boarding/disembarking apparatus backward temporarily. Patent Literatures 2 and 3 give almost no consideration to a case where the aircraft has stopped in a manner to deviate from a predetermined stop position. Accordingly, it is considered that there will be a case where when the boarding/disembarking apparatus is moved closer and positioned at the front of the predicted position of the aircraft door, the aircraft door cannot be recognized by the video camera depending on the degree of the deviation.

[0008] Embodiments of the present invention are made to solve the above-described problems. Embodiments of the present invention provide a passenger boarding bridge that is capable of, even in a case where an aircraft has stopped in a manner to deviate from a predetermined stop position, docking a cab with the aircraft without measuring the amount of the deviation, while making it possible to eliminate or simplify operations performed by an operator.

Solution to Problem

[0009] According to an aspect of the present invention, there is provided a passenger boarding bridge including: a tunnel unit including a walkway; a cab rotatably provided on a distal end of the tunnel unit; a drive wheel provided on the tunnel unit or the cab; a rotational mechanism configured to rotate the cab; a controller configured to control the drive wheel to move the cab, control the rotational mechanism to rotate the cab such that the cab is in an orientation in which a distal end part of the cab faces an entrance of an aircraft, and cause the distal end part of the cab to be docked with the entrance; an entrance image capturing camera mounted to the cab and configured to capture an image of the entrance of the aircraft together with a bumper provided at a distal end of a floor of the cab; and an entrance position calculator configured to detect the entrance of the aircraft based on the image of the entrance, which is captured by the entrance image capturing camera, and calculate horizontal positional information of the entrance. The controller is, when the cab is at a predetermined standby position from which the cab starts moving at a time of performing docking of the cab with the entrance, configured to: calculate a target position based on the horizontal positional information of the entrance, which is calculated by the entrance position calculator, the target position being a destination position to which the cab is moved for docking the cab with the entrance; and move the cab from the standby position to the target position.

[0010] According to the above aspect, the controller: calculates the target position, i.e., a destination position to which the cab is moved, based on the horizontal positional information of the entrance, which is calculated based on the image of the entrance captured by the entrance image capturing camera; and moves the cab from the standby position to the target position. Therefore, even in a case where the aircraft has stopped in a manner to deviate from a

predetermined stop position, the operator is not required to perform any special operations, such as measuring and inputting the amount of the deviation. This makes it possible to move the cab from the standby position and dock the cab with the aircraft while eliminating or simplifying operations performed by the operator. Further, at the standby position, from which the cab starts moving at the time of performing the docking of the cab with the entrance, the image of the entrance is captured by the entrance image capturing camera and the target position is calculated. Therefore, even in a case where the aircraft has stopped in a manner to deviate from the predetermined stop position, at the time of moving the cab toward the entrance, the movement of the cab can be directed to the entrance from the begging of the moving. This makes is possible to reduce a moving distance and a moving time of the cab that are required for docking the cab with the entrance.

[0011] In an embodiment, the target position may be a position of the cab at which the cab is spaced apart forward from the entrance by a predetermined distance. The controller may be configured to: when the cab has reached the target position, calculate a docking position based on the horizontal positional information of the entrance, which is calculated by the entrance position calculator, the docking position being a position at which the cab is docked with the entrance; and move the cab to the docking position, and stop the cab at the docking position.

[0012] According to the above embodiment, the docking position of the cab is calculated when the cab has moved closer and reached the position that is spaced apart forward from the entrance by the predetermined distance. This makes it possible to precisely and automatically move the cab from the standby position to the docking position.

[0013] In an embodiment, the controller may be configured to: when the cab has reached the target position, temporarily stop the cab from moving; while the cab is temporarily stopped from moving, calculate the docking position; and then cause the cab to start moving again toward the docking position.

[0014] According to the above embodiment, the cab is temporarily stopped from moving when calculating the docking position, and thereby the docking position can be calculated more precisely.

[0015] In an embodiment, the target position may be a position of the cab at which the cab is docked with the entrance, and the controller may be configured to stop the cab from moving when the cab has reached the target position.

[0016] According to the above embodiment, the cab can be quickly and automatically moved from the standby position to the docking position.

