DESCRIPTION

Title of Invention: ATTACHING SYSTEM AND ATTACHING METHOD

Technical Field

[0001] The present invention relates to an attaching system and an attaching method.

Background Art

[0002] Conventionally, a passenger boarding bridge is known as boarding/disembarking equipment for passengers, which is used between an aircraft and a terminal building of an airport. When the cab of the passenger boarding bridge is attached to a door of the aircraft, the passenger boarding bridge is used to form a passenger walkway to the aircraft.

[0003] Usually, when the passenger boarding bridge is moved between a standby position and an attaching position where the passenger boarding bridge is attached to the aircraft, an operator manually operates the passenger boarding bridge by using a joystick or the like while visually checking the attaching position and the standby position. However, such manual operation requires a highly skillful technique, and also, for example, an attaching time necessary for attaching the passenger boarding bridge to the aircraft or the ability to operate the passenger boarding bridge varies from operator to operator. In view of these, automatic attachment of a passenger boarding bridge to an aircraft has already been proposed (see Patent Literatures 1 to 6, for example).

Citation List

Patent Literature

[0004] PTL 1: Japanese Laid-Open Patent Application Publication No. 2003-212194

PTL 2: Japanese National Phase PCT Laid-Open Application Publication No. 2005-518308

PTL 3: Japanese Laid-Open Patent Application Publication No. 2004-314700

PTL 4: Japanese Laid-Open Patent Application Publication No. S58-188795

PTL 5: Japanese Patent No. 4293874

PTL 6: Japanese National Phase PCT Laid-Open Application Publication No. H10-505562

Summary of Invention

Technical Problem

[0005] However, Patent Literatures 1 to 6 do not sufficiently discuss problems including:

the problem of deviation of the stop position of an aircraft in a case where a plurality of passenger boarding bridges are to be attached to the aircraft; and the problem of cost increase. These problems will be described below in detail in Description of Embodiments.

[0006] Embodiments of the present invention have been made in view of such circumstances, and provides an attaching system and an attaching method that make it possible, in the case of attaching a plurality of passenger boarding bridges to an aircraft, to automatically attach the passenger boarding bridges to the aircraft more properly and more easily than the conventional art even if deviation of the stop position of the aircraft occurs.

Solution to Problem

[0007]

According to a first aspect of the present invention, there is provided an attaching system comprising: a first passenger boarding bridge and a second passenger boarding bridge that are provided on a terminal building; a detector provided on the first passenger boarding bridge; and a controller configured to receive an output signal from the detector, wherein after the first passenger boarding bridge is attached to an aircraft and/or while the first passenger boarding bridge is moving before being attached to the aircraft, the controller: acquires position data of the first passenger boarding bridge by using the detector; calculates attaching position data of the second passenger boarding bridge for attachment of the second passenger boarding bridge to the aircraft by using the position data, known data obtained from a fuselage of the aircraft, and known data obtained from the terminal building; and controls automatic attachment of the second passenger boarding bridge to the aircraft based on the attaching position data.

[0007a] According to a second aspect of the present invention, there is provided an attaching method comprising: after a first passenger boarding bridge provided on a terminal building is

attached to an aircraft and/or while the first passenger boarding bridge is moving before being attached to the aircraft, acquiring position data of the first passenger boarding bridge by using a detector; calculating attaching position data of a second passenger boarding bridge provided on the terminal building for attachment of the second passenger boarding bridge to the aircraft by using the position data, known data obtained from a fuselage of the aircraft, and known data obtained from the terminal building; and automatically attaching the second passenger boarding bridge to the aircraft based on the attaching position data.

Advantageous Effects of Invention

[0008] According to embodiments of the present invention, in the case of attaching a plurality of passenger boarding bridges to the aircraft, even if deviation of the stop position of the aircraft occurs, the passenger boarding bridges can be automatically attached to the aircraft more properly and more easily than the conventional art.

Brief Description of Drawings

[0009] Fig. 1 shows one example of a first passenger boarding bridge.

Fig. 2 is a diagram used for describing position data of the first passenger boarding bridge, the position data being detected by a detector.

Fig. 3 is a diagram used for describing known data obtained from the fuselage of an aircraft.

Fig. 4 is a diagram used for describing known data obtained from a terminal building.

Fig. 5 is a diagram used for describing arithmetic formulas for calculating attaching position data of a second passenger boarding bridge.

Fig. 6 shows one example of a controller.

Fig. 7 is a flowchart showing one example of an automatic attachment operation of the second passenger boarding bridge by the controller.

