



US 20170029103A1

(19) **United States**(12) **Patent Application Publication**  
**CHANG et al.**(10) **Pub. No.: US 2017/0029103 A1**(43) **Pub. Date: Feb. 2, 2017**(54) **UNMANNED VEHICLE****B64C 39/02** (2006.01)**B64C 27/08** (2006.01)(71) Applicants: **Inventec Appliances (Pudong)**  
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(2013.01); **B64C 27/08** (2013.01); **G05D**  
**1/0038** (2013.01); **G08G 5/0069** (2013.01);  
**B64C 2201/108** (2013.01); **B64C 2201/146**  
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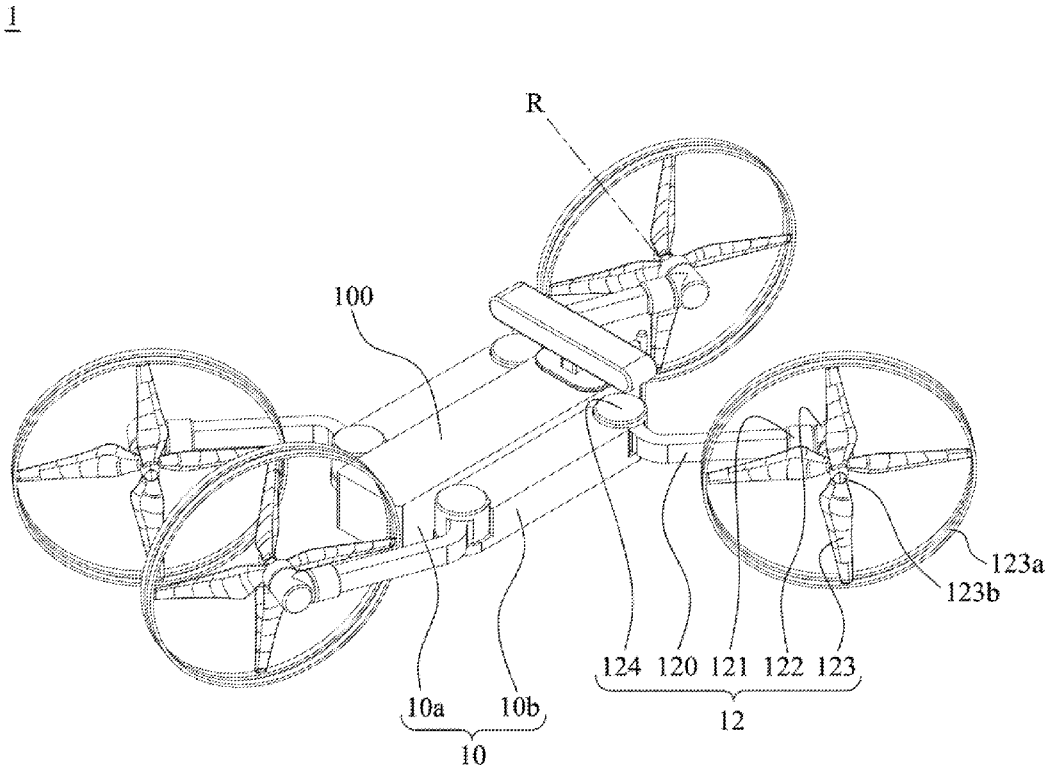
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**ABSTRACT**

An unmanned vehicle includes a vehicle body and at least one arm assembly. The arm assembly is coupled to the vehicle body. The arm assembly includes a first rotating member, a second rotating member, and a propeller. The second rotating member is coupled to the first rotating member. The propeller includes a propeller rim encircling an outer edge of the propeller and a rotatable axle coupled to the second rotating member. The rotatable axle extends along a rotating axis. The second rotating member is configured to turn the propeller by rotating the rotatable axle about the rotating axis. The first rotating member is configured to rotate and effect a movement of the second rotating member so as to selectively adjust the rotatable axle to align the rotating axis at least with a first axial direction and a second axial direction.

(21) Appl. No.: **14/989,778**(22) Filed: **Jan. 6, 2016****Related U.S. Application Data**

(60) Provisional application No. 62/197,596, filed on Jul. 28, 2015.

