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Vertiport having wind generator, and method for landing aircraft using the same

Abstract

An embodiment vertiport includes a main body portion having a lower space, a take-off and landing zone disposed in the lower space and spaced apart from the main body portion by a predetermined gap, a door portion disposed in the gap and configured to open or close the gap, a plurality of elevating portions disposed to surround the take-off and landing zone in the lower space, a ring-shaped portion surrounding the take-off and landing zone and connected to the plurality of elevating portions, wherein the ring-shaped portion is configured to be elevated by the plurality of elevating portions, and a plurality of generators disposed on the ring-shaped portion in a fixed position.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
5998882	12/1998	Alston	60/226.1	F03D 9/22
7380751	12/2007	Henson	244/1R	F03D 9/12
8378518	12/2012	Khavari	290/55	F03D 13/20
9359997	12/2015	Toh	N/A	F03D 9/00
9784244	12/2016	Souryal	N/A	H02K 7/1838
9970419	12/2017	Souryal	N/A	F03D 1/04
10220861	12/2018	Boukari	N/A	B61L 27/40
10253759	12/2018	Souryal	N/A	H02K 7/1838
10938275	12/2020	Glatfelter	N/A	F03D 3/002
2009/0250936	12/2008	Souryal	290/55	F03D 9/255
2010/0276940	12/2009	Khavari	290/55	F03D 9/43
2011/0174925	12/2010	Ying	N/A	N/A
2016/0052531	12/2015	Boukari	348/148	B61L 23/04
2018/0226860	12/2017	Glatfelter	N/A	H02K 7/1823
2019/0225249	12/2018	Boukari	N/A	B61K 9/08
2019/0280563	12/2018	Glatfelter	N/A	F03D 9/43
2023/0271721	12/2022	Sauer	N/A	N/A

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
210047636	12/2019	CN	N/A
211417634	12/2019	CN	N/A
2023028989	12/2022	JP	N/A
20200011402	12/2019	KR	N/A
20200043980	12/2019	KR	N/A
20210143448	12/2020	KR	N/A
20220074826	12/2021	KR	N/A
102490173	12/2022	KR	N/A
2019005937	12/2018	WO	N/A
2020243364	12/2019	WO	N/A

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application claims the benefit of Korean Patent Application No. 10-2023-0192626, filed on Dec. 27, 2023, which application is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

(2) The present disclosure relates to a vertiport having a wind generator and a method for landing an aircraft using the same.

BACKGROUND

(3) With the development of the urban air mobility vehicle (hereinafter, referred to as a UAM vehicle), a take-off and landing area where a UAM vehicle may take-off and land within an urban area is required. The take-off and landing area is being considered to be installed on the rooftop of a high-rise building or in a park within the urban area. Because of this, the take-off and landing area inevitably occupies a much smaller area than an airport with a typical runway.

(4) Meanwhile, the take-off and landing area is provided with infrastructure and a support system for landing, ground handling, take-off, and the like of UAM vehicles. To this end, electricity for lighting and support systems or electricity for charging an electric-powered UAM is required, and there may be no alternative to covering electricity demand other than with commercially available electricity.

SUMMARY

(5) The present disclosure relates to a vertiport having a wind generator and a method for landing an aircraft using the same. Particular embodiments relate to a vertiport having a wind turbine generator that can produce electricity using wind generated during take-off and landing of an aircraft and a method for landing an aircraft using the same.

(6) An embodiment of the present disclosure provides a vertiport having a wind turbine generator capable of producing electricity using wind generated during take-off and landing of an aircraft and a method for landing an aircraft using the same.

(7) According to an embodiment of the present disclosure, a vertiport may include a main body portion having a lower space, a take-off and landing zone disposed in the lower space and spaced apart from the main body portion by a predetermined gap, a door portion disposed in the gap to open or close the gap, a plurality of elevating portions disposed to surround the take-off and landing zone in the lower space, a ring-shaped portion surrounding the take-off and landing zone and which is elevated through being connected to the plurality of elevating portions, and a plurality of generators disposed on the ring-shaped portion, wherein the plurality of generators may have a fixed position on the ring-shaped portion.

(8) The vertiport may be converted into a basic mode, in which the door portion is closed, and the ring-shaped portion and the plurality of generators are lowered by the elevating portion and are located in the lower space, and a power generation mode in which the door portion is opened, and the ring-shaped portion and the plurality of generators are raised by the elevating portion, so that the plurality of generators are exposed externally within the gap.

(9) The take-off and landing zone may include a marking portion providing a reference position and reference direction so that an aircraft lands with a constant position and direction.

(10) The marking portion may indicate magnetic north.

(11) The marking portion may include a beacon transmitting non-directional radio waves.