Description of Embodiments

[0010] (Embodiment)

The inventors of the present invention conducted diligent studies on problems including: the problem of deviation of the stop position of an aircraft in a case where a plurality of passenger boarding bridges are to be attached to the aircraft; and the problem of cost increase. As a result of the studies, they have obtained the findings described below.

[0011] Patent Literature 1 and Patent Literature 2 each propose a technique in which a passenger boarding bridge is provided with an optical sensor or image recognition device, with which the single passenger boarding bridge is automatically attached to the fuselage of an aircraft. In this case, however, the optical sensor or image recognition device needs to be additionally installed, which causes increase in cost. In addition, the precision of the detector, such as the optical sensor, may become unstable due to such factors as the body color of the aircraft and weather.

[0012] Patent Literature 3 proposes a technique in which a passenger boarding bridge in an origin confirmation position is rotated by a predetermined angle, and then the length of its tunnel unit is expanded to a predetermined length. In this manner, the passenger boarding bridge is automatically attached to the fuselage of an aircraft. Patent Literature 5 proposes a technique in which the amount of deviation of an actual stop position of an aircraft from its predetermined stop position when a passenger boarding bridge is attached to the aircraft for the first time is taken into account for setting a target position for attaching the passenger boarding bridge to the aircraft for the second time and thereafter. However, these techniques of Patent Literature 3 and Patent Literature 5 are on the assumption that the aircraft stops at a substantially fixed position every time. Therefore, for example, when the stop position of the aircraft deviates from the fixed position due to, for example, control of the aircraft by the pilot, these techniques are useless.

[0013] In view of the above, the inventors of the present invention have come up with the

idea of, in the case of attaching a plurality of passenger boarding bridges to an aircraft, when one of the passenger boarding bridges is attached to the aircraft or while the one passenger boarding bridge is moving before being attached to the aircraft, utilizing position data of the one passenger boarding bridge for automatic attachment of the other passenger boarding bridge(s) to the aircraft.

[0014] Specifically, an attaching system according to a first aspect of the present invention includes: a first passenger boarding bridge and a second passenger boarding bridge that are provided on a terminal building; a detector provided on the first passenger boarding bridge; and a controller configured to receive an output signal from the detector. After the first passenger boarding bridge is attached to an aircraft and/or while the first passenger boarding bridge is moving before being attached to the aircraft, the controller: acquires position data of the first passenger boarding bridge by using the detector; calculates attaching position data of the second passenger boarding bridge for attachment of the second passenger boarding bridge to the aircraft by using the position data, known data obtained from a fuselage of the aircraft, and known data obtained from the terminal building; and controls automatic attachment of the second passenger boarding bridge to the aircraft based on the attaching position data.

[0015] An attaching method according to the first aspect of the present invention includes: after a first passenger boarding bridge provided on a terminal building is attached to an aircraft and/or while the first passenger boarding bridge is moving before being attached to the aircraft, acquiring position data of the first passenger boarding bridge by using a detector; calculating attaching position data of a second passenger boarding bridge provided on the terminal building for attachment of the second passenger boarding bridge to the aircraft by using the position data, known data obtained from a fuselage of the aircraft, and known data obtained from the terminal building; and automatically attaching the second passenger boarding bridge to the aircraft based on the attaching position data.

[0016] An attaching system according to a second aspect of the present invention is such that, in the attaching system according to the first aspect, each of the first passenger boarding bridge and the second passenger boarding bridge includes: a rotunda connected to a gate of the terminal building; a tunnel unit connected to the rotunda; and a cab connected to the tunnel unit. The detector includes: a rotunda rotation angle detector configured to detect a rotation angle of the rotunda of the first passenger boarding bridge; a tunnel unit length detector configured to detect a length of the tunnel unit of the first passenger boarding bridge in a front-rear direction of the tunnel unit; and a cab rotation angle detector configured to detect a rotation angle of the cab of the first passenger boarding bridge. The attaching position data includes: a rotation angle of

the rotunda of the second passenger boarding bridge; a length of the tunnel unit of the second passenger boarding bridge in a front-rear direction of the tunnel unit; and a rotation angle of the cab of the second passenger boarding bridge.

