Technical Problem

[0006] In the case of Patent Literature 1, the operator can visually perform the docking of the cab with the aircraft entrance, relying on the indication by the lighting. In this case, however, the cab docking precision significantly depends on the skill of the operator. Particularly in the case of docking the cab with a large aircraft having a large entrance door, there is not much gap between the movement trajectory of the door and the internal space of the cab. Therefore, in this case, high docking precision is strictly required. For this reason, in this case, if a non-proficient operator performs the docking, there is a risk that the door may interfere with part of the cab before the door is fully opened.

[0007] In the case of Patent Literature 2, after the cab is automatically docked with the entrance of the aircraft, the cab is moved to follow upward/downward movements of the aircraft. However, Patent Literature 2 does not take into consideration whether or not the automatically docked state satisfies a strictly required high docking precision, particularly in the case of docking the cab with the entrance of a large aircraft having a large door. In the case of docking the cab with an entrance having a large door, final checking of the docking position is crucial in order to prevent the interference between the door and the cab.

[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 makes it possible to prevent interference between the door of a large aircraft and the cab from occurring before the door is fully opened.

Solution to Problem

[0009] A passenger boarding bridge according to one aspect of the present invention includes: a rotunda connected to a terminal building; a tunnel unit whose proximal end is connected to the rotunda in such a manner that the tunnel unit is liftable and lowerable, the tunnel unit being configured to be extendable and retractable in a longitudinal direction of the tunnel unit; a cab provided at a distal end of the tunnel unit; a mover that moves the cab to dock the cab with an entrance of an aircraft; a door position detector that is provided inside the cab and that detects, after the cab is docked with the entrance by the mover, a position of an edge portion of a door of the entrance in a width direction of the door with respect to the cab in a case where a width of the door is greater than or equal to a predetermined width; a door opening determiner that determines whether or not the door of the entrance can be opened smoothly based on whether or not the position of the edge portion of the door in the width direction of the door, the position being detected by the door position detector, is present within a predetermined allowable region; and a notifier that notifies that there is an abnormality in a case where the door

opening determiner has determined that the door of the entrance cannot be opened smoothly.

[0010] According to the above aspect, in a case where the aircraft is a large aircraft whose door width is greater than or equal to the predetermined width, after the cab is docked with the entrance and before the door is opened, the door opening determiner determines whether or not the door can be opened smoothly based on whether or not the position of the edge portion of the door in the width direction of the door, the position being detected by the door position detector, is present within the predetermined allowable region. If it is determined that the door cannot be opened smoothly, the notifier notifies that there is an abnormality. Accordingly, an operator performs the docking of the cab with the entrance again. This makes it possible to prevent interference between the door of the large aircraft and the cab from occurring when the door is opened.

[0011] In an embodiment of the above aspect, the mover may be configured to perform, by automatic control, an operation of: moving the cab from a predetermined standby position, from which the cab is to start moving, to a temporary stop position, at which the cab is located forward away from the entrance by a predetermined distance; and then moving the cab to a position at which the cab gets docked with the entrance. The passenger boarding bridge may further include: a camera that is mounted to the cab and that captures an image of the entrance of the aircraft; a pre-docking door width calculator that detects, when the cab is at the temporary stop position, a first characteristic portion and a second characteristic portion based on the image of the entrance captured by the camera, the first and second characteristic portions being present around the door of the entrance and being away from each other in the width direction of the door, and calculates the width of the door based on positions of the respective first and second characteristic portions on the image; and a door width determiner that determines whether or not the width of the door calculated by the pre-docking door width calculator is greater than or equal to the predetermined width. The door position detector may be configured to detect the position of the edge portion of the door in the width direction of the door with respect to the cab in a case where the door width determiner has determined that the width of the door calculated by the pre-docking door width calculator is greater than or equal to the predetermined width.

