position corresponding to a position of the opening **30***e* of the front panel **30***a* of the door **30** and may have a corresponding size to a size of the opening **30***e*.

[0278] The handle housing **30***d***4** may be provided with the rail groove **30***d***45** and the protruding surface portion **30***d***46**, each configured to implement the horizontal or linear movement of the pop-up handle **31** as described above.

[0279] The rail groove **30***d***45** may be formed in each of a left side surface and a right side surface of the handle housing **30***d***4**, and may be formed by partially protruding each of the left side and right side surfaces thereof toward the outer wall **30***d***3**.

[0280] The protruding surface portion **30***d***46** may be formed on an upper surface of the handle housing **30***d***4**, and may be formed by protruding a portion of the upper surface **30***d***41** thereof downwards.

[0281] In one example, as illustrated, a cut-away **30***d***44** may be defined in a lower surface **30***d***42** of the handle housing **30***d***4** to provide a movement path of the pivot link **353** of the handle driver **35**.

[0282] FIG. **16** illustrates a detailed structure of the pop-up handle **31** disposed in front of the first

handle body **311** as described above.

[0283] 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**.

[0284] 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.

[0285] 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.

[0286] The following description will be based on an example in which the LED element is applied as the light-source element **3131**. However, embodiments of the present disclosure are not limited thereto.

[0287] FIG. **16** illustrates a configuration in which a total of **7** LED elements are mounted on the handle substrate **313**. However, embodiments 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**.

[0288] In one example, the light-guide plate **314** serves to diffuse the visible light generated from the light-source element **3131**.

[0289] 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**.

[0290] 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 **30***a* of the door **30** as described above.

[0291] 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**.

[0292] 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**.

[0293] 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**.

[0294] 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**.

[0295] 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.

[0296] 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**.

[0297] Therefore, during the automatic backward movement of the pop-up handle **31**, there is a possibility that the hand of the user or an object may be caught into between the first handle body

311 and the door **30**. Therefore, the dish washer **1** may include a structure for providing a warning of an event where a hand is caught during the operation of the handle to the user to thereby prevent the hand from being caught.

[0298] In some implementations, a vibration element **3132** can provided in the pop-up handle **31** to provide a warning for a hand being caught.

[0299] 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.

[0300] As shown in FIG. **16**, the vibration element **3132** may be mounted on the handle substrate **313**.

[0301] 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**.

[0302] In some examples, the pop-up handle **31** may further include a detector for detecting the hand being caught.

[0303] As will be described later, the detectors for detecting the hand being caught may be referred to as a first safety sensor S_f**1** and a second safety sensor S_f**2**.

[0304] The first safety sensor S_f**1** detects whether the hand of the user is caught with into between the first handle body **311** and the door **30**.

[0305] In one example, the first safety sensor S_f**1** may include either a touch sensor S_ct or an infrared sensor S_if.

[0306] The touch sensor S_ct 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.

[0307] The infrared sensor S_if may be configured to project infrared rays from a transmitter S_if**1** toward a receiver S_if**2** and identify presence of the user's finger between the transmitter S_if**1** and the receiver S_if**2** based on whether the infrared rays are received by the receiver S_if**2**. In some examples, as illustrated in FIG. **16**, the transmitter S_if**1** and the receiver S_if**2** may be separately and respectively disposed at both opposing ends of the first handle body **311**.

[0308] However, the positions of the transmitter S_if**1** and receiver S_if**2** are only examples, and the transmitter S_if**1** and receiver S_if**2** may be installed in other positions than the positions on the first handle body **311**.

[0309] The second safety sensor S_f**2** detects whether an object other than the hand of the user is located between the pop-up handle **31** and the door **30**.

[0310] For example, the second safety sensor S_f**2** 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.

[0311] 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**.

[0312] 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**.

[0313] Hereinafter, referring to FIG. **18**, the configuration of the controller **100** included in the dish washer **1** will be described.

[0314] As shown in FIG. **18**, the dish washer **1** may include the controller **100** for controlling each of the functional modules of the dish washer.

[0315] For example, the controller **100** may include various forms such as an electric circuit, a

computer, a microcontroller, a microcomputer, or a microprocessor.

[0316] 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.

[0317] When the user's intention to open the door **30** is identified as being present using the proximity sensor S_p, 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 Pd.

[0318] Furthermore, when 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 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.

[0319] In some examples, the predetermined waiting time may be in a range of 2.5 seconds inclusive to 3.5 seconds inclusive.

