When the measured angle is, for example, θ_{R1}, θ_{R2}, or θ_{R3}, there is a measurement error $\Delta\theta_{R1}$, $\Delta\theta_{R2}$, or $\Delta\theta_{R3}$, respectively, from the actual angle.

[0021] FIG. 9B shows one example of a travel path of the drive wheels 9 of the travel unit 12 when there are measurement errors between the measured angle and the actual angle as indicated by errors $\Delta\theta_{R1}$, $\Delta\theta_{R2}$, and $\Delta\theta_{R3}$ in FIG. 9A. In FIG. 9B, unhatched rectangles represent the positions of the respective left and right drive wheels 9 according to the control calculation, and hatched rectangles represent actual positions of the respective left and right drive wheels 9. In this example, at a time point when the travel unit 12 starts traveling (i.e., when the travel unit 12 is at the standby position), the measured angle and the actual angle are both θ_{R0}, and the positions of the respective drive wheels 9 according to the control calculation coincide with the actual positions of the respective drive wheels 9. However, in reality, in some cases, there is a measurement error from the actual angle.

[0022] Even in the aforementioned case where the feedback control is ideally performed on the linear target travel path R1 and thereby the center point of the travel unit 12 moves on the target travel path R1 according to the control calculation, an actual travel path R2 deviates from the target travel path R1 due to the measurement errors $\Delta\theta_R$ of the rotunda angle sensor.

[0023] The amount of positional deviation between a travel position (the position of the center point of the travel unit 12) according to the control calculation and an actual travel position at a certain time point during traveling is substantially proportional to the product of the rotunda-to-travel unit horizontal distance LW and the measurement error $\Delta\theta_R$ at the time point. Here, the amount of positional deviation due to the measurement error $\Delta\theta_R$ is great since the rotunda-to-travel unit horizontal distance LW is about 10 to 45 m, which is a relatively great distance.

[0024] As shown in FIG. 9A, the measurement error $\Delta\theta_R$ varies. Accordingly, in a case where the travel unit 12 reaches, for example, a target position such as a docking position when the absolute value of the measurement error $\Delta\theta_R$ is great, the amount of positional deviation from the target docking position is great, which may cause a problem in that the cab 6 cannot be properly docked with the aircraft 3.

[0025] Embodiments of the present invention have been made to solve the above-described problems. Embodiments of the present invention provide a method of controlling traveling of a passenger boarding bridge, the method making it possible to cause a travel unit of the passenger boarding bridge to properly perform straight traveling from a movement start position to a destination position.

Solution to Problem

[0026] According to an aspect of the present invention there is provided, a method of

controlling traveling of a passenger boarding bridge , the passenger boarding bridge including: a rotunda connected to a terminal building and rotatable in regular and reverse directions about a vertical axis; 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; a cab rotatably provided at a distal end of the tunnel unit; a lifting/lowering mechanism mounted to the tunnel unit or the cab and configured to lift and lower the tunnel unit or the cab; a travel unit mounted below the lifting/lowering mechanism, the travel unit being configured to travel on a ground and rotate in regular and reverse directions about an axis that passes through a center point of the travel unit, such that a travel direction of the travel unit is changeable; a rotunda angle sensor that detects a rotational angle of the rotunda; a travel unit angle sensor that detects a rotational angle of the travel unit; a horizontal distance measurer that measures a horizontal distance from the vertical axis to the center point of the travel unit; and an inclination angle measurer that measures an inclination angle of the tunnel unit relative to a horizontal plane. The method includes, at a time of docking the cab with an entrance of an aircraft: a step of calculating relative positional information indicating a position of the entrance as seen from the cab when the travel unit is at a movement start position; a step of calculating positional information of a destination position, the destination position being a position to which the travel unit is moved for docking the cab with the entrance, based on positional information of the travel unit at the movement start position and the relative positional information of the entrance in a case where a distance from the movement start position to the destination position is in a predetermined state in which the distance is less than the horizontal distance from the vertical axis to the center point of the travel unit at the movement start position; a step of moving the travel unit to a point that is closer to the destination position such that the distance from the movement start position to the destination position becomes the predetermined state in a case where the distance is not in the predetermined state and calculating positional information of the destination position with the point set as a new movement start position; a step of calculating a target travel angle that is an angle formed by a direction extending linearly from the movement start position toward the destination position and a particular direction; and a traveling step of: causing the travel unit to travel from the movement start position toward the destination position; calculating, at predetermined time intervals during traveling of the travel unit, a travel angle that is an angle formed by a current travel direction of the travel unit and the particular direction; and controlling the travel unit by taking only the travel angle into account, such that the travel angle is kept to the target travel angle. The step of calculating the positional information of the destination position includes calculating positional information of the movement start position based on the horizontal distance from the vertical axis to the center point of the travel unit, the horizontal distance being measured by the