**Publication Classification**(51) **Int. Cl.****B64C 37/00** (2006.01)**G08G 5/00** (2006.01)**G05D 1/00** (2006.01)

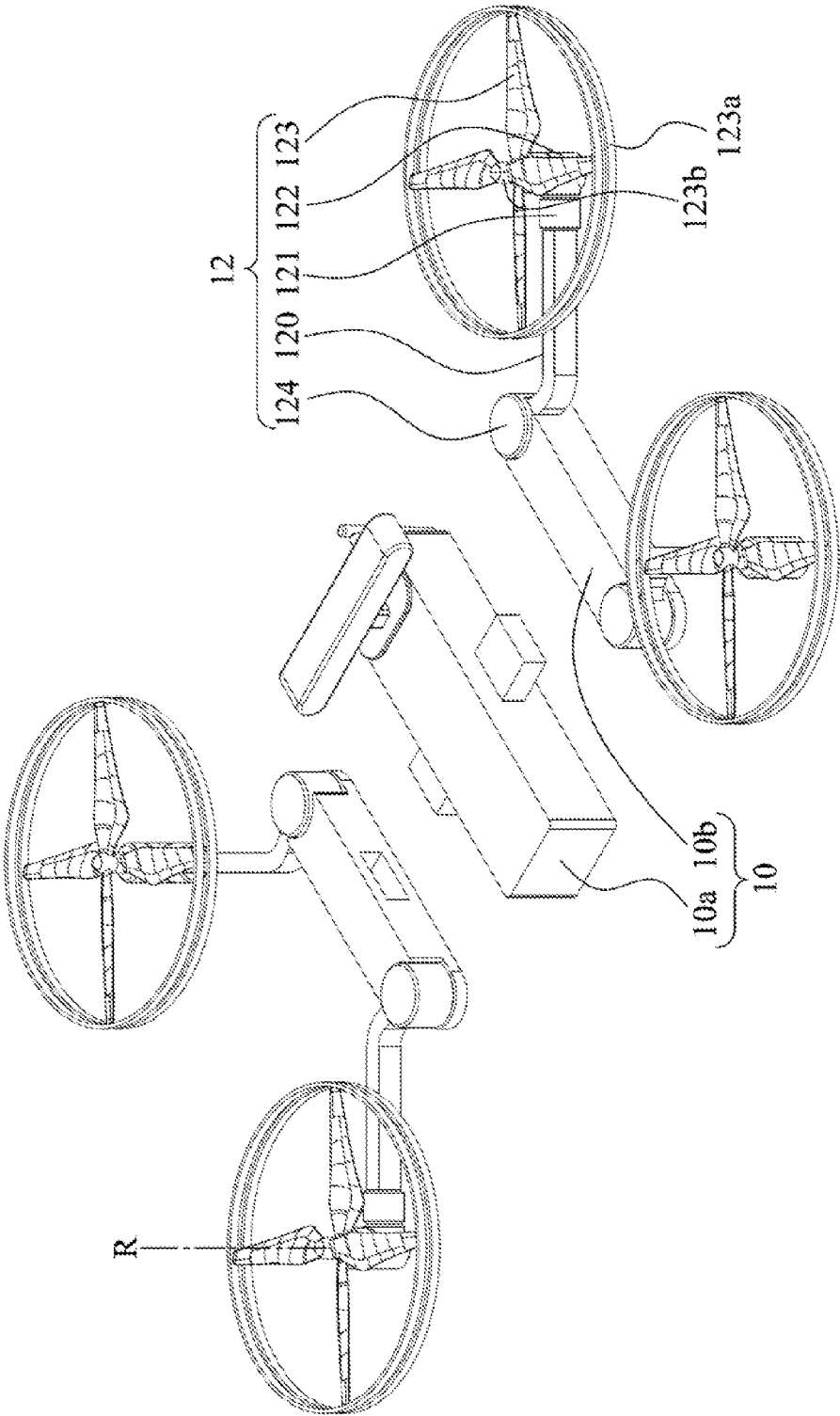