[0320] The above-defined range of the predetermined waiting time may be selected based on a time duration it takes for the user to remove the hand thereof from the pop-up handle **31** after grasping the pop-up handle **31** to open the door **30**.

[0321] 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**.

[0322] 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.

[0323] 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**.

[0324] 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 Pd when the door **30** needs to be opened.

[0325] 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.

[0326] As described above, the proximity sensor S_p may include one of a radar sensor, an image sensor, or an infrared sensor.

[0327] Furthermore, the controller **100** may be electrically connected to the first safety sensor S_f**1**. As described above, the first safety sensor S_f**1** detects whether the hand of the user is caught into between the pop-up handle **31** and the door **30**. The controller **100** may determine whether the hand of the user is caught into between the pop-up handle **31** and the door **30** based on a signal received from the first safety sensor S_f**1**.

[0328] As described above, the first safety sensor S_f**1** may include either the touch sensor S_ct or the infrared sensor S_if.

[0329] Furthermore, the controller **100** may be electrically connected to the second safety sensor.

As described above, the second safety sensor detects whether an object other than the hand of the user is present between the pop-up handle **31** and the door **30**.

[0330] The controller **100** may be configured to determine whether the object is caught into between the pop-up handle **31** and the door **30** based on a signal received from the second safety sensor.

[0331] As described above, the second safety sensor may include either the 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.

[0332] 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**.

[0333] 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 sequentially, 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.

[0334] As described above, the light-source element **3131** may be embodied as the LED element that may receive the power to emit predetermined visible light.

[0335] Furthermore, when the controller **100** determines that the hand of the user or an object is caught into between the pop-up handle **31** and the door **30** after the backward movement of the pop-up handle **31** has begun, based on the output signal received from the first safety sensor S_f**1** or the second safety sensor, the controller may be configured to supply power to the vibration element **3132** to generate a predetermined haptic vibration to warn the user of the "hand or object being caught".

[0336] As described above, the vibration element **3132** may include either the piezo element or the haptic motor.

[0337] As described below, the controller **100** has generated a haptic vibration for the primary warning purpose using the vibration element **3132**. However, thereafter, the controller may be configured to detect that the hand of the user is still present between the pop-up handle **31** and the door **30**. In this case, the controller **100** may be configured to increase the intensity of the haptic vibration by increasing the intensity of the power supplied to the vibration element **3132**.

[0338] Furthermore, the controller **100** may be configured to be electrically connected to a sound output unit that generates voice output or sound output.

[0339] As will be described below, when the controller **100** detects that the hand of the user or an object is caught into between the pop-up handle **31** and the door **30** based on the signal from the first safety sensor S_f**1** or the second safety sensor, the controller **100** may be configured to generate a voice alarm or an acoustic alarm through the sound output unit to instruct the user to remove the hand or object from the pop-up handle **31**.

[0340] For example, the voice alarm may include guidance information or warning information such as 'Please remove your hand. I will retract the handle' or 'Please remove the object from the handle. I will retract the handle'.

[0341] 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.

[0342] Furthermore, as will be described later, information about a first set time duration and information about a second set time duration used for switching the operation of the handle driver **35** may be further stored in the memory.

[0343] 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.

[0344] In some examples, the cycles may include a pre-washing cycle S**1**, a washing cycle S**2**, a rinsing cycle S**3**, a heating and rinsing cycle S**4**, and a drying cycle S**5** as shown in FIG. **19**.

[0345] Hereinafter, a method for controlling the dish washer **1** according to the present disclosure will be described with reference to FIG. **19** to FIG. **22**.

[0346] As illustrated in FIG. **19**, the controller **100** may be configured to generally control progress of the washing course of the dish washer **1** in which the pre-washing cycle S**1**, the washing cycle S**2**, the rinsing cycle S**3**, the heating and rinsing cycle S**4**, and the drying cycle S**5** are executed in this order.

[0347] The pre-washing cycle S**1** 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 S**2** refers to a cycle in which dishes are washed by circulating the washing water while injecting the detergent through the detergent supply device.

[0348] Each of the rinsing cycle S**3** and the heating and rinsing cycle S**4** 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.

[0349] During the heating and rinsing cycle S**4**, 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 S**5** that is performed after the completion of the rinsing cycle S**3** and heating and rinsing cycle S**4**.

[0350] 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.

[0351] 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.

[0352] The water supply cycle may be included before the pre-washing cycle S**1**.