horizontal distance measurer, the rotational angle of the rotunda detected by the rotunda angle sensor, and the inclination angle measured by the inclination angle measurer. The traveling step includes calculating the travel angle based on the rotational angle of the travel unit detected by the travel unit angle sensor and the rotational angle of the rotunda detected by the rotunda angle sensor.

[0027] According to the above method of controlling traveling of a passenger boarding bridge, when the travel unit is at the movement start position, in a case where a distance (distance A) from the movement start position to the destination position is in the predetermined state, in which the distance A is less than the horizontal distance (distance B) from the rotational center (the vertical axis) of the rotunda to the center point of the travel unit, the positional information of the destination position is calculated, and during the traveling of the travel unit, the travel angle is calculated at predetermined time intervals, and the travel unit is controlled only such that the travel angle is kept to the target travel angle. At the time of performing the control, the positional discrepancy between the current position of the travel unit, the calculation of which is significantly affected by a measurement error of the rotunda angle sensor, and a scheduled current position of the travel unit on a target travel path (a path linearly connecting between the movement start position and the destination position) is not taken into account, but only the travel angle is taken into account as described above in a case where the distance A is less than the distance B. This makes it possible to reduce the amount of positional deviation of the travel unit from the target travel path and cause the travel unit to travel straight properly from the movement start position to the destination position. It should be noted that the movement start position may be a position of the travel unit after the travel unit has been moved by any means or by any cause, or may be a position that the travel unit passes while moving.

[0028] The destination position may be a position of the travel unit when the cab is docked with the entrance.

[0029] The step of calculating the relative positional information may include: detecting the entrance based on an image of the entrance, the image being captured by a camera mounted to the cab; and calculating the relative positional information of the detected entrance.

[0030] The travel unit may include two drive wheels that are arranged parallel to each other, with the center point of the travel unit positioned therebetween, the two drive wheels being drivable to rotate independently of each other. The traveling step may include controlling the travel unit by adjusting a rotation speed of each of the two drive wheels.

[0031] In the step of calculating the positional information of the destination position, the predetermined state may be a state in which the distance from the movement start position to the destination position is less than or equal to a predetermined distance that is less than the horizontal distance from the vertical axis to the center point of the travel unit in a case where the

tunnel unit is fully retracted.

Advantageous Effects of Invention

[0032] Embodiments of the present invention have an advantage of being able to provide a method of controlling traveling of a passenger boarding bridge, the method making it possible to cause a travel unit of the passenger boarding bridge to properly perform straight traveling from a movement start position to a destination position.

Brief Description of Drawings

[0033] 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 side view schematically showing the passenger boarding bridge.

FIG. 3 is a front view of the distal end part of a cab to be docked with an aircraft.

FIG. 4 shows one example of an operation panel, etc.

FIG. 5 is a flowchart showing one example of operations of the passenger boarding bridge at the time of docking.

FIG. 6 is a flowchart showing one example of a method of calculating control amounts for operations of the passenger boarding bridge at the time of docking.

FIG. 7 is a schematic diagram showing one example of an image captured by a door image capturing camera when the cab is at a standby position.

FIG. 8 is a schematic plan view of a conventional passenger boarding bridge.

FIG. 9A shows one example of a relationship between an angle measured by a rotunda angle sensor and an actual angle, and FIG. 9B shows one example of an actual travel path of drive wheels when there are measurement errors between the measured angle and the actual angle as shown in FIG. 9A.