(12) The elevating portion may include a plurality of rails installed upright in the lower space of the main body portion and having a rack gear formed on one side thereof, a support bracket formed on one side thereof, so that the rail penetrates therethrough, a first driving unit fixedly installed to the support bracket, and a first pinion gear connected to the first driving unit and engaged with the rack

gear.
(13) The ring-shaped portion may further include a rotating portion moving the plurality of generators in a circumferential direction.
(14) The rotating portion may include an external ring gear formed on a lateral peripheral surface of the ring-shaped portion in a circumferential direction, a second driving unit fixedly installed on the support bracket, and a second pinion gear connected to the second driving unit and engaged with the external ring gear.
(15) The support bracket may be provided with a connection portion having a rolling member to connect the ring-shaped portion, the ring-shaped portion may be provided with a connection groove formed in the circumferential direction of the ring-shaped portion, and the rolling member may travel within the connection groove.
(16) The vertiport may further include a control unit electrically connected to at least the door portion and the elevating portion and controlling opening and closing of the door portion and raising and lowering of the ring-shaped portion by the elevating portion.
(17) The ring-shaped portion may further include a rotating portion moving the plurality of generators in a circumferential direction, wherein the control unit may be electrically connected to the rotating portion to drive the rotating portion and rotate the ring-shaped portion based on model information and state information of an aircraft, thereby changing the positions of the plurality of generators by a predetermined angle.
(18) The plurality of generators may include a wind turbine generator producing electricity using wind generated during the landing of an aircraft in the take-off and landing zone.
(19) According to an embodiment of the present disclosure, a method for landing an aircraft may include operations in which an aircraft approaches a vertiport, it is determined whether the aircraft is a model of aircraft capable of generating power, a door portion of the vertiport is opened and a ring-shaped portion and a plurality of generators thereof are raised when it is determined that that aircraft is a model of aircraft capable of generating power, electricity is produced using the plurality of generators as the aircraft is lowered, the aircraft lands on a take-off and landing zone of the vertiport and is parked, and the ring-shaped portion and the plurality of generators are lowered and the door portion is closed.
(20) In the determining whether the aircraft is a model of aircraft capable of generating power, by receiving coordinates regarding disposition of each rotor from a center of the aircraft, a control unit may determine whether the aircraft is a model of aircraft capable of generating power.
(21) The method for landing an aircraft may further include rotating the ring-shaped portion and moving the plurality of generators to an operating position that can increase power generation efficiency, based on model information and state information of an aircraft.
(22) In the producing electricity, the plurality of generators may produce electricity using wind generated when the aircraft is lowered.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The above and other aspects, features, and advantages of embodiments of the present disclosure will be more clearly understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:
(2) FIG. **1** is a perspective view illustrating a vertiport according to embodiments of the present disclosure;
(3) FIG. **2** is a perspective view illustrating a state in which a generator is raised in a vertiport;
(4) FIG. **3** is a perspective view illustrating a state in which an aircraft lands on a vertiport;
(5) FIG. **4** is an enlarged view illustrating the configuration and disposition of an elevating portion,

a ring-shaped portion, and a rotating portion; and
(6) FIG. **5** is a flowchart illustrating a method for landing an aircraft according to embodiments of the present disclosure.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

(7) Hereinafter, embodiments of the present disclosure will be described in detail with reference to exemplary drawings. In adding reference numerals to components of each drawing, it should be noted that the same components are indicated by the same numerals even though displayed on different drawings.
(8) The vertiport according to embodiments of the present disclosure may refer to a ground structure for vertical take-off and landing, charging, maintenance, and the like of an aircraft, and the vertiport may be understood to include a vertihub, a vertiport, a vertistop, and the like classified according to size.
(9) Here, a vertihub is the largest take-off and landing area, enabling large-scale transfer of surrounding transportation, and has support infrastructure such as charging and maintenance infrastructure, so it may accommodate multiple UAM vehicles after their operations have ended. A vertiport is a smaller take-off and landing area than a vertihub, has support infrastructure such as charging and maintenance infrastructure, and may provide convenience facilities for passengers. A vertistop or vertistation is smaller than a vertiport and may refer to a small-scale take-off and landing area with one or two aprons.
(10) In this specification, for convenience of explanation, an example of a take-off and landing area such as a vertihub, vertiport, vertistop and the like will be described, but the embodiments of the present disclosure are not necessarily limited thereto.
(11) In addition, embodiments of the present disclosure may be applied to an aircraft, such as a UAM vehicle, for example. The aircraft may be used to transport individuals or a plurality of passengers within or between urban areas. In addition, the aircraft can also be used for cargo delivery, such as courier services.
(12) In the present specification, an aircraft may refer to a vehicle configured to fly and move through the air. In other words, the aircraft may refer to a drone, a tilt rotor aircraft, a vertical take-off and landing aircraft, a rotary-wing aircraft, and the like, and it may also include a vehicle that may land on the ground, a structure, or the like, using a landing device, after the flight.
(13) In addition, the aircraft may include a manned aircraft and an unmanned aircraft. The manned aircraft may include a vehicle that may operate in autonomous flight in addition to an aircraft operated by a pilot.
(14) For convenience of explanation, embodiments of the present disclosure are explained and illustrated as an example of application to a tilt-rotor aircraft or vertical take-off and landing aircraft capable of vertical take-off from and landing in a narrow take-off and landing area. However, application examples of embodiments of the present disclosure are not necessarily limited thereto.
(15) FIG. **1** is a perspective view illustrating a vertiport according to embodiments of the present disclosure, and FIG. **2** is a perspective view illustrating a state in which a generator is raised in a vertiport. FIG. **3** is a perspective view illustrating a state in which an aircraft lands on a vertiport.
(16) The vertiport according to embodiments of the present disclosure may include a main body portion **10**, a take-off and landing zone **20**, a door portion **30**, a plurality of elevating portions **40**, a ring-shaped portion **50**, and a plurality of generators **70**.
(17) The main body portion **10** may be configured to allow an aircraft **1** to take-off and land, stop for a certain period of time, or move. Other components of the vertiport may be disposed inside and/or outside the main body portion.
(18) For example, the take-off and landing zone **20** and the door portion **30** may be disposed to be exposed externally within the main body portion **10**, and the elevating portion **40**, the ring-shaped portion **50**, and the like may be disposed inside the main body portion **10**. In addition, the generator