[0353] The water discharge cycle and the water supply cycle may be performed between the pre-washing cycle S**1** and the washing cycle S**2**, between the washing cycle S**2** and the rinsing cycle S**3**, and between the heating and rinsing cycle S**4** and the rinsing cycle S**3**. The water discharge cycle may be performed between the heating and rinsing cycle S**4** and the drying cycle S**5**.

[0354] 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.

[0355] 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.

[0356] 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.

[0357] Furthermore, when the user's intention to open the door **30** is additionally identified as being present using an additional detector, 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.

[0358] 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.

[0359] 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.

[0360] FIG. **20** illustrates an example of a control method of the dish washer **1** according to the present disclosure. The control method includes step S**20** of controlling the operation of the handle driver **35** to prevent the hand of the user or the object from being caught into between the pop-up handle **31** and the door **30** when the pop-up handle **31** moves backwards.

[0361] As described above, when the controller **100** has identified the user's intention to open the door **30** based on the signal from the proximity sensor S_p before start of the selected washing course and after completion of the selected washing course, the controller may be configured to supply power to the handle driver **35** to operate the handle driver **35** in the forward direction to automatically move the pop-up handle **31** forwardly from the retracted position Pa to the extended position Pd and perform completing the forward movement of the handle driver **35** in S**10**.

[0362] The step S**20** may be performed after a predetermined waiting time has elapsed after the forward movement of the pop-up handle **31** has been completed in S**10**.

[0363] As described above, the predetermined waiting time may be in a range of 2.5 seconds inclusive to 3.5 seconds inclusive.

[0364] FIG. **21** and FIG. **22** illustrate detailed steps of the step S**20**.

[0365] Referring to FIG. **21**, the controller **100** is configured to first receive the output signal from the door position sensor S_d, and determines whether the door **30** is currently closed or opened based on the received output signal of the door position sensor S_d in S**201** and S**202**.

[0366] The identifying of whether the door **30** is opened or closed in this way is done in consideration of the fact that upon determination that the door is open, the user may close the door **30** using the pop-up handle **31**. That is, after the user closes the door **30** using the pop-up handle **31**, the backward movement of the pop-up handle **31** may be initiated.

[0367] When, in step S**202**, the door **30** is identified as being currently closed, the controller **100** is configured to receive the output signal from the first safety sensor S_f**1** in S**203**.

[0368] The first safety sensor S_f**1** may include either the touch sensor S_ct or the infrared sensor S_if.

[0369] When the output signal has been received from the first safety sensor S_f**1** in step S**203**, the controller **100** is configured to determine whether the hand of the user is detected as being present between the pop-up handle **31** and the door **30** for the first set time duration or larger based on the received output signal of the first safety sensor S_f**1** in S**204**.

[0370] For example, the first set time duration may be in a range of 0.4 seconds inclusive to 0.6 seconds inclusive. In some implementations, the first set time duration may be 0.5 seconds.

[0371] In some examples, identifying whether the hand of the user is continuously detected for the first set time duration or larger even when the hand of the user is detected to be caught into between the pop-up handle **31** and the door **30** based on the signal from the first safety sensor S_f**1** is done in consideration of the fact that a temporary touch motion of the user may occur and the user may take an action to immediately remove the hand from the pop-up handle **31**.

[0372] When it is determined that the hand of the user is detected as being present between the pop-up handle **31** and the door **30** for the first set time duration or larger based on the output signal of the first safety sensor S_f**1** in step S**204**, the controller **100** is configured to supply the power to the vibration element **3132** to operate the vibration element **3132** to generate the haptic vibration in the pop-up handle **31** in S**205**.

[0373] This haptic vibration may be a first haptic vibration alarm to notify that the backward

movement of the pop-up handle **31** will begin immediately and, consequently, injury to the hand of the user may occur.

[0374] When the first haptic vibration alarm has been generated in step S**205**, the controller **100** may be configured to supply power to the driving motor **351** to drive the driving motor **351** in the reverse direction to initiate the backward movement of the pop-up handle **31** in S**206**.

[0375] In some examples, the controller **100** may be configured to adjust the power to be supplied to the driving motor **351** so that the driving motor **351** drives at a normal speed when the operation of the pop-up handle **31** starts, but after the operation thereof starts, the rotation speed of driving motor **351** is gradually decreased.

[0376] The rotation speed of the driving motor **351** is decreased in this way, such that a backward movement speed of the pop-up handle **31** may be reduced, and thus, a possibility of injury to the hand of the user may be further reduced.