Fig. 1A

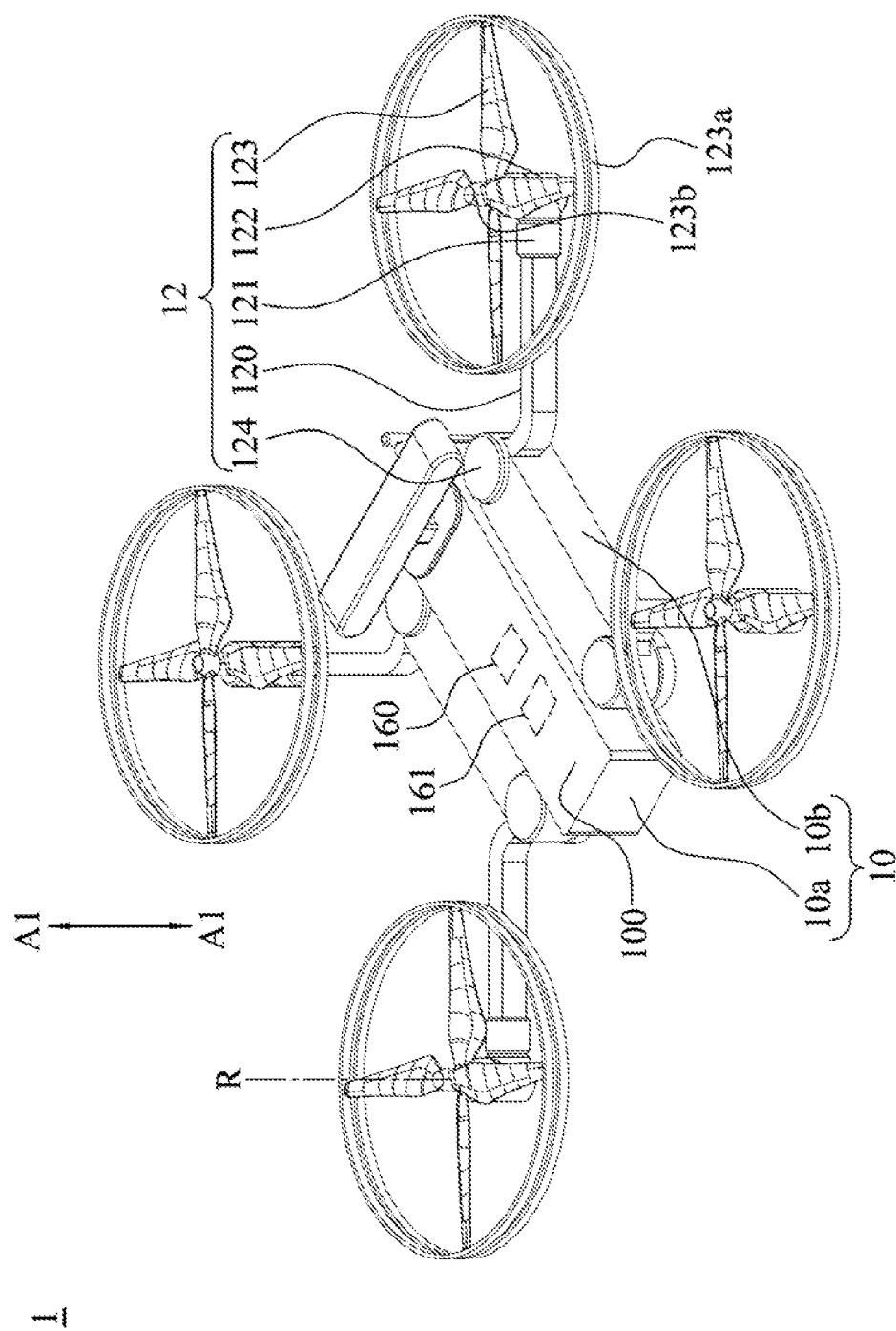


Fig. 1B

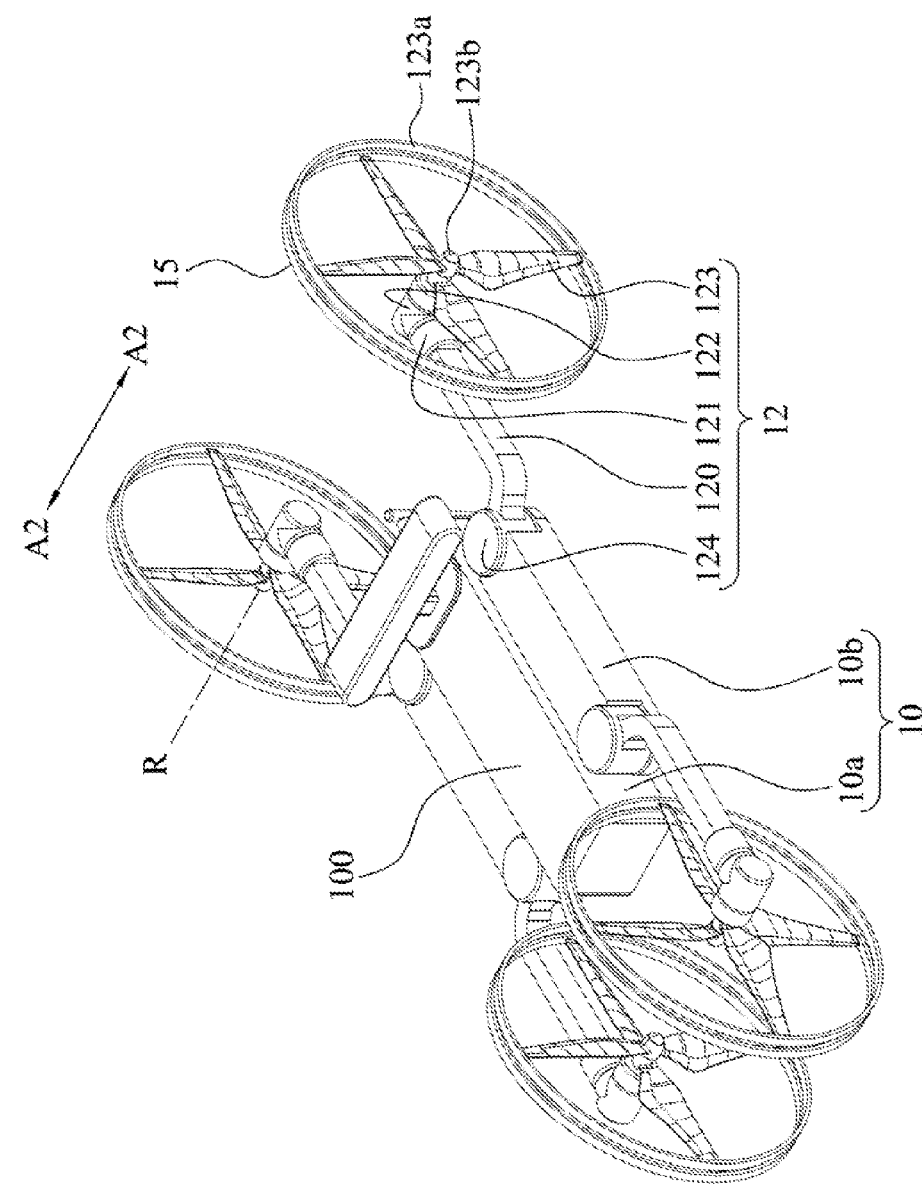
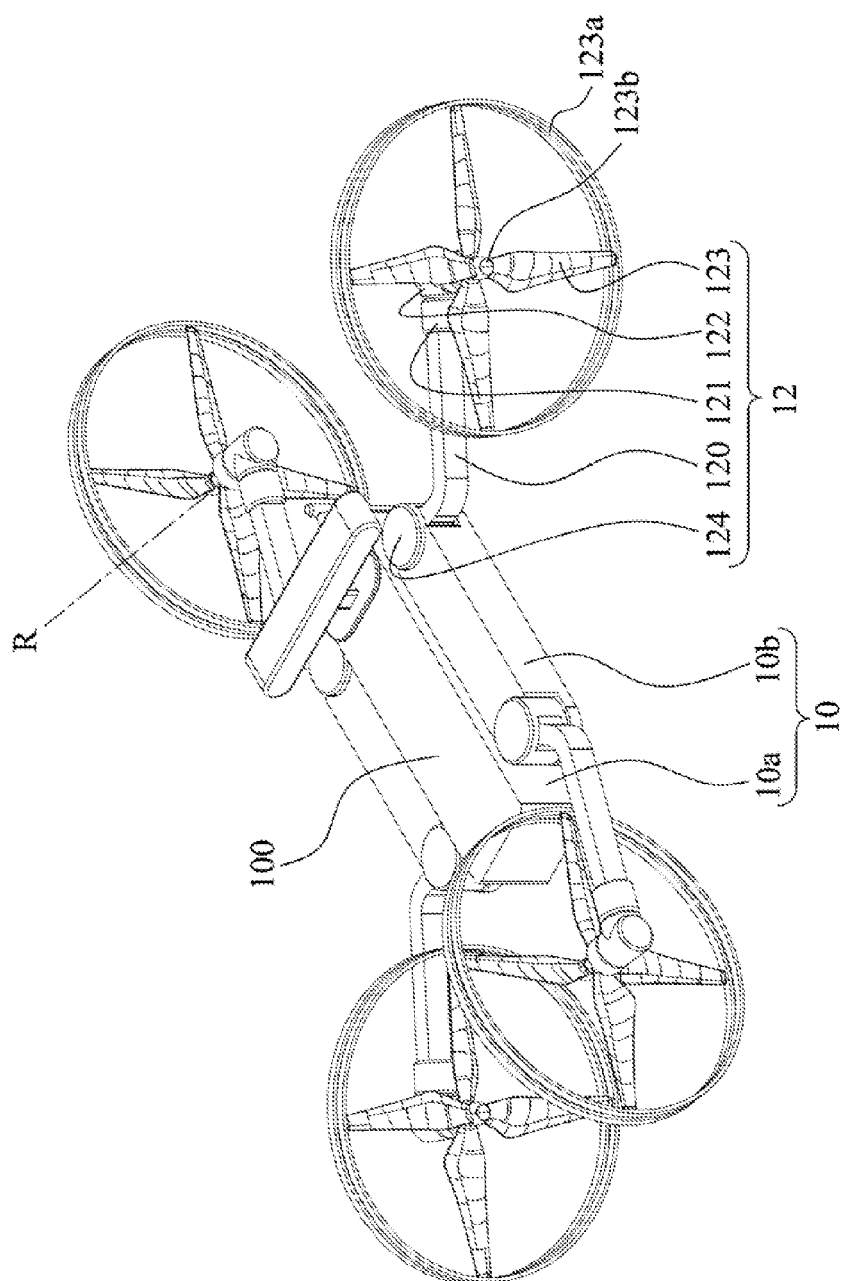