[0012] In an embodiment of the above aspect, the passenger boarding bridge may further include a pre-moving door width calculator that detects, when the cab is at the standby position, the first and second characteristic portions based on the image of the entrance captured by the camera, and calculates the width of the door based on the positions of the respective first and second characteristic portions on the image. The passenger boarding bridge may be configured to terminate the automatic control of the operation of the mover in a case where a discrepancy between the width of the door calculated by the pre-moving door width calculator and the width

of the door calculated by the pre-docking door width calculator is out of a predetermined allowable range.

[0013] In an embodiment of the above aspect, the first and second characteristic portions may be in a predetermined positional relationship in which their positions are different from each other in both a left-right direction and a vertical direction of the door. The passenger boarding bridge may further include an image determiner that determines whether or not a positional relationship between the first and second characteristic portions on the image is the predetermined positional relationship. The passenger boarding bridge may be configured to terminate the automatic control of the operation of the mover in a case where the image determiner has determined that the positional relationship between the first and second characteristic portions is not the predetermined positional relationship.

[0014] In an embodiment of the above aspect, the passenger boarding bridge may further include: a bellows-shaped closure that is provided at a distal end of the cab and that is extendable and contractible in a front-back direction; and a level detector that is mounted to the cab and that comes into contact with the aircraft and detects an upward/downward movement of the aircraft with respect to the cab. The passenger boarding bridge may be configured to: perform automatic control of operations of the closure and the level detector, following the automatic control of the operation of the mover; and terminate the automatic control of the operations of the closure and the level detector in a case where the door opening determiner has determined that the door of the entrance cannot be opened smoothly.

[0015] In an embodiment of the above aspect, the mover may be configured to perform, by manual control, an operation of moving the cab from a predetermined standby position, from which the cab is to start moving, to a position at which the cab gets docked with the entrance. The passenger boarding bridge may further include: a bellows-shaped closure that is provided at a distal end of the cab and that is extendable and contractible in a front-back direction; a level detector that is mounted to the cab and that comes into contact with the aircraft and detects an upward/downward movement of the aircraft with respect to the cab; and a door width identifier that receives an input of aircraft type information about the aircraft, with which the cab is to be docked, and based on the inputted aircraft type information, identifies whether or not the width of the door of the aircraft is greater than or equal to the predetermined width. In a case where the door width identifier has identified that the width of the door of the aircraft is greater than or equal to the predetermined width, the door position detector may be configured to detect, after the cab is docked with the entrance, the position of the edge portion of the door in the width direction of the door with respect to the cab based on at least one of a manually controlled operation of causing the closure to extend and a manually controlled operation of causing the

level detector to start operating.

[0016] In an embodiment of the above aspect, the door position detector may be a laser displacement sensor that detects a groove between a fuselage and the edge portion of the door in the width direction of the door.

Advantageous Effects of Invention

[0017] Embodiments of the present invention advantageously provide a passenger boarding bridge that makes it possible to prevent interference between the door of a large aircraft and the cab from occurring before the door is fully opened.

[0018] The above aspect, other aspects, features, and advantages of the present invention will be made clear by the following detailed description of preferred embodiments with reference to the accompanying drawings.

Brief Description of Drawings

[0019] FIG. 1 is a schematic plan view showing one example of a passenger boarding bridge according to an embodiment of the present invention.

FIG. 2 is a schematic side view of the passenger boarding bridge.

FIG. 3 is a side view showing one example of a state where a cab is docked with an aircraft.

FIG. 4 is a front view of a cab distal end part to be docked with the aircraft (the front view is taken from the aircraft side).

FIG. 5 is a plan view showing one example of arrangement of a laser displacement sensor installed in the cab.

FIG. 6 shows one example of a control panel, etc.

FIG. 7 is a flowchart schematically showing one example of operations performed at the time of docking of the passenger boarding bridge.

FIG. 8 is a flowchart showing one example of various determination processes performed during automatic control of the passenger boarding bridge.

FIG. 9 is a schematic diagram showing one example of an image captured by a camera when the cab is at a standby position.

FIG. 10 shows a detection region of the laser displacement sensor.

Description of Embodiments