70 may be disposed to be able to reciprocate inside and outside of the main body portion.
(19) The main body portion **10** may be provided to support the opening and closing operation of the door portion **30** and the raising and lowering operation of the elevating portion **40**. For example, the door portion may be coupled to at least a portion of the main body portion and may be opened or closed. In addition, an elevating portion may be installed on at least a portion of the main body portion so that the ring-shaped portion **50** may be raised or lowered.
(20) As described above, the main body portion **10** may be comprised of a structure on which other components of the vertiport may be disposed and/or installed. To this end, the main body portion may include a flat surface **11** comprising a floor or platform and a lower space **12** located below the flat surface **11**.
(21) In addition, although not shown in the drawings, the main body portion **10** may be provided with equipment or auxiliary facilities for take-off, landing, stopping, charging, maintenance, movement, and the like of the aircraft **1**.
(22) The take-off and landing zone **20** is a zone on which the aircraft **1** takes-off or lands and the aircraft is parked, and it may be formed in at least a portion of the main body portion **10**. The take-off and landing zone **20** may include an upper surface parallel with the flat surface **11** of the main body portion **10**.
(23) The take-off and landing zone **20** may be disposed in the lower space **12** of the main body portion **10** to be spaced apart from the main body portion **10**. As a result, a gap G may be formed between the take-off and landing zone **20** and the main body portion **10**.
(24) The gap G between the take-off and landing zone **20** and the main body portion **10** may provide a space in which the door portion **30** is disposed, and when the door portion is opened, the ring-shaped portion **50** may be raised to provide a space in which a plurality of generators **70** are exposed externally.
(25) For example, the take-off and landing zone **20** may be formed in the form of a pillar with a cross-sectional shape such as circular, oval, or polygonal, but embodiments of the present disclosure are not necessarily limited thereto. Additionally, according to the examples shown and described, the take-off and landing zone **20** may be formed separately from the main body portion **10**, but embodiments of the present disclosure are not necessarily limited thereto.
(26) As another example, the take-off and landing zone **20** may be formed integrally with the main body portion **10** and may also be provided as a portion of the main body portion **10**. In other words, the main body portion **10** may include a main section and a take-off and landing section, and the gap G may be formed between the main section and the take-off and landing section. In this case, the take-off and landing section may form a take-off and landing zone.
(27) The take-off and landing zone **20** may be provided with a marking portion **21** providing a reference position and reference direction so that the aircraft **1** lands with a constant position and direction. As illustrated in FIGS. **1** to **3**, characters such as the alphabet or patterns such as arrows drawn on the upper surface of the take-off and landing zone **20** may be used as the marking portion **21**. Preferably, the marking portion **21** may indicate magnetic north (N).
(28) In this case, the aircraft **1** may measure its own position by receiving a global positioning system (GPS) signal from a satellite or sensing by an inertial navigation system (INS). A pilot may operate the aircraft based on the measured position information so that the aircraft reaches the reference position of the marking portion **21** in the sky above the take-off and landing zone **20**.
(29) Subsequently, the pilot may identify the reference direction of the marking portion **21** with the naked eye in the sky above the take-off and landing zone **20**, or the pilot may turn the aircraft **1** based on azimuth information provided by a geomagnetic sensor in the aircraft **1**, or the like, so that a head direction of the aircraft **1** may be made consistent with the reference direction of the marking portion **21**.
(30) Alternatively, a beacon **22** transmitting constant non-directional radio waves may be employed as the marking portion **21**. In this case, the pilot may turn the aircraft **1** based on relative direction