Fig. 1C



100-100000

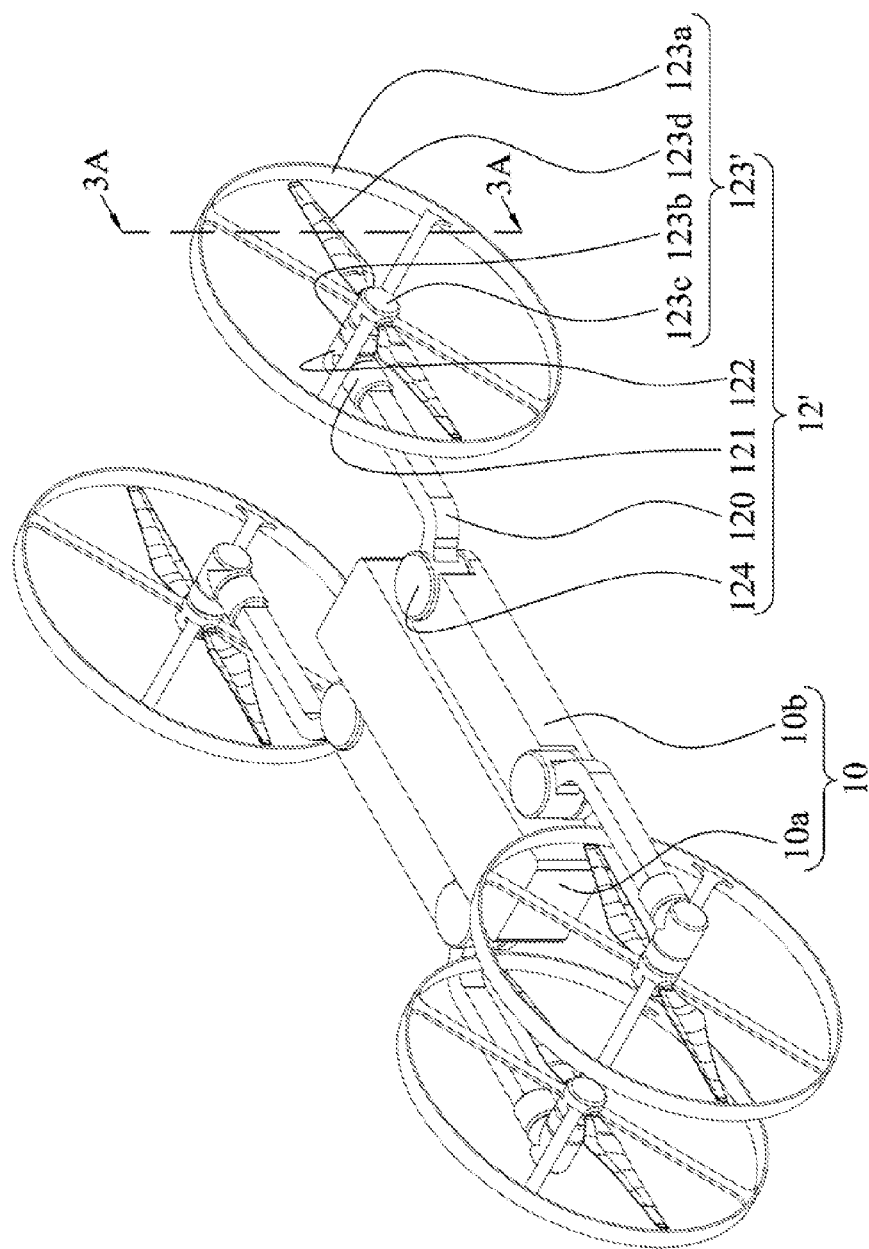


Fig. 2

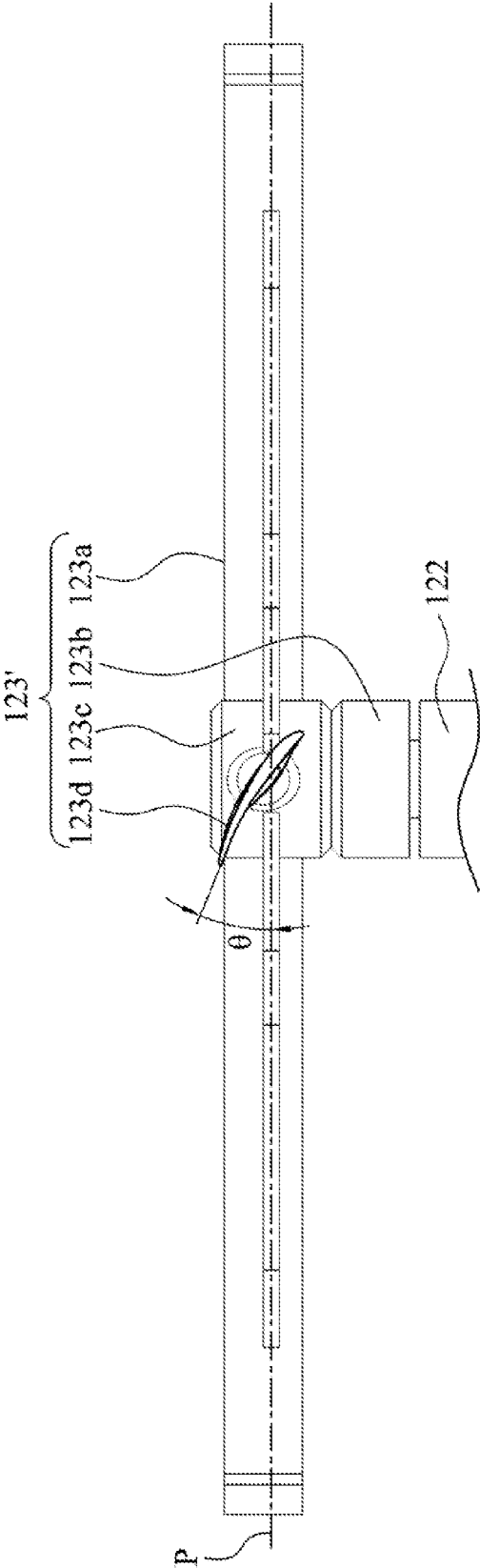


Fig. 3A

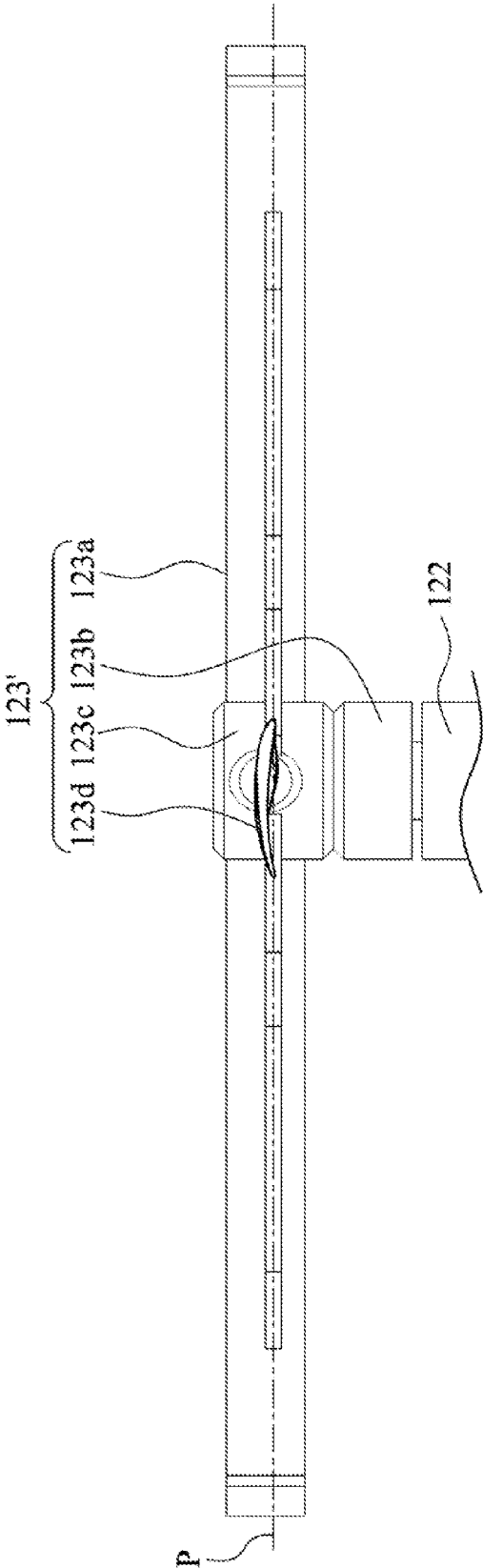


Fig. 3B

1

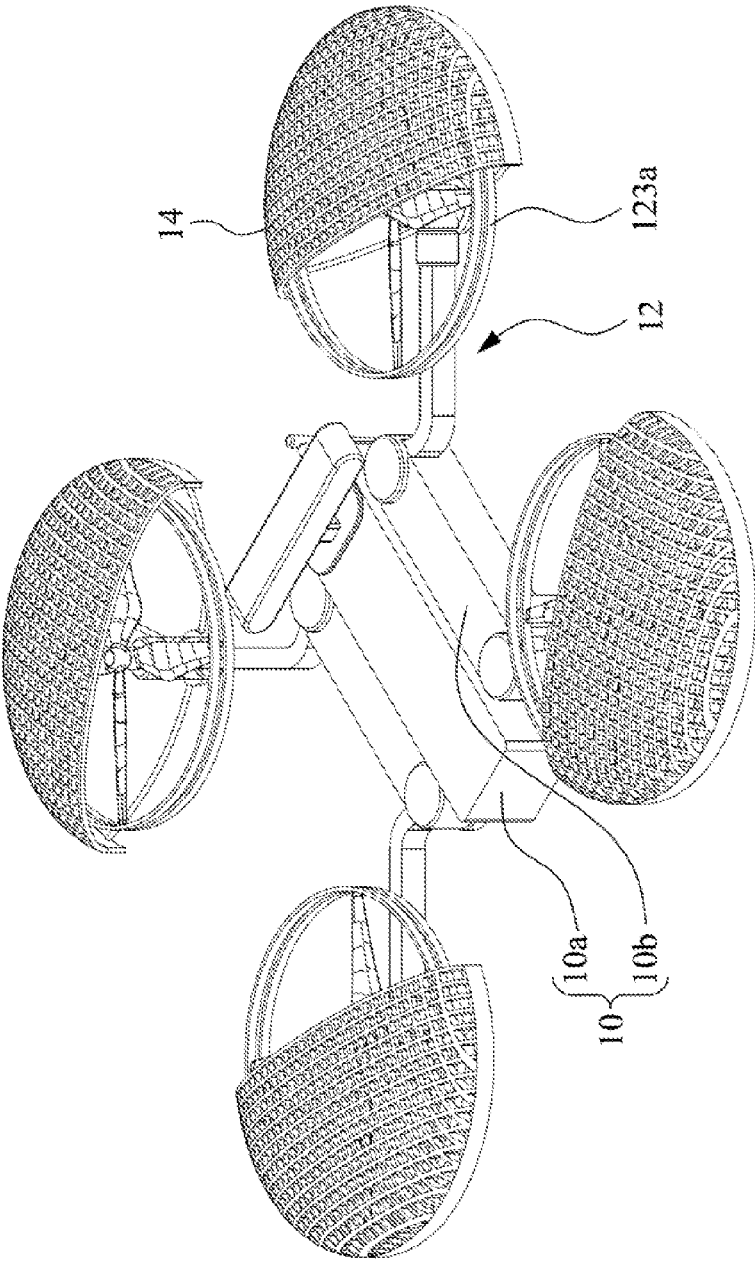


Fig. 4

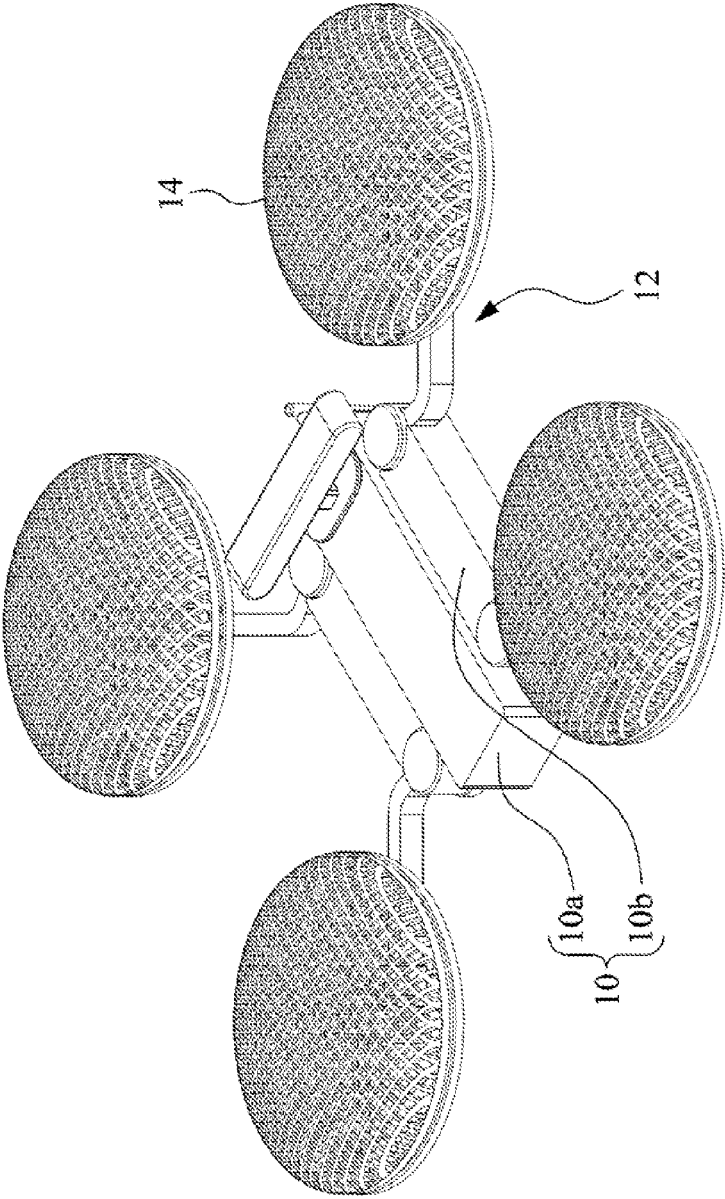


Fig. 5

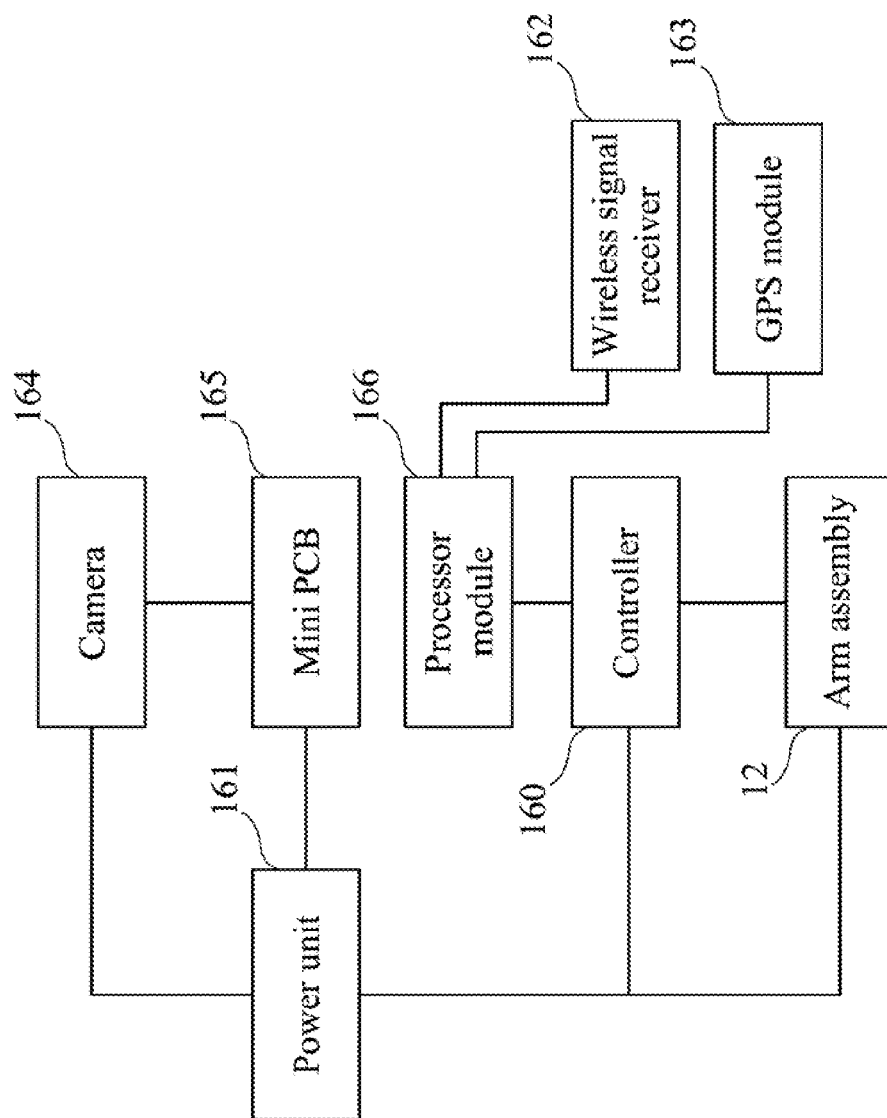


Fig. 6

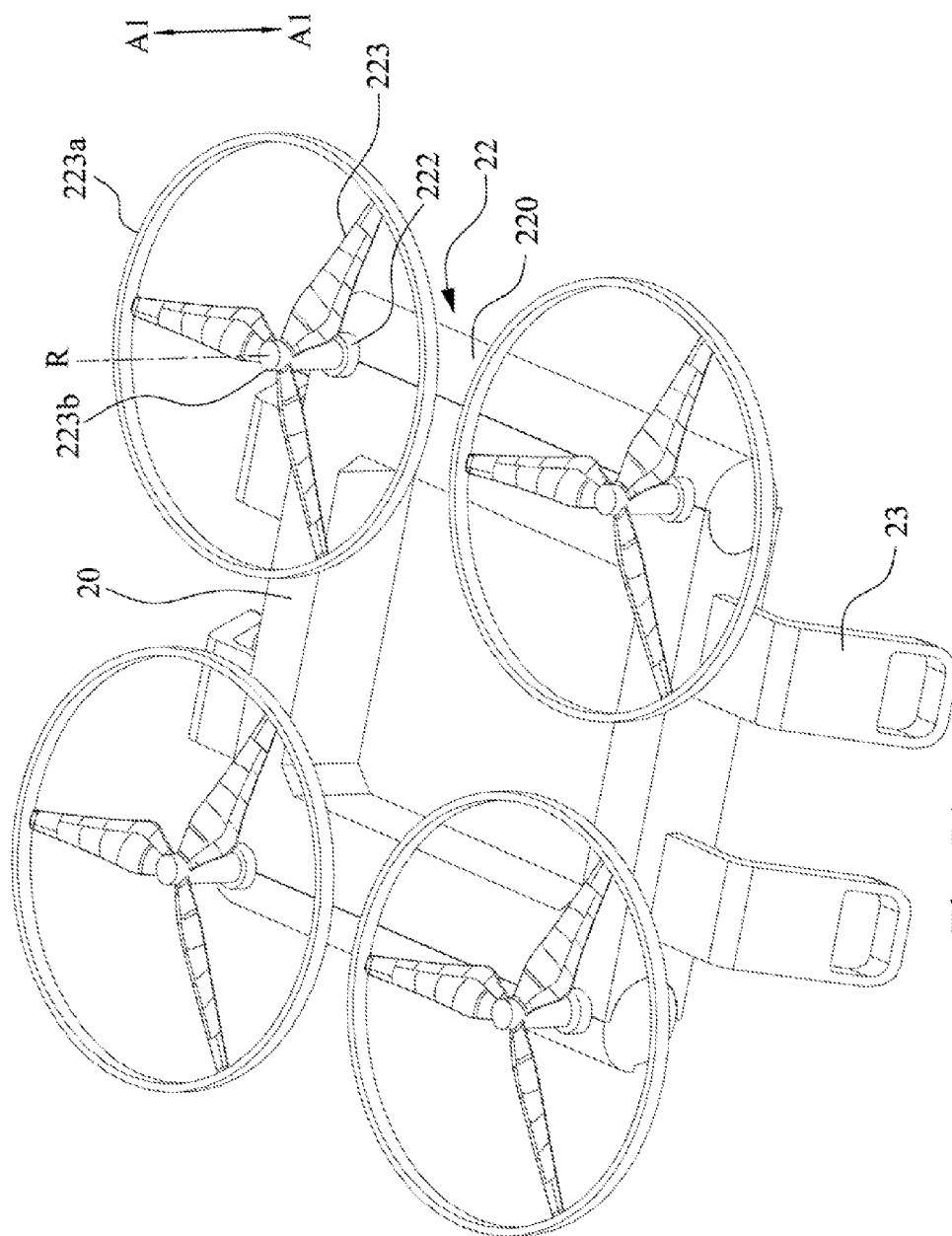


Fig. 7A

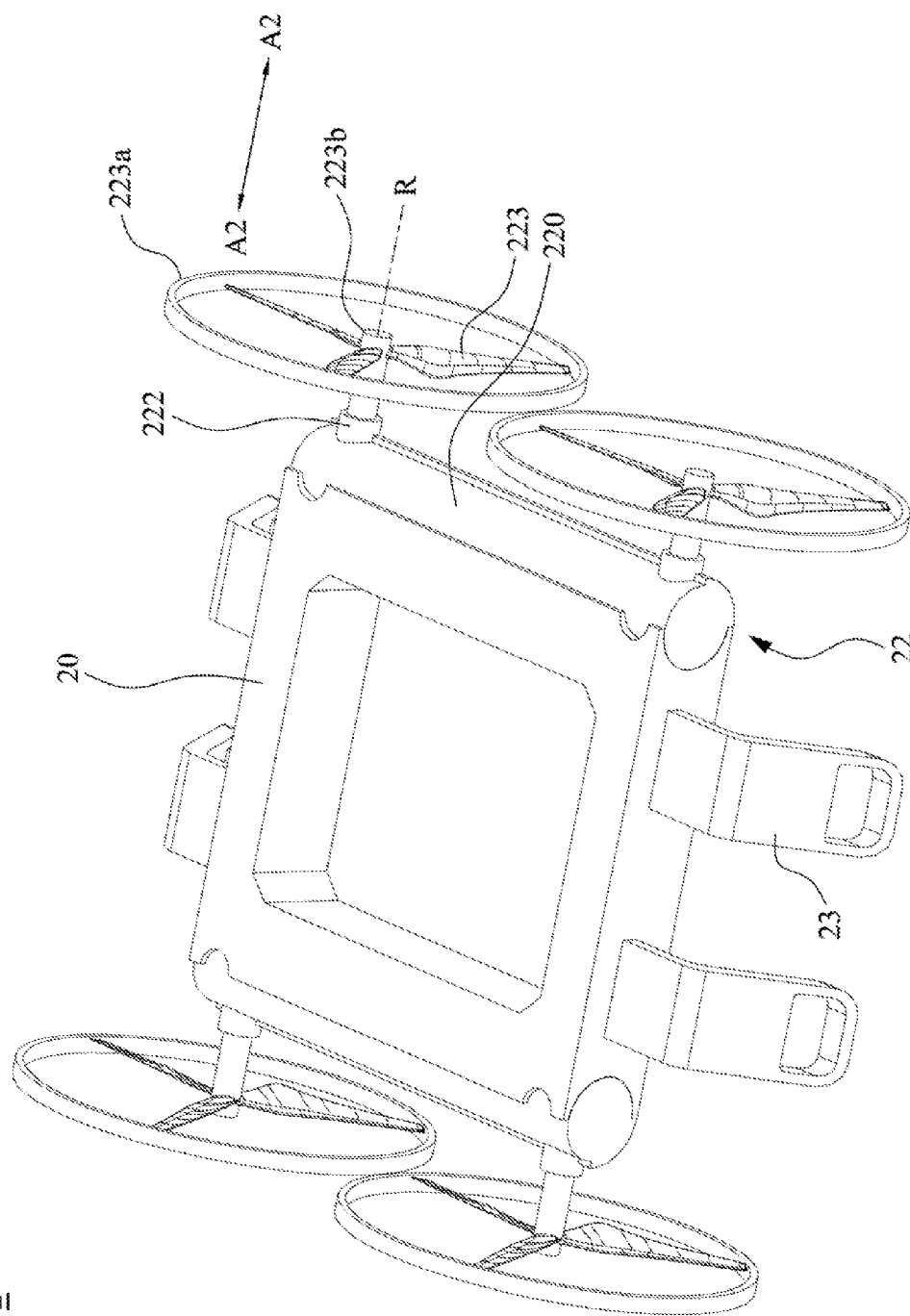


Fig. 7B

2

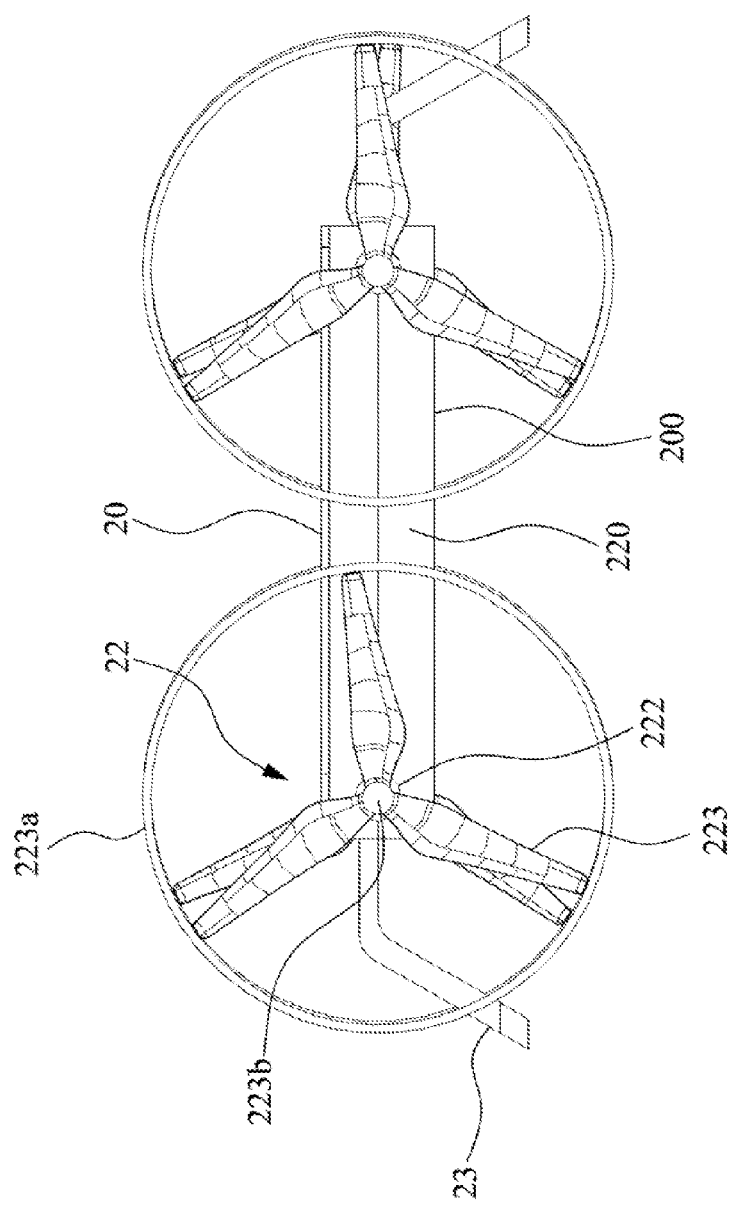


Fig. 7C

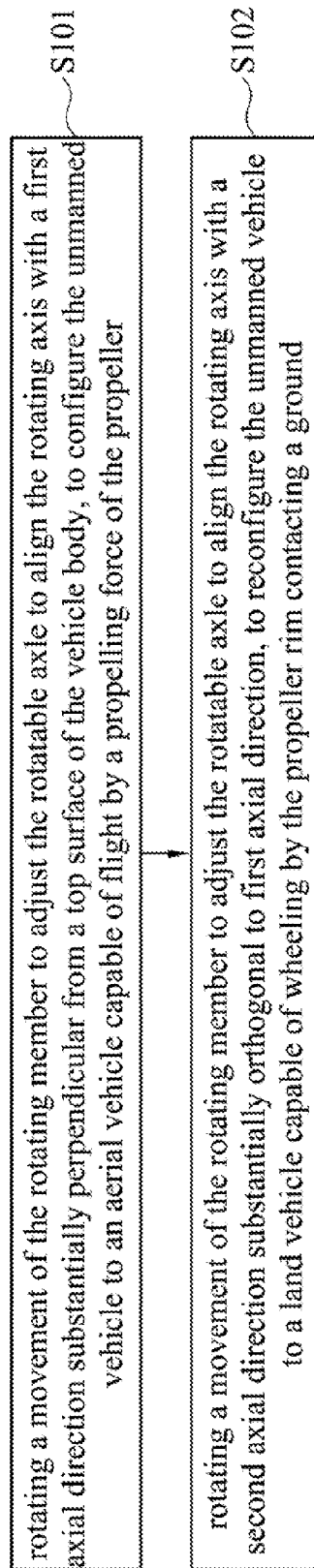


Fig. 8

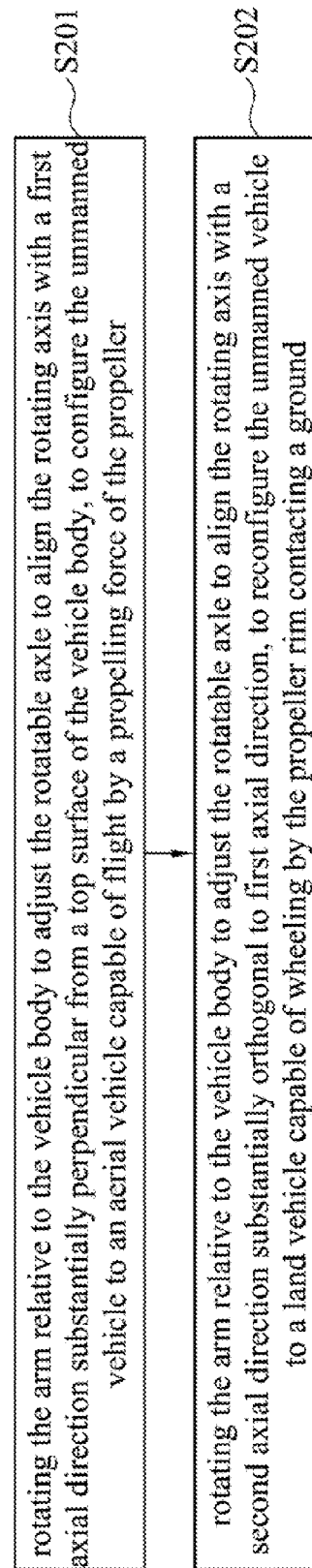


Fig. 9

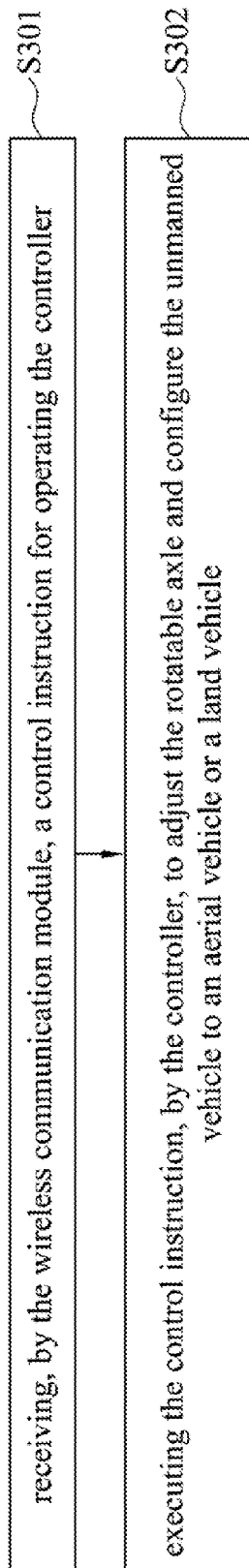


Fig. 10

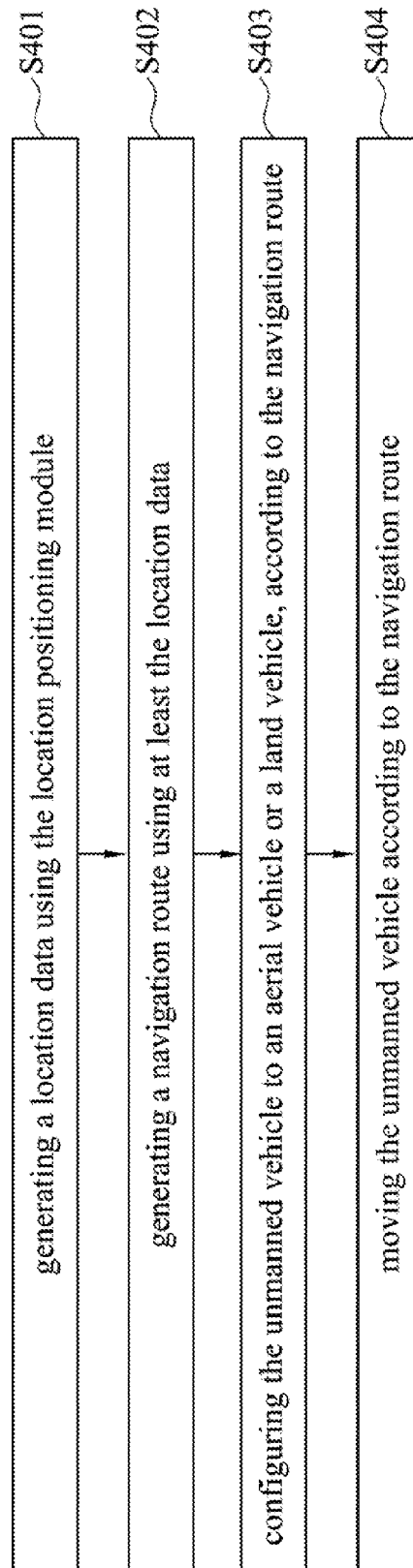


Fig. 11

## UNMANNED VEHICLE

### RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application Ser. No. 62/197,596, filed Jul. 28, 2015, which is herein incorporated by reference.

### BACKGROUND

[0002] Technical Field

[0003] The present disclosure relates to an unmanned vehicle.

[0004] Description of Related Art