[0017] An attaching method according to the second aspect of the present invention is such that, in the attaching method according to the first aspect, the position data includes: a rotation angle of a rotunda of the first passenger boarding bridge, the rotunda being connected to a gate of the terminal building; a length of a tunnel unit of the first passenger boarding bridge in a front-rear direction of the tunnel unit, the tunnel unit being connected to the rotunda; and a rotation angle of a cab of the first passenger boarding bridge, the cab being connected to the tunnel unit. The attaching position data includes: a rotation angle of a rotunda of the second passenger boarding bridge, the rotunda being connected to a gate of the terminal building; a length of a tunnel unit of the second passenger boarding bridge in a front-rear direction of the tunnel unit, the tunnel unit being connected to the rotunda of the second passenger boarding bridge; and a rotation angle of a cab of the second passenger boarding bridge, the cab being connected to the tunnel unit of the second passenger boarding bridge.

[0018] According to the above systems and methods, in the case of attaching the first passenger boarding bridge and the second passenger boarding bridge to the aircraft, even if deviation of the stop position of the aircraft occurs, the second passenger boarding bridge can be automatically attached to the aircraft more properly and more easily than the conventional art. Specifically, even if the stop position of the aircraft deviates from a predetermined fixed position, the attaching position of the second passenger boarding bridge is calculated based on the position data of the first passenger boarding bridge, the position data being detected by the detector, and therefore the attaching position data are suitable values in which the deviation of the stop position is taken into account. In a case where an optical sensor, image recognition device, or the like is not used in the automatic attachment of the second passenger boarding bridge to the aircraft, the attaching system of the present embodiment can be readily configured. Moreover, in this case, the problem that the precision of the detector, such as the optical sensor, becomes unstable due to such factors as the body color of the aircraft and weather can be prevented.

[0019] An attaching system according to a third aspect of the present invention is such that the attaching system according to the first or second aspect includes: an image capturing device provided on the second passenger boarding bridge and configured to capture an image of a door of the aircraft; and a display device provided on the first passenger boarding bridge and configured to display the image captured by the image capturing device.

[0020] According to the above configuration, in a case where the image capturing device

and the display device are used in the automatic attachment of the second passenger boarding bridge to the aircraft, an operator on the first passenger boarding bridge can readily check the state of attachment between the door of the aircraft and the second passenger boarding bridge. For example, when an abnormality occurs in the attachment between the door of the aircraft and the second passenger boarding bridge, the operator can readily perform, for example, emergency handling to address the abnormality.

[0021] Hereinafter, specific examples of the present embodiment 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.

[0022] It should be noted that the present embodiment is not limited to the specific examples described below. For example, automatic attachment of a second passenger boarding bridge by a controller does not necessarily mean that all the steps in the attachment of the second passenger boarding bridge to an aircraft door are performed automatically. Details will be given in this regard in Variation 4 described below.

[0023] [Configuration of Passenger Boarding Bridge]

Fig. 1 shows one example of a first passenger boarding bridge. It should be noted that the present embodiment is directed to a passenger boarding bridge attaching system in which a plurality of passenger boarding bridges (in this example, a first passenger boarding bridge 100A and a second passenger boarding bridge 100B) are attached to an aircraft 200 (see Fig. 5, for example). The configuration of the first passenger boarding bridge 100A is the same as that of the second passenger boarding bridge 100B. Accordingly, Fig. 1 only shows the first passenger boarding bridge 100A, and the description of the configuration of the second passenger boarding bridge 100B is omitted herein. Fig. 1 shows a state where the overall length of a tunnel unit 10A of the first passenger boarding bridge 100A is contracted. Hereinafter, the configuration of the first passenger boarding bridge 100A is described assuming that: the direction in which the overall length of the tunnel unit 10A of the first passenger boarding bridge 100A is expanded and contracted is the front-rear direction; the aircraft 200 side of the first passenger boarding bridge 100A is the “front side”; and the terminal building 300 side of the first passenger boarding bridge 100A is the “rear side”.

[0024] The first passenger boarding bridge 100A includes: a rotunda (a rear round room) 12A connected to a gate of the terminal building 300; the tunnel unit 10A connected to the rotunda 12A; and a cab (front round room) 20A connected to the front end of the tunnel unit 10A.

[0025] The tunnel unit 10A is configured such that adjoining tunnels thereof are fitted

together in such a manner that the inner tunnel is nested in the outer tunnel, and the overall length of the tunnel unit 10A can be expanded and contracted in the front-rear direction. Specifically, drive columns (not shown) are coupled to a suitable part of the tunnel unit 10A (e.g., a front part of the outermost tunnel) in a manner to sandwich the tunnel unit 10A. Accordingly, when drive wheels at the bottom of the drive columns run on the ground (apron), expanding or contracting power in the front-rear direction is exerted on the tunnel unit 10A. As a result of the overall length of the tunnel unit 10A being expanded, the cab 20A disposed at the front end of the tunnel unit 10A reaches a door of the aircraft 200, and thereby a walkway for passengers is formed between the gate of the terminal building 300 and the door of the aircraft 200. At the time, the tunnel unit 10A and the cab 20A can be swung vertically with respect to the rotunda 12A by expanding or contracting movement of the drive columns in the vertical direction, which is perpendicular to the plane of Fig. 1.