[0377] When the backward movement of the pop-up handle **31** starts in step S**206**, the controller **100** is configured to determine whether the hand of the user is continuously detected as being present between the pop-up handle **31** and the door **30** based on the output signal of the first safety sensor S_f**1** in S**207**.

[0378] When it is determined in step S**207** that the hand of the user is still detected as being present between the pop-up handle **31** and the door **30** based on the output signal of the first safety sensor S_f**1** after the backward movement of the pop-up handle **31** has been initiated, the controller **100** is configured to cut off the power being supplied to the driving motor **351** of the handle driver **35** to stop the operation of the driving motor **351** and thus stop the backward movement of the pop-up handle **31** for the user's safety and injury prevention in S**208**.

[0379] When the backward movement of the pop-up handle **31** is stopped in step S**208**, the controller **100** is configured to increases an intensity of the power being supplied to the vibration element **3132** to increase an intensity of the haptic vibration of the pop-up handle **31** and is further configured to generate the voice alarm through the sound output unit in S**209**.

[0380] In some examples, the increased intensity haptic vibration may be a secondary haptic vibration alarm to warn that the hand of the user is in a dangerous state.

[0381] Furthermore, the voice alarm may include information that informs that the hand of the user is in a dangerous state, such as, for example, 'Please take your hand off. I will retract the handle.'.

[0382] When the secondary haptic vibration alarm and the voice alarm have been generated in step S**209**, the control method of the controller **100** may proceed to step S**207** as described above in which the controller **100** may be configured to determine whether the hand of the user is still detected as being present between the pop-up handle **31** and the door **30**.

[0383] In some examples, when it is determined in step S**207** that the hand of the user is not detected as being present between the pop-up handle **31** and the door **30** after the backward movement of the pop-up handle **31** has been initiated, it is determined that the hand of the user has been currently removed from the pop-up handle **31** and thus the dangerous state is resolved. In response to this determination, the controller **100** may be configured to supply a normal power to the driving motor **351** so that the driving motor **351** drives in the reverse direction at a normal speed S**210**.

[0384] Accordingly, the pop-up handle **31** may continue to move in the backward direction at a normal speed.

[0385] When the backward movement of the pop-up handle **31** continues such that the backward movement of the pop-up handle **31** to the retracted position Pa has been completed, the controller **100** may be configured to cut off the power being supplied to the driving motor **351** to stop the operation of the handle driver **35** to terminate the backward movement of the pop-up handle **31** in S**30**.

[0386] In one example, when it is determined in step S**204** that the hand of the user is not detected as being present between the pop-up handle **31** and the door **30** for the first set time duration or

larger based on the output signal of the first safety sensor S_f**1**, the controller **100** may be configured to determine that the user's safety is secured and thus to supply the power to the driving motor **351** to drive the driving motor **351** in the reverse direction to initiate the backward movement of the pop-up handle **31** in S**211**.

[0387] In this case, the controller **100** may be configured to supply the normal power to the driving motor **351** so that the driving motor **351** drives at a normal speed to move the pop-up handle **31** backwards at a normal speed.

[0388] When the backward movement of the pop-up handle **31** has been initiated in step S**211**, the controller **100** is configured to receive the output signal from the second safety sensor and to determine whether an object is caught into between the pop-up handle **31** and the door **30** based on the received output signal of the second safety sensor in S**212** and S**213**.

[0389] As described above, the second safety sensor 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.

[0390] When the object has been detected as being present between the pop-up handle **31** and the door **30** in step S**213**, the controller **100** is configured to cut off the power being supplied to the driving motor **351** to stop the driving motor **351** in order to prevent damage to the pop-up handle **31** or the handle driver **35** due to the object being caught into between the pop-up handle **31** and the door **30**, and then, to immediately re-supply the power so that the driving motor **351** may drive in the forward direction in S**214**.

[0391] Thus, the pop-up handle **31** may move forwards again toward the extended position Pd, such that damage to or breakage of the pop-up handle **31** and the handle driver **35** due to the object being caught into between the pop-up handle **31** and the door **30** may be minimized.

[0392] In one example, after the forward movement of the pop-up handle **31** has been initiated in step S**214**, the controller **100** is configured to supply the power to the vibration element **3132** to operate the vibration element **3132** to generate the haptic vibration in the pop-up handle **31** in S**215**.