information provided by a receiver, an automatic direction finder (ADF), or the like, receiving the radio waves in the sky above the take-off and landing zone **20**, so that a head direction of the aircraft **1** may be made consistent with the reference direction of the marking portion **21**.
(31) The door portion **30** may be installed to enable opening and closing operations between the take-off and landing zone **20** and the main body portion **10**. Specifically, the door portion **30** may be disposed in the gap G between the take-off and landing zone **20** and the main body portion **10** to open or close the gap G.
(32) For example, an electric door to which a motor is applied along with an iris mechanism may be used as the door portion **30**, but embodiments of the present disclosure are not necessarily limited thereto. Since iris mechanisms with various configurations are already known, detailed descriptions thereof will be omitted in this specification.
(33) When the door portion **30** is closed, the gap G between the take-off and landing zone **20** and the main body portion **10** may be closed and covered by the door portion **30**. In this case, the door portion **30** may act as a walkway connecting the take-off and landing zone **20** and the main body **10** so that passengers may safely and easily cross the gap G.
(34) When the door portion **30** is opened, the gap G between the take-off and landing zone **20** and the main body portion **10** is exposed externally, and a passage which allows the plurality of generators **70** to reciprocate may be formed.
(35) Meanwhile, as illustrated in FIGS. **2** and **3**, the aircraft **1** may include a fuselage **2** provided with a boarding space and a boarding gate and a plurality of rotors **3** provided in the fuselage.
(36) At least a portion of the plurality of rotors **3** may be configured as tilting rotors capable of tilting upwardly or downwardly for lifting or cruising the fuselage **2**. At least two of these rotors **3** may be disposed on the left and right sides of the fuselage, respectively, based on the center of the fuselage, but the position and number of rotors are not necessarily limited thereto. For example, a helicopter may have a single rotor **3** disposed on the fuselage **2**.
(37) Passengers may board the fuselage **2**, and the fuselage **2** is capable of vertical take-off and landing and horizontal cruising. Additionally, a landing gear **5** may be installed on the bottom of the fuselage **2** to support or allow movement of the fuselage **2** on the ground or in a vertiport. The disposition and the number of landing gear members are not limited to the examples shown.
(38) The aircraft **1** shown in FIGS. **2** and **3** is illustrative, and the shape of the aircraft which takes-off from and lands on the vertiport according to embodiments of the present disclosure is not particularly limited, and various types of aircrafts capable of vertical take-off and landing may take-off from and land on the vertiport.
(39) FIG. **4** is an enlarged view illustrating the configuration and disposition of an elevating portion, a ring-shaped portion, and a rotating portion.
(40) A plurality of elevating portions **40** may be disposed to surround the take-off and landing zone **20** in the lower space **12** of the main body portion **10**. The elevating portion **40** supports the ring-shaped portion **50** and allows the ring-shaped portion **50** to be raised and lowered. To this end, the elevating portion **40** may include, for example, a rack and pinion mechanism, but embodiments of the present disclosure are not necessarily limited thereto.
(41) Specifically, the elevating portion **40** may include a plurality of rails **42** installed upright around the take-off and landing zone **20** in the lower space **12** of the main body portion **10** and having a rack gear **41** formed on one side, a support bracket **43** formed on one side thereof so that the rail **42** penetrates therethrough, a first driving unit **44** fixedly installed on the support bracket **43**, and a first pinion gear **45** connected to the first driving unit **44** and engaged with the rack gear **41**.
(42) At least two or more rails **42** may be disposed to be parallel to each other with the take-off and landing zone **20** interposed therebetween. The rack gear **41** may be formed on one side of each rail **42** in a longitudinal direction of the rail **42**.
(43) A through-hole is formed in the support bracket **43**, and the rail **42** may be inserted into the

through-hole to penetrate through the support bracket **43**. Optionally, the through-hole may be provided with a grommet allowing the rail **42** to pass through and move smoothly relative to the support bracket **43**.
(44) In addition, the first driving unit **44** may be fixedly installed on the support bracket **43** by, for example, bolting or adhesion. The first driving unit **44** may include a motor capable of forward and reverse rotation and the first pinion gear **45** may be directly connected to the motor shaft. When the first driving unit **44** has a reducer, the first pinion gear **45** may be connected to the motor shaft via the reducer.
(45) In addition, the support bracket **43** may be provided with a connection portion **46** for connecting the ring-shaped portion **50**. For example, the connection portion **46** may be formed as a protrusion, and a connection groove **51** may be formed on a bottom surface of the ring-shaped portion **50**. The protrusion of the connection portion **46** may be locked or shape-fitted into the connection groove **51**, so that the support bracket **53** and the ring-shaped portion **50** may be connected.
(46) However, the configuration of the elevating portion **40** is not limited to the above-described example, and instead of the rack and pinion mechanism, for example, a mechanism including a sprocket and chain, or a mechanism including a pulley and a belt, and the like may be adopted.
(47) The elevating portion **40** configured in this manner may elevate the ring-shaped portion **50** in the vertical direction, and the ring-shaped portion **50** may support a plurality of generators **70**, so that the generators **70** may be raised or lowered by the elevating portion **40** together with the ring-shaped portion **50**.
(48) The ring-shaped portion **50** may be formed in a ring shape such as a circle, oval, or polygon. In the drawings, it is shown as a circular ring, but embodiments of the present disclosure are not necessarily limited thereto.
(49) For example, the ring-shaped portion **50** may be formed in a ring shape corresponding to the shape of the gap G so that the ring-shaped portion **50** may be located in the gap G between the take-off and landing zone **20** and the main body portion **10**. The bottom surface of the ring-shaped portion **50** may be supported by the support bracket **43** on each of the plurality of elevating portions **40**, and the ring-shaped portion **50** may support the plurality of generators **70** at intervals from each other in a circumferential direction on the upper surface so that the positions of the generators **70** are fixed.
(50) The ring-shaped portion **50** may be raised along the elevating portion **40** to expose the plurality of generators **70** onto the main body portion **10**, so that the vertiport may be converted from a basic mode to a power generation mode. Conversely, the ring-shaped portion **50** may be lowered along the elevating portion **40** to locate the plurality of generators **70** in the lower space **12** of the main body portion **10** and to close the door portion **30**, so that the vertiport may be converted from a power generation mode to a basic mode.
(51) In the power generation mode, as the door portion **30** is opened, the ring-shaped portion **50** and the generators **70** may be raised and may be located in the gap G between the take-off and landing zone **20** and the main body portion **10**. In the basic mode, the ring-shaped portion **50** and the generators **70** may be lowered and accommodated in the gap G and located in the lower space **12** of the main body portion **10** and then the door portion **30** may be closed. Here, the opening and closing operation of the door portion **30** and the raising and lowering operation of the elevating portion **40** may be controlled by a control unit **80**, which will be described later.
(52) Optionally, the ring-shaped portion **50** may support the plurality of generators **70** to move in a circumferential direction on the upper surface, thereby supporting the plurality of generators **70** so that the positions of the generators **70** vary at a predetermined angle. To this end, the ring-shaped portion **50** may further include a rotating portion **60** having, for example, a ring gear and a pinion gear.
(53) Specifically, the rotating portion **60** may include an external ring gear **61** formed in a