[0026] It should be noted that a controller 50 (see Fig. 6) is provided inside the cab 20A, and an operator can operate various equipment (e.g., drive columns) of the first passenger boarding bridge 100A by using a joystick 51 (see Fig. 6) of the controller 50. Auxiliary stairs 16A are provided on the side of the tunnel unit 10A in a manner to connect between the inside of the tunnel unit 10A and the apron. The auxiliary stairs 16 are used, for example, to allow the operator to get in and out of the cab 20A.

[0027] [Definition of Symbols]

First, symbols used in arithmetic operations performed by a control system of the present embodiment are defined.

[0028] Fig. 2 is a diagram used for describing position data of the first passenger boarding bridge, the position data being detected by a detector. Fig. 3 is a diagram used for describing known data obtained from the fuselage of the aircraft. Fig. 4 is a diagram used for describing known data obtained from the terminal building. Fig. 5 is a diagram used for describing arithmetic formulas for calculating attaching position data of the second passenger boarding bridge.

[0029] <Position Data of First Passenger Boarding Bridge Detected by Detector (see Fig. 2)>

Symbol γ represents the rotation angle of the rotunda 12A (i.e., an angle formed by a center straight line 401A, which connects between a rotational center 112A of the rotunda 12A and a rotational center 120A of the cab 20A, and a predetermined reference straight line 400A).

Symbol L represents the length of the tunnel unit 10A (i.e., a distance between the rotational center 112A of the rotunda 12A and the rotational center 120A of the cab 20A).

Symbol ε represents the rotation angle of the cab 20A (i.e., an angle formed by the center straight line 401A and a tangent line in an attaching position of the cab 20A in a case where the cab 20A is properly attached to the door of the aircraft 200).

<Known Data Obtained from Fuselage of Aircraft (see Fig. 3)>

Symbol a represents a distance between the rotational center 120A of the cab 20A and a rotational center 120B of a cab 20B in a case where the cab 20A of the first passenger boarding bridge 100A and the cab 20B of the second passenger boarding bridge 100B are properly attached to respective doors of the aircraft 200.

Symbol α represents an angle formed by a center straight line 402, which connects between the rotational center 120A of the cab 20A and the rotational center 120B of the cab 20B, and the tangent line in the attaching position of the cab 20A in the case where the cab 20A is properly attached to the door of the aircraft 200.

Symbol δ represents an angle formed by the center straight line 402 and a tangent line in an attaching position of the cab 20B in a case where the cab 20B is properly attached to the door of the aircraft 200.

<Known Data Obtained from Terminal Building (see Fig. 4)>

Symbol b represents a distance between the rotational center 112A of the rotunda 12A of the first passenger boarding bridge 100A and a rotational center 112B of a rotunda 12B of the second passenger boarding bridge 100B.

Symbol β represents an angle formed by a center straight line 403, which connects between the rotational center 112A of the rotunda 12A and the rotational center 112B of the rotunda 12B, and the predetermined reference straight line 400A.

<Attaching Position Data of Second Passenger Boarding Bridge Calculated through Arithmetic Operation by Control System (see Fig. 5)>

Symbol C represents the rotation angle of the rotunda 12B (i.e., an angle formed by a center straight line 401B, which connects between the rotational center 112B of the rotunda 12B and the rotational center 120B of the cab 20B, and a predetermined reference straight line 400B).

Symbol A represents the length of a tunnel unit 10B (i.e., a distance between the rotational center 112B of the rotunda 12B and the rotational center 120B of the cab 20B).

Symbol B represents the rotation angle of the cab 20B (i.e., an angle formed by the center straight line 401B and the tangent line in the attaching position of the cab 20B in the case where the cab 20B is properly attached to the door of the aircraft 200.)

<Inter-Point Distance and Angle Calculated in the Middle of Arithmetic Operation by Control System (see Fig. 5)>

Symbol x represents a distance between the rotational center 112B of the rotunda 12B of the second passenger boarding bridge 100B and the rotational center 120A of the cab 20A of the first passenger boarding bridge 100A.

Symbol y represents a distance between the rotational center 112A of the rotunda 12A of the first passenger boarding bridge 100A and the rotational center 120B of the cab 20B of the second passenger boarding bridge 100B.