[0017] In an embodiment, the passenger boarding bridge may further include a lifting/lowering mechanism controlled by the controller and configured to lift and lower the cab.

The entrance position calculator may be configured to calculate, based on the image of the entrance, an upward/downward moving amount of the cab for adjusting a height of the cab to a height of the entrance. The controller may be configured to lift and lower the cab based on the upward/downward moving amount of the cab, which is calculated by the entrance position calculator.

[0018] In an embodiment, the entrance position calculator may be configured to: detect the entrance of the aircraft based on a shape of a corner of a door of the entrance, whose image is captured by the entrance image capturing camera; and detect a boundary point between a curved portion of the corner of the door and a straight portion that is continuous with the corner, and calculate the horizontal positional information of the entrance based on the boundary point.

[0019] The above embodiment makes it possible to detect the entrance without relying on aircraft type information. Also, according to the above embodiment, it is not necessary to add any particular features to the aircraft for the detection of the entrance.

[0020] In an embodiment, the entrance position calculator may be configured to detect the entrance based on: the shape of the corner of the door, whose image is captured by the entrance image capturing camera; and a shape of a reinforcing plate that is present immediately below the door.

[0021] The above embodiment makes it possible to detect the entrance without relying on aircraft type information. Also, according to the above embodiment, it is not necessary to add any particular features to the aircraft for the detection of the entrance.

[0022] In an embodiment, the passenger boarding bridge may further include: a front wheel image capturing camera mounted to the cab and configured to capture an image of a front wheel of the aircraft and a vicinity around the front wheel; and an aircraft type determiner configured to determine an aircraft type of the aircraft by comparing the image of the front wheel of the aircraft and the vicinity around the front wheel, the image being captured by the front wheel image capturing camera when the cab is at the standby position, with each of shape patterns of a front wheel of an aircraft and a vicinity around the front wheel, the shape patterns being prestored for respective aircraft types.

[0023] According to the above embodiment, the passenger boarding bridge is capable of autonomously determining the aircraft type without requiring the operator to input aircraft type information into the passenger boarding bridge or without receiving aircraft type information fed from external equipment. In addition, if the operator inputs the aircraft type information into the passenger boarding bridge, whether or not an input error has been made can be confirmed.

[0024] It should be noted that, by utilizing aircraft type information, control can be performed to rotate the cab so as to adjust the orientation of the cab at the target position to a predetermined orientation in accordance with the aircraft type determined by the aircraft type determiner, and also, the precision in entrance detection can be increased.

[0025] In an embodiment, the passenger boarding bridge may further include a pair of distance sensors that are mounted to right and left sides of the distal end part of the cab, respectively, the distance sensors each being configured to measure a distance from the aircraft. The controller may be configured to rotate the cab, such that measurement values from the pair of respective distance sensors are equalized.

[0026] In an embodiment, the passenger boarding bridge may further include an aircraft detector configured to detect, when the cab is at the standby position, that the aircraft has arrived and stopped at a predetermined aircraft parking area. The entrance position calculator may be configured to start operating when the aircraft detector has detected that the aircraft has arrived and stopped at the predetermined aircraft parking area.

[0027] According to the above embodiment, when the aircraft has arrived and stopped at the aircraft parking area, the cab automatically starts moving.

[0028] In an embodiment, the passenger boarding bridge may further include a notifier mounted to the cab, the notifier being configured to notify a crew member of the aircraft that the docking of the cab with the entrance of the aircraft has been completed. The controller may be configured to cause the notifier to notify that the docking has been completed when the cab has been docked with the entrance.

[0029] According to the above embodiment, since the crew member of the aircraft is notified by the notifier that the docking has been completed, the crew member thus notified can open the entrance door to enable boarding onto and disembarking from the aircraft.

Advantageous Effects of Invention

[0030] Embodiments of the present invention have an advantage of being able to provide a passenger boarding bridge that is capable of, even in a case where an aircraft has stopped in a manner to deviate from a predetermined stop position, docking a cab with the aircraft without measuring the amount of the deviation, while making it possible to eliminate or simplify operations performed by an operator.

[0031] The above and other aspects, features, and advantages of the present invention will more fully be apparent from the following detailed description of a preferred embodiment with accompanying drawings.