circumferential direction on a lateral peripheral surface of the ring-shaped portion **50**, a second driving unit **64** fixedly installed on the support bracket **43** of the elevating portion **40**, and a second pinion gear **65** connected to the second driving unit **64** and engaged with the external ring gear **61**.

(54) The second driving unit **64** may be fixedly installed on the support bracket **43** by, for example, bolting or adhesion. The second driving unit **64** may include a motor capable of forward and reverse rotation, and the second pinion gear **65** may be directly connected to a motor shaft. When the second driving unit **64** has a reducer, the second pinion gear **65** may be connected to the motor shaft via the reducer.

(55) In this case, the connection portion **46** mounted on the support bracket **43** may have a rolling member **47** such as a roller, a ball, or the like, and the connection groove **51** may be formed in a circumferential direction of the ring-shaped portion **50** on a bottom surface of the ring-shaped portion **50**.

(56) The connection groove **51** may act as a travelling path guiding the rolling member **47** of the connection portion **46** and may simultaneously accommodate the rolling member **47** to hold and support the same. As a result, the connection groove **51** may allow the support bracket **43** and the ring-shaped portion **50** to be connected and moved, and it may prevent the ring-shaped portion **50** from being separated from the support bracket **43**.

(57) However, the configuration of the rotating portion **60** is not limited to the above-described examples, and instead of the ring gear and pinion gear, for example, a mechanism including a sprocket and a chain, a mechanism including a pulley and a belt, or the like may be adopted.

(58) The rotating portion **60** configured in this manner may allow the ring-shaped portion **50** to move in the circumferential direction to vary the positions of the plurality of generators **70** according to the direction of the aircraft **1**. Here, since the plurality of generators **70** have a fixed position and are supported on the upper surface of the ring-shaped portion **50**, electricity may be generated by at least a portion of the generators **70** for the corresponding rotors **3** of the aircraft **1** in which the number and position of the rotors **3** are specified.

(59) The plurality of generators **70** may generate electricity using wind power of a vortex generated during take-off and landing of the aircraft **1**. For example, the generator **70** may convert kinetic energy of wind caused by a vortex into mechanical energy and produce electricity using the converted mechanical energy. The generator **70** may include a wind turbine or a wind turbine generator.

(60) The electricity produced through the generator **70** may be supplied to demand sources (for example, lighting or system power) provided in the vertiport or may be used to charge the aircraft **1** parked at the vertiport. However, the utilization of electricity is not limited to the examples described above.

(61) When the ring-shaped portion **50** further includes the rotating portion **60**, the plurality of generators **70** may be moved to an operating position that can increase electricity generation efficiency based on model information and state information of the aircraft **1** landing on the take-off and landing zone **20** of the vertiport. Here, the operating position that can increase power generation efficiency can be calculated and determined by the control unit **80**.

(62) The control unit **80** may control the overall operation and driving of the vertiport. The control unit **80** may be provided in the main body portion **10**. The control unit **80** may control the opening and closing of the door portion **30**, the raising and lowering of the ring-shaped portion **50** by the elevating portion **40**, the movement of the ring-shaped portion **50** by the rotating portion **60**, and the like. To this end, the control unit **80** may be electrically connected to the motor of the door portion **30**, the first driving unit **44** of the elevating portion **40**, and the second driving unit **64** of the rotating portion **60**.

(63) The control unit **80** may transmit or receive various information and/or signals related to the take-off and landing of the aircraft to or from the aircraft **1** and/or a control server (not shown). The control unit **80** includes a communication module, and the communication module may be