Symbol z represents an angle formed by the center straight line 401A and a straight line that connects between the rotational center 112B of the rotunda 12B of the second passenger boarding bridge 100B and the rotational center 120A of the cab 20A of the first passenger boarding bridge 100A.

It should be noted that, in a plan view seen perpendicularly to the plane of the drawing, the reference straight line 400A and the reference straight line 400B may extend in any direction, so long as the reference straight line 400A and the reference straight line 400B are parallel to each other. In this example, as shown in the drawing, the aircraft 200 is stopped at a proper position, and the reference straight line 400A and the reference straight line 400B are perpendicular to the center line of the aircraft 200 in the front-rear direction, while passing through the rotational center 112A of the rotunda 12A and the rotational center 112B of the rotunda 12B, respectively.

[0030] [Configuration of Control System]

As shown in Fig. 2, a detector 30 is provided on the first passenger boarding bridge 100A. It should be noted that, although not illustrated, the same detector 30 may be provided on the second passenger boarding bridge 100B.

[0031] The detector 30 includes a rotunda rotation angle detector 31, a tunnel unit length detector 32, and a cab rotation angle detector 33.

[0032] The rotunda rotation angle detector 31 detects the rotation angle γ of the rotunda 12A of the first passenger boarding bridge 100A. The rotunda rotation angle detector 31 may be configured in any form, so long as the rotunda rotation angle detector 31 is capable of detecting the rotation angle γ of the rotunda 12A. One example of the rotunda rotation angle detector 31 is a rotary encoder.

[0033] The tunnel unit length detector 32 detects the length L of the tunnel unit 10A of the first passenger boarding bridge 100A in the front-rear direction. The tunnel unit length detector 32 may be configured in any form, so long as the tunnel unit length detector 32 is capable of detecting the length L of the tunnel unit 10A in the front-rear direction. One example of the tunnel unit length detector 32 is as a linear encoder. One example of the linear encoder is a

length gauge that includes: a magnetic tape disposed on the inner surface of the side wall of the outer tunnel; and a magnetic sensor disposed on the distal end of the inner tunnel.

[0034] The cab rotation angle detector 33 detects the rotation angle of the cab 20A of the first passenger boarding bridge 100A. The cab rotation angle detector 33 may be configured in any form, so long as the cab rotation angle detector 33 is capable of detecting the rotation angle of the cab 20A. One example of the cab rotation angle detector 33 is a rotary encoder.

[0035] As shown in Fig. 6, the controller 50 includes the joystick 51, an operating panel 52, and a display device 53. Since the joystick 51, the operating panel 52, and the display device 53 are well known, a detailed description thereof is omitted herein.

[0036] The controller 50 receives an output signal from the detector 30. After the first passenger boarding bridge 100A is attached to the aircraft 200, the controller 50 acquires the position data γ, L, and ε of the first passenger boarding bridge 100A by using the detector 30. By using the position data γ, L, and ε, the known data a, α, and δ obtained from the fuselage of the aircraft 200, and the known data b and β obtained from the terminal building 300, the controller 50 calculates the attaching position data A, B, and C of the second passenger boarding bridge 100B for attachment of the second passenger boarding bridge 100B to the aircraft 200. The controller 50 controls automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 based on the attaching position data A, B, and C. The automatic attachment of the second passenger boarding bridge 100B by the controller 50 will be described below in detail.

[0037] The controller 50 may be configured in any manner, so long as the controller 50 has control functions. The controller 50 may include, for example, an arithmetic operation unit (not shown) and a storage unit (not shown) storing a control program. Examples of the arithmetic operation unit include a PLC, MPU, and CPU. The storage unit is a memory, for example. The controller 50 may be configured as a single controller, or may be configured as a plurality of controllers.

[0038] [Automatic Attachment Operation of Second Passenger Boarding Bridge by Controller]

Fig. 7 is a flowchart showing one example of an automatic attachment operation of the second passenger boarding bridge by the controller.

[0039] First, in step S1, attachment of the first passenger boarding bridge 100A to the aircraft 200 is performed. The attachment may be manually performed by an operator in the cab 20A of the first passenger boarding bridge 100A, or may be automatically performed by using a conventional technique for automatically attaching the passenger boarding bridge to the

aircraft.

[0040] When the attachment of the first passenger boarding bridge 100A to the aircraft 200 in step S1 is completed, the controller 50 acquires the position data γ, L, and ε of the first passenger boarding bridge 100A, which are detected by the detector 30 (step S2). Specifically, the controller 50 acquires the rotation angle γ of the rotunda 12A, the length L of the tunnel unit 10A, and the rotation angle ε of the cab 20A.