[0393] After the haptic vibration has been generated in step S**215** or at the same time as a time when the haptic vibration has been generated in step S**215**, the controller **100** is configured to generate the voice alarm through the sound output unit in S**216**.

[0394] In some examples, the voice alarm may include information such as, for example, "Please remove the object from the handle. I will retract the handle." This is because while the object is caught into between the pop-up handle **31** and the door **30**, the pop-up handle **31** may not move backwards.

[0395] After the voice alarm has been generated in step S**216**, the controller **100** is configured to determine whether an elapsed time duration after the driving motor **351** drives in the forward direction is greater than or equal to the predetermined second set time duration using a timer in S**217**.

[0396] In some examples, the second set time duration may be in a range of 9 seconds inclusive to 11 seconds inclusive. For instance, the second set time duration may be 10 seconds.

[0397] In some examples, the second set time duration may be set in consideration of a time duration taken for the user to recognize the object being caught into therebetween through the voice alarm, etc. and then, to remove the caught object from the pop-up handle **31**.

[0398] When it is determined in step S**217** that the elapsed time duration after the driving motor **351** drives in the forward direction is greater than the predetermined second set time duration, the controller **100** determines whether the object is re-detected as being present between the pop-up handle **31** and the door **30** based on the output signal received from the second safety sensor in S**218**.

[0399] Upon determination that the object is re-detected as being present between the pop-up

handle **31** and the door **30** in step S**218**, the control method of the controller may return to step S**215** as described above in which the controller **100** may be configured to repeat the subsequent steps thereto.

[0400] In one example, upon determination that the object is not re-detected as being present between the pop-up handle **31** and the door **30** in step S**218**, that is, when it is determined that the object has been removed from the handle **31**, the controller **100** is configured to supply the normal power to the driving motor **351** so that the driving motor **351** drives in the reverse direction at a normal speed in S**219**.

[0401] Accordingly, the pop-up handle **31** may start moving backwards from the extended position Pd at a normal speed.

[0402] When the backward driving of the pop-up handle **31** continues in this manner such that the backward movement of the pop-up handle **31** to the retracted position Pa has been completed, the controller **100** may be configured to cut off the power being supplied to the driving motor **351** to stop the operation of the handle driver **35** to terminate the backward movement of the pop-up handle **31** in S**30**.

[0403] Although the embodiments 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 embodiments, and may be modified in a various manner within the scope of the technical spirit of the present disclosure. Accordingly, the embodiments 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 embodiments. Therefore, it should be understood that the embodiments 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 embodiment 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 that is 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 a forward direction relative to the door and (ii) a retracted position in which the handle is at least partially accommodated within the door; and 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, wherein the handle driver comprises: a pivot link having (i) a first end configured to rotate relative to the door and (ii) a second end that is connected to the handle and configured to rotate relative to the handle, a driving cam configured to (i) press the pivot link in a frontward direction based on the driving cam rotating in a first direction and (ii) press the pivot link in a rearward direction based on the driving cam rotating in a second direction opposite to the first direction, and a driving motor configured to generate a driving force for rotating the driving cam in the first direction or the second direction, the driving motor comprising a rotation shaft disposed below a vertical level of the handle.

2. The dish washer of claim 1, wherein the door is configured to pivot about a pivot axis relative to the tub to thereby open and close the open front surface of the tub, and wherein a rotation direction of the door around the pivot axis to open the tub matches one of the first direction or the second direction of the drive motor to move the handle toward the extended position.

3. The dish washer of claim 1, wherein the driving cam comprises: a cam body configured to rotate based on the driving force of the driving motor; and a driving pin that protrudes from one side surface of the cam body toward the pivot link, wherein the pivot link defines a guide groove

between the first end and the second end and, the guide groove receiving the driving pin, and wherein the driving pin is configured to, based on the cam body rotating in the first or second direction, move relative to and along the guide groove to thereby cause the pivot link to pivot in the frontward or rearward direction.

4. The dish washer of claim 3, wherein the driving pin is located at a position that defines, in a state in which the handle is located at the extended position, a predetermined intersection angle between (i) a virtual first extension line extending from a rotation center of the cam body to a center of the driving pin and (ii) a virtual second extension line that is parallel to a movement direction of the handle to the extended position and extends through the rotation center of the cam body.

5. The dish washer of claim 4, wherein the predetermined intersection angle is less than or equal to 5 degrees.

6. The dish washer of claim 1, further comprising a handle housing disposed inside the door and configured to receive the handle therein based on the handle moving to the retracted position, wherein the handle housing defines a rail groove configured to guide a reciprocating movement of the handle between the extended position and the retracted position.