connected to at least one communication network among, for example, a wired, wireless, or wired/wireless communication network.
(64) For example, the control unit **80** may receive information about the aircraft **1** which is about to land on a vertiport from the aircraft **1** and/or a control server. In particular, by receiving coordinates regarding the disposition of each rotor **3** from a center of the aircraft **1**, the control unit **80** may determine whether the aircraft **1** is a model of aircraft capable of generating power using wind power.
(65) If the aircraft **1** is determined to be capable of generating power using wind power, the control unit **80** may control the door portion **30** and the elevating portion **40** to open the door portion **30** and operate the elevating portion **40** to raise the ring-shaped portion **50** and the plurality of generators **70**. In addition, when preparations for landing are completed, the control unit **80** may transmit a landing permission signal to the aircraft **1** and/or the control server.
(66) In addition, when a landing completion signal is received from the aircraft **1**, the control unit **80** may control the door portion **30** and the elevating portion **40** to close the door portion **30** and operate the elevating portion **40** to lower the ring-shaped portion **50** and the plurality of generators **70**. In addition, when the door portion **30** is completely closed, the control unit **80** may transmit a signal for permission for passengers to disembark and/or for cargo to be unloaded to the aircraft **1** and/or the control server.
(67) The above-described information and/or signal transmission is illustrative, and in addition to the above-described information, the control unit **80** may transmit and receive additional information and/or signals required in relation to take-off and landing of the aircraft **1** with the aircraft **1** and/or the control server.
(68) The control unit **80** may include a processor and memory. The processor may process the overall operation of the control unit **80**, and the memory may store programs for the operation of the control unit **80**, input/output data, various setting information, and the like.
(69) For example, the memory of the control unit **80** may store model information (in particular, the position of the rotor **3** for each model) about various types of aircraft **1** which take-off from and land on a vertiport. In addition, a logic for calculating an operating position at which the generator **70** has maximum power generation efficiency in response to the model information and state information of the aircraft **1** may be stored in the memory of the control unit **80**.
(70) When the ring-shaped portion **50** further includes the rotating portion **60**, for example, if the aircraft **1** deviates from a reference direction and intends to land, the rotating portion **60** is operated under the control of the control unit **80** based on azimuth information provided from a geomagnetic sensor in the aircraft **1**, so that the plurality of generators **70** may be moved to an operating position that can increase electricity generation efficiency.
(71) As described above, when the ring-shaped portion **50** further includes the rotating portion **60**, based on the model information and state information of the aircraft **1** to be landed, the positions of the generators **70** in the vertiport may be adjusted to vary at a predetermined angle in order to increase the power generation efficiency of the generators **70**.
(72) The model information of the aircraft **1** is mainly related to the type of aircraft and may include location information of the rotor **3** for each type. In addition, the state information of the aircraft **1** relates to a state in which the aircraft **1** is landing and may include the position and direction in which the aircraft **1** is landing. The state information of the aircraft **1** may be detected or calculated through the deviation in the relative position and direction of the aircraft **1** with respect to the reference position and reference direction set by the marking portion **21** of the take-off and landing zone **20**.
(73) Accordingly, the control unit **80** may calculate the operating position of the generator **70** that can obtain maximum efficiency by comprehensively considering the position and direction in which the aircraft intends to land on the take-off and landing zone **20** along with the position of the rotor **3** in the aircraft **1** and move each of the generators **70** to a desired operating position by

driving the rotating portion **60** to rotate the ring-shaped portion **50**.
(74) If the ring-shaped portion **50** does not have the rotating portion **60**, the marking portion **21** indicating magnetic north N is provided as described above, and it is assumed that the aircraft **1** lands on the take-off and landing zone **20** to be consistent with the reference position and reference direction, so that each of the plurality of generators **70** may be disposed to be set at a position corresponding to the rotor **3** in a specific model of aircraft. In this case, the generators **70** may only be raised and lowered without the movement.
(75) FIG. **5** is a flowchart illustrating a method for landing an aircraft according to embodiments of the present disclosure.
(76) The method for landing an aircraft **1** on a vertiport may include operations in which: an aircraft approaches a vertiport (S**1**); it is determined whether the aircraft is a model of aircraft capable of generating power using wind power (S**2**); a door portion of the vertiport is opened, an elevating portion is operated, and a plurality of generators thereof are raised, when it is determined that the aircraft is a model of aircraft capable of generating power using wind power (S**3**); electricity is generated using the plurality of generators as the aircraft is lowered (S**4**); the aircraft lands on a take-off and landing zone of the vertiport and is parked (S**5**); and the elevating portion is operated, the ring-shaped portion and the plurality of generators are lowered, and the door portion is closed (S**6**).
(77) The aircraft **1** may approach a vertiport to land on the vertiport (S**1**). In this case, the vertiport may be placed in the basic mode shown in FIG. **1**.
(78) The aircraft **1** may transmit the model information and state information of the aircraft to the control unit **80** of the vertiport via a control server. In particular, by receiving coordinates regarding the disposition of each rotor **3** from a center of the aircraft **1**, the control unit **80** may determine whether the aircraft **1** is a model of aircraft capable of generating power using wind power (S**2**).
(79) When it is determined that the aircraft **1** is a model of aircraft capable of generating power using wind power, the control unit **80** may control the door portion **30** and the elevating portion **40** to open the door portion **30** and operate the elevating portion **40** to raise the ring-shaped portion **50** and the plurality of generators **70**.
(80) As the door portion **30** is opened and the ring-shaped portion **50** is raised by the elevating portion **40**, the plurality of generators **70** may move externally through the gap G between the take-off and landing zone **20** and the main body portion **10** and be exposed (S**3**).
(81) Thereby, the vertiport may be converted into a state of a power generation mode shown in FIG. **2**. In this case, the aircraft **1** may hover above the take-off and landing zone **20**, and the plurality of generators **70** may be optionally moved to an operating position that can increase power generation efficiency by the rotating portion **60**.
(82) Optionally, when the ring-shaped portion **50** further includes the rotating portion **60**, the control unit **80** may calculate an operating position of the generator **70** based on model information and state information of the aircraft **1**, and the rotating portion **60** may operate under the control of the control unit **80** and the plurality of generators **70** may be moved to an operating position that can increase power generation efficiency (S**3**′).
(83) Here, the operating position refers to a position of the generator **70** that can produce electricity with maximum efficiency in response to the direction in which the aircraft **1** is landing and the position of the rotor **3**.
(84) For example, the control unit **80** may calculate deviation in a relative position and direction of the aircraft **1** with respect to the reference position and reference direction set in the take-off and landing zone **20**, and the operating position of the generator **70** that can produce electricity with maximum efficiency in response to the relative position of rotor **3** according to the calculated deviation in the direction may be determined.
(85) When preparations for landing are completed, that is, when the vertiport is converted to be in a power generation mode, the control unit **80** may transmit a landing permission signal to the aircraft