[0041] The controller 50 acquires the known data a, α, and δ, which are obtained from the fuselage of the aircraft 200, and also acquires the known data b and β, which are obtained from the terminal building 300 (step S3). It should be noted that, for example, these data may be prestored in the storage unit of the controller 50 for each aircraft type of the aircraft 200, or may be inputted to the controller 50 by the operator's operation.

[0042] Next, by using the position data γ, L, and ε of the first passenger boarding bridge 100A acquired in step S2, the known data a, α, and δ obtained from the fuselage of the aircraft 200 and acquired in step S3, and the known data b and β obtained from the terminal building 300 and acquired in step S3, the controller 50 calculates the attaching position data A, B, and C of the second passenger boarding bridge 100B for attachment of the second passenger boarding bridge 100B to the aircraft 200 (step S4).

[0043] This calculation is performed, for example, by using arithmetic formulas (1) to (6) indicated below. It should be noted that these arithmetic formulas (1) to (6) are prestored in the storage unit of the controller 50.

[0044] As shown in Fig. 5, the inter-point distances x and y and the angle z are expressed in the following arithmetic formulas (1) to (3) by using the law of cosines.

[0045] [Math. 1]

$$X = \sqrt{L^2 + b^2 - 2Lb\cos(180 - \beta - \gamma)} \quad \cdots (1)$$

[0046] [Math. 2]

$$y = \sqrt{a^2 + L^2 - 2aL\cos(180 - \varepsilon + \alpha)} \quad \cdots (2)$$

[0047] [Math. 3]

$$z = \cos^{-1}\left(\frac{L^2 + x^2 - b^2}{2Lx}\right) \quad \cdots (3)$$

Accordingly, the attaching position data A, B, and C of the second passenger boarding bridge 100B can be expressed in the following arithmetic formulas (4) to (6).

[0048] [Math. 4]

$$A = \sqrt{a^2 + x^2 - 2ax\cos(180 - \varepsilon - z + \alpha)} \quad \cdots (4)$$

[0049] [Math. 5]

$$B = \cos^{-1}\left(\frac{A^2 + a^2 - x^2}{2Aa}\right) - \delta \quad \cdots (5)$$

[0050] [Math. 6]

$$C = \cos^{-1}\left(\frac{A^2 + b^2 - y^2}{2Ab}\right) - \beta \quad \cdots (6)$$

Next, the operator pushes an operating button on the operating panel 52 (step S5). In response thereto, the controller 50 performs automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 based on the attaching position data A, B, and C (step S6). Specifically, the rotunda 12B automatically turns by the rotation angle C; the tunnel unit 10B automatically expands by the length A; and the cab 20B automatically turns by the rotation angle B. As a result, the second passenger boarding bridge 100B is automatically attached to the door of the aircraft 200.

[0051] It should be noted that, in the present embodiment, the operating button is in an ON state only while the operator is pushing the button, i.e., configured as a dead man's switch. Accordingly, when the operator releases his/her hand from the operating button, the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 is canceled (step S7), and thereby the automatic attachment is forcibly terminated (step S8). For example, if the operator finds some kind of abnormality in the second passenger boarding bridge 100B, the operator releases his/her hand from the operating button, and thereby the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 can be immediately and forcibly terminated.

[0052] As described above, in the case of attaching the first passenger boarding bridge 100A and the second passenger boarding bridge 100B to the aircraft 200, even if deviation of the stop position of the aircraft 200 occurs, the second passenger boarding bridge 100B can be automatically attached to the aircraft 200 more properly and more easily than the conventional

art. Specifically, even if the stop position of the aircraft 200 deviates from a predetermined fixed position, the attaching position data A, B, and C of the second passenger boarding bridge 100B are calculated based on the position data γ, L, and ε of the first passenger boarding bridge 100A, which are detected by the detector 30, and therefore the attaching position data A, B, and C are suitable values in which the deviation of the stop position is taken into account.

[0053] In a case where an optical sensor, image recognition device, or the like is not used in the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200, the attaching system of the present embodiment can be readily configured. Moreover, in this case, the problem that the precision of the detector, such as the optical sensor, becomes unstable due to such factors as the body color of the aircraft 200 and weather can be prevented.