7. The dish washer of claim 6, wherein the handle comprises a guide protrusion that protrudes toward the rail groove and is inserted into the rail groove, and wherein the guide protrusion is configured to move along the rail groove during the reciprocating movement of the handle.

8. The dish washer of claim 1, wherein the door defines an opening at a front surface thereof, and wherein the handle is configured to reciprocate through the opening of the door during a reciprocating movement of the handle and configured to close the opening of the door based on the handle being disposed at the retracted position.

9. The dish washer of claim 8, wherein the opening is spaced apart from a top surface of the door by a vertical distance, and wherein the opening is spaced apart from each of right and left side surfaces of the door by a left-right distance that is less than the vertical distance.

10. The dish washer of claim 8, wherein the handle has a front end surface that is configured to be coplanar with the front surface of the door based on the handle being disposed at the retracted position.

11. The dish washer of claim 1, wherein the handle comprises: a first handle body configured to be exposed out of the door based on the handle moving to the extended position; and a second handle body connected to a rear end of the first handle body and received inside the door.

12. The dish washer of claim 11, wherein a vertical width of the second handle body is greater than a vertical width of the first handle body.

13. The dish washer of claim 12, wherein a front surface of the second handle body is configured to, based on the handle being disposed at the extended position, be disposed at a front surface of the door or rearward relative to the front surface of the door.

14. The dish washer of claim 1, further comprising a controller configured to determine whether to move the handle driver and to control power to be supplied to the handle driver, wherein the controller is configured to control an operation of the handle driver to prevent an object or a hand of a user from being caught between the handle and the door while the handle moves from the extended position to the retracted position.

15. The dish washer of claim 14, further comprising a first safety sensor configured to detect whether the hand of the user is present between the handle and the door, wherein the controller configured to: based on an output signal received from the first safety sensor, determine whether the hand of the user is present between the handle and the door for a first set time duration or longer; and based on a determination that the hand of the user is present between the handle and the door for a time duration greater than the first set time duration, initiate the operation of the handle driver to move the handle backwards toward the retracted position and decrease a movement speed of the handle after the operation of the handle driver has been initiated.

16. The dish washer of claim 15, wherein the first safety sensor comprises a capacitive touch sensor

or an infrared sensor.

17. The dish washer of claim 15, further comprising a vibration element disposed at the handle and configured to generate a haptic vibration, wherein the controller is configured to turn on the vibration element to generate the haptic vibration based on the determination that the hand of the user is present between the handle and the door for the time duration greater than the first set time duration.

18. The dish washer of claim 15, wherein the controller is configured to: after decreasing the movement speed of the handle, re-determine whether the hand of the user is still present between the handle and the door based on the output signal received from the first safety sensor.

19. The dish washer of claim 18, wherein the controller is further configured to: based on a determination that the hand of the user is still present between the handle and the door, stop the operation of the handle driver to stop a movement of the handle toward the retracted position.

20. The dish washer of claim 15, further comprising a second safety sensor configured to detect whether the object or the hand of the user is present between the handle and the door, wherein the controller is further configured to: based on the output signal received from the first safety sensor, determine that the hand of the user is absent between the handle and the door for a time duration greater than the first set time duration; based on a determination that the hand of the user is absent between the handle and the door for the time duration greater than the first set time duration, initiate the operation of the handle driver to move the handle backwards; after the operation of the handle driver has been initiated, determine whether the object or the hand of the user is present between the handle and the door based on an output signal received from the second safety sensor; based on determination that the object or the hand of the user is present between the handle and the door, stop the operation of the handle driver to stop a movement of the handle toward the retracted position; and after the handle has stopped, start an operation of the handle driver to move the handle forwards toward the extended position.

21. The dish washer of claim 20, wherein the second safety sensor comprises a strain sensor disposed on the handle or the handle driver, or a current sensor configured to detect electric current supplied to the handle driver.

22. The dish washer of claim 17, wherein the controller is further configured to: determine whether a second set time duration has elapsed after starting the operation of the handle driver to move the handle forwards toward the extended position; based on a determination that the second set time duration has elapsed, re-determine whether the object or the hand of the user is present between the handle and the door based on the output signal received from the second safety sensor; and based on a determination that the object or the hand of the user is absent between the handle and the door, operate the handle driver to move the handle backwards toward the retracted position.