1 and/or the control server.
(86) Subsequently, the aircraft **1** may be lowered toward the take-off and landing zone **20** for landing. The plurality of generators **70** may produce electricity by generating power using a vortex generated as the aircraft is lowered (S**4**). Electricity produced by the plurality of generators may be supplied to demand sources provided on the vertiport.
(87) When the aircraft **1** is parked on the take-off and landing zone **20** and landing is completed (S**5**), the aircraft may transmit a landing completion signal to the control unit **80** via the control server, and after receiving a landing completion signal from the aircraft **1**, the control unit **80** may operate the elevating portion **40** to lower the ring-shaped portion **50** and the plurality of generators **70** and prepare for closing the door portion **30**.
(88) After the ring-shaped portion **50** and the plurality of generators **70** are completely lowered, the door portion **30** may be closed (S**6**). When the door portion **30** is completely closed, the control unit **80** may transmit a signal for permission to load and/or unload passengers and/or cargo to the aircraft **1** and/or the control server.
(89) Meanwhile, the aircraft **1** may communicate with a control server generally controlling the aircraft's route and take-off and landing, and the control unit **80** of the vertiport may transmit and receive various information signals related to take-off and landing of the aircraft **1** to and from the aircraft **1** via the control server. According to various embodiments, the control server may include the control unit **80** of the vertiport.
(90) In addition, optionally, when the aircraft **1** waits for a long time at the vertiport before take-off, the door portion **30** may be opened and the plurality of generators **70** may be raised, so that power may be generated using a vortex generated when the aircraft waits for take-off while the rotor **3** rotates. In this case, the method for taking off the aircraft from the vertiport according to embodiments of the present disclosure may be roughly implemented in the reverse order of the above-described example.
(91) As described above, according to the embodiments of the present disclosure, downdraft energy generated during the landing and take-off of an aircraft may be converted into electrical energy and may be utilized, so that energy efficiency may be increased and at least a certain level of energy independence at the vertiport may be secured, and an eco-friendly vertiport may be built.
(92) As set forth above, according to an embodiment of the present disclosure, by converting wind energy generated during a landing process of an aircraft into electrical energy and utilizing the same, in addition to increasing energy efficiency and securing at least a certain level of energy independence in the take-off and landing area, it is possible to build an eco-friendly take-off and landing area.
(93) The aforementioned description merely illustrates the technical concept of the present disclosure, and a person skilled in the art to which the present invention pertains may make various modifications without departing from the essential characteristics of the embodiments of the present disclosure.
(94) Therefore, the example embodiments disclosed in this specification and drawings are not intended to limit but to explain the technical concept of the present disclosure, and the scope of the technical idea of the present disclosure is not limited by these example embodiments. The scope of protection of the present disclosure should be interpreted by the following claims, and all technical ideas within the scope equivalent thereto should be interpreted as being included in the scope of the present disclosure.

Claims

1. A vertiport comprising: a main body portion having a lower space and a flat surface; a take-off and landing zone disposed in the lower space and spaced apart from the main body portion by a predetermined gap, wherein the take-off and landing zone comprises an upper surface parallel with

the flat surface of the main body portion; a door portion disposed in the gap and configured to open or close the gap; a plurality of elevating portions disposed to surround the take-off and landing zone in the lower space; a ring-shaped portion surrounding the take-off and landing zone and connected to the plurality of elevating portions, wherein the ring-shaped portion is configured to be elevated by the plurality of elevating portions; and a plurality of generators disposed on the ring-shaped portion in a fixed position.

2. The vertiport of claim 1, wherein: the vertiport is configured to switch between a basic mode and a power generation mode; in the basic mode, the door portion is in a closed state and the ring-shaped portion and the plurality of generators are in a lowered state and are situated in the lower space; and in the power generation mode, the door portion is in an open state, the ring-shaped portion and the plurality of generators are in a raised state, and the plurality of generators are exposed externally within the gap.

3. The vertiport of claim 1, wherein the take-off and landing zone comprises a marking portion configured to provide a reference position and a reference direction to enable an aircraft to land with a constant position and a constant direction.

4. The vertiport of claim 3, wherein the marking portion indicates magnetic north.

5. The vertiport of claim 3, wherein the marking portion comprises a beacon configured to transmit non-directional radio waves.