[0054] Furthermore, since the first passenger boarding bridge 100A and the second passenger boarding bridge 100B are operated by a single operator, the operation of the first passenger boarding bridge 100A and the second passenger boarding bridge 100B is stabilized, and thereby the operation cost of the first passenger boarding bridge 100A and the second passenger boarding bridge 100B can be reduced. Specifically, if two operators operate the first passenger boarding bridge 100A and the second passenger boarding bridge 100B, respectively, there is a problem that the attaching time one operator requires for attaching the first passenger boarding bridge 100A to the aircraft or the ability of the one operator to operate the first passenger boarding bridge 100A may vary from the attaching time the other operator requires for attaching the second passenger boarding bridge 100B to the aircraft or the ability of the other operator to operate the second passenger boarding bridge 100B. The present embodiment eliminates this problem. Since the first passenger boarding bridge 100A and the second passenger boarding bridge 100B can be operated by a single operator, the number of operators required for the operation is reduced compared to the case where two operators operate the first passenger boarding bridge 100A and the second passenger boarding bridge 100B, respectively. This makes it possible to reduce the operation cost of the first passenger boarding bridge 100A and the second passenger boarding bridge 100B.

[0055] (Variation 1)

The above embodiment describes an example in which, after the first passenger boarding bridge 100A is attached to the aircraft 200, the controller 50 starts the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 based on the attaching position data A, B, and C of the second passenger boarding bridge 100B. However, the present embodiment is not thus limited. For example, even while the first passenger boarding bridge 100A is moving before being attached to the aircraft 200, the controller 50 can

calculate the attaching position data A, B, and C of the moving second passenger boarding bridge 100B with each passing moment by using the arithmetic formulas (1) to (6). Accordingly, even while the first passenger boarding bridge 100A is moving before being attached to the aircraft 200, the controller 50 can control the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 based on the attaching position data A, B, and C of the moving second passenger boarding bridge 100B. This makes it possible to reduce the attaching time of the second passenger boarding bridge 100B as compared to the case where the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 is started after the first passenger boarding bridge 100A is attached to the aircraft 200.

[0056] (Variation 2)

The above embodiment describes an example in which an image-capturing device for capturing an image of a door of the aircraft 200 is not additionally installed. However, the present embodiment is not thus limited. For example, the attaching system according to Variation 2 includes: an image capturing device (not shown) provided on the second passenger boarding bridge 100B and configured to capture an image of a door of the aircraft 200; and a display device (not shown) such as an LCD monitor provided on the first passenger boarding bridge 100A and configured to display the image captured by the image capturing device (not shown) such as an image-capturing camera.

[0057] According to the above configuration, in a case where the image capturing device and the display device are used in the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200, the operator in the cab 20A of the first passenger boarding bridge 100A can readily check the state of attachment between the door of the aircraft 200 and the second passenger boarding bridge 100B. Moreover, when an abnormality occurs in the attachment between the door of the aircraft 200 and the second passenger boarding bridge 100B, the operator can readily perform, for example, emergency handling to address the abnormality. For example, if the operator finds an attachment abnormality in the image captured by the image capturing device during the attachment of the second passenger boarding bridge 100B, then in steps S7 and S8 of Fig. 7, the operator can immediately and forcibly terminate the automatic attachment of the second passenger boarding bridge 100B to the aircraft 200 by removing his/her hand from the operating button.

[0058] (Variation 3)

The above embodiment describes the attachment of the first passenger boarding bridge 100A and the second passenger boarding bridge 100B to the aircraft 200. However, the number of passenger boarding bridges to be attached to the aircraft 200 is not limited to two.

The technique of the present disclosure for automatically attaching passenger boarding bridges to an aircraft is applicable to a case where three or more passenger boarding bridges are to be attached to an aircraft.

[0059] (Variation 4)

The above embodiment describes an operation example in which all the steps in the attachment of the second passenger boarding bridge 100B to the door of the aircraft 200 are performed automatically. However, the present embodiment is not thus limited.

[0060] For example, the controller 50 may be configured to perform the automatic attachment operation for automatically attaching the second passenger boarding bridge 100B to the door of the aircraft 200 until the second passenger boarding bridge 100B is moved to near the front of the door of the aircraft 200. Then, the automatic attachment operation may be terminated, and the operator in the cab 20A of the first passenger boarding bridge 100A may manually perform a remote operation to fully attach the second passenger boarding bridge 100B to the door of the aircraft 200 by using, for example, the above-described image capturing device and display device.

[0061] Also by such automatic attachment, similar to the above-described embodiment, when deviation of the stop position of the aircraft 200 occurs, the second passenger boarding bridge 100B can be automatically attached to the aircraft 200 more properly and more easily than the conventional art. In addition, in this case, the operator need not perform the remote operation of the second passenger boarding bridge 100B for all the steps in the attachment of the second passenger boarding bridge 100B to the door of the aircraft 200 while checking the image on the display device. This improves the operation efficiency.