[0005] In recent years, unmanned aerial vehicles (UAVs) have been widely used in various fields such as aerial photography, surveillance, scientific research, geological survey, and remote sensing. Typically, the UAVs carry onboard a variety of electrical components used to control various aspects of the operation of the UAVs. At the same time, the UAVs sometimes also need to carry one or more sensors for navigational, surveillance or remote sensing purposes.

[0006] However, traditional UAVs are aerial vehicles and can only move in the sky. When the climate is bad or there are obstructions in the aerial pathway, the traditional UAVs are unable to work properly. That is, traditional UAVs are unable to cope with a variety of climate conditions or complex routes.

### SUMMARY

[0007] According to an embodiment, the disclosure provides an unmanned vehicle. The unmanned vehicle includes a vehicle body and at least one arm assembly. The arm assembly is coupled to the vehicle body. The arm assembly includes a first rotating member, a second rotating member, and a propeller. The second rotating member is coupled to the first rotating member. The propeller includes a propeller rim encircling an outer edge of the propeller. The propeller further includes a rotatable axle coupled to the second rotating member. The rotatable axle extends along a rotating axis. The second rotating member is configured to turn the propeller by rotating the rotatable axle about the rotating axis. The first rotating member is configured to rotate and effect a movement of the second rotating member so as to selectively adjust the rotatable axle to align the rotating axis at least with a first axial direction and a second axial direction.

[0008] According to another embodiment, the disclosure provides an unmanned vehicle. The unmanned vehicle includes a vehicle body and at least one arm assembly. The arm assembly includes an arm, a propeller rotating member, a propeller, and a rim. The arm is rotatably coupled to the vehicle body. The propeller rotating member is disposed on a surface of the arm. The propeller is coupled to the propeller rotating member. The propeller has a rotatable axle extending along a rotating axis perpendicular to the surface of the arm. The rim is coupled to the outer edge of the propeller. The propeller rotating member is configured to turn