6. The vertiport of claim 1, wherein each of the elevating portions comprises: a rail installed upright in the lower space of the main body portion, the rail having a rack gear disposed on one side thereof; a support bracket disposed on one side of the elevating portion such that the rail penetrates therethrough; a first driving unit fixedly installed on the support bracket; and a first pinion gear connected to the first driving unit and engaged with the rack gear.

7. The vertiport of claim 6, wherein the ring-shaped portion further comprises a rotating portion configured to move the plurality of generators in a circumferential direction.

8. The vertiport of claim 7, wherein the rotating portion comprises: an external ring gear disposed on a lateral peripheral surface of the ring-shaped portion in the circumferential direction; a second driving unit fixedly installed on the support bracket; and a second pinion gear connected to the second driving unit and engaged with the external ring gear.

9. The vertiport of claim 6, wherein: the support bracket comprises a connection portion having a rolling member to connect the ring-shaped portion; the ring-shaped portion comprises a connection groove disposed in a circumferential direction of the ring-shaped portion; and the rolling member is configured to travel within the connection groove.

10. The vertiport of claim 1, further comprising a controller electrically connected to the door portion and the elevating portion and configured to control opening and closing of the door portion and raising and lowering of the ring-shaped portion by the elevating portion.

11. The vertiport of claim 10, wherein: the ring-shaped portion further comprises a rotating portion configured to move the plurality of generators in a circumferential direction; and the controller is electrically connected to the rotating portion and configured to drive the rotating portion and rotate the ring-shaped portion based on model information and state information of an aircraft to change the positions of the plurality of generators by a predetermined angle.

12. The vertiport of claim 1, wherein the plurality of generators comprises a wind turbine generator configured to produce electricity using wind generated during landing of an aircraft in the take-off and landing zone.

13. A method for landing an aircraft, the method comprising: determining whether the aircraft approaching a vertiport is a model of aircraft capable of generating power; opening a door portion of the vertiport and raising a ring-shaped portion and a plurality of generators in response to a determination that the aircraft is the model of aircraft capable of generating power, wherein the plurality of generators is disposed on the ring-shaped portion in a fixed position; generating electricity using the plurality of generators during an operation in which the aircraft lowers toward

the vertiport; and lowering the ring-shaped portion and the plurality of generators and closing the door portion after the aircraft lands on a take-off and landing zone of the vertiport and is parked.

14. The method of claim 13, wherein determining whether the aircraft is the model of aircraft capable of generating power comprises: receiving coordinates regarding a disposition of each rotor of the aircraft from a center of the aircraft; and determining whether the aircraft is the model of aircraft capable of generating power based on the disposition of each rotor.

15. The method of claim 13, further comprising rotating the ring-shaped portion and moving the plurality of generators to an operating position that can increase electricity generation efficiency based on model information and state information of the aircraft.

16. The method of claim 13, wherein generating the electricity comprises generating the electricity by the plurality of generators using wind generated by the operation in which the aircraft lowers toward the vertiport.

17. A system for operating a vertiport to generate electricity, the system comprising: an aircraft comprising a rotor; and the vertiport comprising: a main body portion having a lower space and a flat surface; a take-off and landing zone disposed in the lower space and spaced apart from the main body portion by a predetermined gap, wherein the take-off and landing zone comprises an upper surface parallel with the flat surface of the main body portion; a door portion disposed in the gap and configured to open or close the gap; a plurality of elevating portions disposed to surround the take-off and landing zone in the lower space; a ring-shaped portion surrounding the take-off and landing zone and connected to the plurality of elevating portions, wherein the ring-shaped portion is configured to be elevated by the plurality of elevating portions; and a plurality of generators disposed on the ring-shaped portion in a fixed position and configured to be moved in a circumferential direction according to a location of the rotor of the aircraft; wherein the vertiport is configured to switch between a basic mode and a power generation mode; wherein, in the basic mode, the door portion is in a closed state and the ring-shaped portion and the plurality of generators are in a lowered state and are situated in the lower space; and wherein, in the power generation mode, the door portion is in an open state, the ring-shaped portion and the plurality of generators are in a raised state, and the plurality of generators are exposed externally within the gap.

18. The system of claim 17, wherein the take-off and landing zone comprises a marking portion configured to provide a reference position and a reference direction to enable the aircraft to land with a constant position and a constant direction.

19. The system of claim 17, wherein the elevating portion comprises: a rail installed upright in the lower space of the main body portion, the rail having a rack gear disposed on one side thereof; a support bracket disposed on one side of the elevating portion such that the rail penetrates therethrough, the support bracket comprising a connection portion having a rolling member to connect the ring-shaped portion; a first driving unit fixedly installed on the support bracket; and a first pinion gear connected to the first driving unit and engaged with the rack gear.

20. The system of claim 19, wherein the ring-shaped portion further comprises: a rotating portion configured to move the plurality of generators in the circumferential direction; an external ring gear disposed on a lateral peripheral surface of the ring-shaped portion in the circumferential direction; a second driving unit fixedly installed on the support bracket; a second pinion gear connected to the second driving unit and engaged with the external ring gear; and a connection groove disposed in the circumferential direction of the ring-shaped portion, wherein the rolling member of the support bracket is configured to travel within the connection groove.