[0062] From the foregoing description, numerous modifications and other embodiments of the present invention are obvious to a person skilled in the art. Therefore, the foregoing description should be interpreted only as an example and is provided for the purpose of teaching the best mode for carrying out the present invention to a person skilled in the art. The structural and/or functional details may be substantially altered without departing from the spirit of the present invention.

Industrial Applicability

[0063] According to one aspect of the present invention, in the case of attaching a plurality of passenger boarding bridges to an aircraft, even if deviation of the stop position of the aircraft occurs, the passenger boarding bridges can be automatically attached to the aircraft more properly and more easily than the conventional art. Therefore, the one aspect of the present

invention is applicable to, for example, a passenger boarding bridge attaching system and a passenger boarding bridge attaching method.

Reference Signs List

[0064]

10A	tunnel unit
10B	tunnel unit
12A	rotunda
12B	rotunda
20A	cab
20B	cab
30	detector
31	rotunda rotation angle detector
32	detector
33	cab rotation angle detector
50	controller
51	joystick
52	operating panel
53	display device
100A	first passenger boarding bridge
100B	second passenger boarding bridge
200	aircraft
300	terminal building

CLAIMS:

1. An attaching system comprising:

a first passenger boarding bridge and a second passenger boarding bridge that are provided on a terminal building;

a detector provided on the first passenger boarding bridge; and

a controller configured to receive an output signal from the detector, wherein

after the first passenger boarding bridge is attached to an aircraft and while the first passenger boarding bridge is moving before being attached to the aircraft, the controller:

acquires position data of the first passenger boarding bridge by using the detector;

calculates attaching position data of the second passenger boarding bridge for attachment of the second passenger boarding bridge to the aircraft by using arithmetic formulas with each of the position data, known data obtained from a fuselage of the aircraft, and known data obtained from the terminal building as a variable; and

controls automatic attachment of the second passenger boarding bridge to the aircraft based on the attaching position data.

2. The attaching system according to claim 1, wherein

each of the first passenger boarding bridge and the second passenger boarding bridge includes:

a rotunda connected to a gate of the terminal building;

a tunnel unit connected to the rotunda; and

a cab connected to the tunnel unit,

the detector includes:

a rotunda rotation angle detector configured to detect a rotation angle of the rotunda of the first passenger boarding bridge;

a tunnel unit length detector configured to detect a length of the tunnel unit of the first passenger boarding bridge in a front-rear direction of the tunnel unit; and

a cab rotation angle detector configured to detect a rotation angle of the cab of the first passenger boarding bridge, and

the attaching position data includes:

a rotation angle of the rotunda of the second passenger boarding bridge;

a length of the tunnel unit of the second passenger boarding bridge in a

front-rear direction of the tunnel unit; and

a rotation angle of the cab of the second passenger boarding bridge.

3. The attaching system according to claim 1 or 2, comprising:

an image capturing device provided on the second passenger boarding bridge and configured to capture an image of a door of the aircraft; and

a display device provided on the first passenger boarding bridge and configured to display the image captured by the image capturing device.

4. An attaching method comprising:

after a first passenger boarding bridge provided on a terminal building is attached to an aircraft and while the first passenger boarding bridge is moving before being attached to the aircraft, acquiring position data of the first passenger boarding bridge by using a detector;

calculating attaching position data of a second passenger boarding bridge provided on the terminal building for attachment of the second passenger boarding bridge to the aircraft by using arithmetic formulas with each of the position data, known data obtained from a fuselage of the aircraft, and known data obtained from the terminal building as a variable; and

automatically attaching the second passenger boarding bridge to the aircraft based on the attaching position data.

5. The attaching method according to claim 4, wherein

the position data includes:

a rotation angle of a rotunda of the first passenger boarding bridge, the rotunda being connected to a gate of the terminal building;

a length of a tunnel unit of the first passenger boarding bridge in a front-rear direction of the tunnel unit, the tunnel unit being connected to the rotunda; and

a rotation angle of a cab of the first passenger boarding bridge, the cab being connected to the tunnel unit, and

the attaching position data includes:

a rotation angle of a rotunda of the second passenger boarding bridge, the rotunda being connected to a gate of the terminal building;

a length of a tunnel unit of the second passenger boarding bridge in a front-rear direction of the tunnel unit, the tunnel unit being connected to the rotunda of the second

passenger boarding bridge; and

a rotation angle of a cab of the second passenger boarding bridge, the cab being connected to the tunnel unit of the second passenger boarding bridge.