Description of Embodiments

[0034] Hereinafter, preferred embodiments of the present invention are described with reference to the drawings. In the drawings, the same or corresponding elements are denoted by the same reference signs, and repeating the same descriptions is avoided below. The present invention is not limited to the embodiments described below.

[0035] (Embodiments)

Claims:

1. A method of controlling traveling of a passenger boarding bridge, the passenger boarding bridge including:

a rotunda connected to a terminal building and rotatable in regular and reverse directions about a vertical axis;

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;

a cab rotatably provided at a distal end of the tunnel unit;

a lifting/lowering mechanism mounted to the tunnel unit or the cab and configured to lift and lower the tunnel unit or the cab;

a travel unit mounted below the lifting/lowering mechanism, the travel unit being configured to travel on a ground and rotate in regular and reverse directions about an axis that passes through a center point of the travel unit, such that a travel direction of the travel unit is changeable;

a rotunda angle sensor that detects a rotational angle of the rotunda;

a travel unit angle sensor that detects a rotational angle of the travel unit;

a horizontal distance measurer that measures a horizontal distance from the vertical axis to the center point of the travel unit; and

an inclination angle measurer that measures an inclination angle of the tunnel unit relative to a horizontal plane,

the method comprising, at a time of docking the cab with an entrance of an aircraft:

a step of calculating relative positional information indicating a position of the entrance as seen from the cab when the travel unit is at a movement start position;

a step of calculating positional information of a destination position, the destination position being a position to which the travel unit is moved for docking the cab with the entrance, based on positional information of the travel unit at the movement start position and the relative positional information of the entrance in a case where a distance from the movement start position to the destination position is in a predetermined state in which the distance is less than the horizontal distance from the vertical axis to the center point of the travel unit at the movement start position;

a step of moving the travel unit to a point that is closer to the destination position such that the distance from the movement start position to the destination position becomes the

predetermined state in a case where the distance is not in the predetermined state and calculating positional information of the destination position with the point set as a new movement start position;

a step of calculating a target travel angle that is an angle formed by a direction extending linearly from the movement start position toward the destination position and a particular direction; and

a traveling step of:

causing the travel unit to travel from the movement start position toward the destination position;

calculating, at predetermined time intervals during traveling of the travel unit, a travel angle that is an angle formed by a current travel direction of the travel unit and the particular direction; and

controlling the travel unit by taking only the travel angle into account, such that the travel angle is kept to the target travel angle, wherein

the step of calculating the positional information of the destination position includes calculating positional information of the movement start position based on the horizontal distance from the vertical axis to the center point of the travel unit, the horizontal distance being measured by the horizontal distance measurer, the rotational angle of the rotunda detected by the rotunda angle sensor, and the inclination angle measured by the inclination angle measurer, and

the traveling step includes calculating the travel angle based on the rotational angle of the travel unit detected by the travel unit angle sensor and the rotational angle of the rotunda detected by the rotunda angle sensor.

2. The method of controlling traveling of a passenger boarding bridge according to claim 1, wherein

the destination position is a position of the travel unit when the cab is docked with the entrance.

3. The method of controlling traveling of a passenger boarding bridge according to claim 1 or 2, wherein

the step of calculating the relative positional information includes:

detecting the entrance based on an image of the entrance, the image being captured by a camera mounted to the cab; and

calculating the relative positional information of the detected entrance.

4. The method of controlling traveling of a passenger boarding bridge according to any one of claims 1 to 3, wherein

the travel unit includes two drive wheels that are arranged parallel to each other, with the center point of the travel unit positioned therebetween, the two drive wheels being drivable to rotate independently of each other, and

the traveling step includes controlling the travel unit by adjusting a rotation speed of each of the two drive wheels.

5. The method of controlling traveling of a passenger boarding bridge according to any one of claims 1 to 4, wherein

in the step of calculating the positional information of the destination position, the predetermined state is a state in which the distance from the movement start position to the destination position is less than or equal to a predetermined distance that is less than the horizontal distance from the vertical axis to the center point of the travel unit in a case where the tunnel unit is fully retracted.

6. The passenger boarding bridge according to any one of claims 1 to 5, wherein

the distance from the movement start position to the destination position is not greater than one-fifth of the horizontal distance from the vertical axis to the center point of the travel unit at the movement start position.