the propeller by rotating the rotatable axle about the rotating axis. The arm is configured to rotate relative to the vehicle body so as to selectively adjust the rotating axis at least to a first axial direction and a second axial direction. The rim is coupled to the outer edge of the propeller.

[0009] According to yet another embodiment, the disclosure provides a method for controlling an unmanned vehicle. The unmanned vehicle includes a vehicle body and at least one arm assembly having a propeller. The propeller includes a propeller rim encircling an outer edge of the propeller. The propeller further includes a rotatable axle extending along a rotating axis. The method includes at least one of: adjusting the rotatable axle to align the rotating axis with a first axial direction substantially perpendicular from a top surface of the vehicle body, to configure the unmanned vehicle to an aerial vehicle capable of flight by a propelling force of the propeller; and adjusting the rotatable axle to align the rotating axis with a second axial direction substantially orthogonal to first axial direction, to configure the unmanned vehicle to a land vehicle capable of wheeling by the propeller rim contacting a ground.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1A is an exploded view of an unmanned vehicle according to an embodiment of the disclosure;

[0011] FIG. 1B is a perspective view of the unmanned vehicle in FIG. 1A, in which rotating axes of propellers are parallel to a first axial direction;

[0012] FIG. 1C is a perspective view of the unmanned vehicle in FIG. 1A, in which the rotating axes of the propellers are parallel to a second axial direction;

[0013] FIG. 1D is a perspective view of the unmanned vehicle in FIG. 1C, in which the rotating axes of the propellers are shifted from the second axial direction;

[0014] FIG. 2 is a perspective view of an unmanned vehicle according to an embodiment of the disclosure;

[0015] FIG. 3A is a partial cross-sectional view of the unmanned vehicle in FIG. 2 taken along line 3A, in which an angle formed between a rotational plane and each of the movable vanes is not zero;

[0016] FIG. 3B is another partial cross-sectional view of the unmanned vehicle in FIG. 2 along line 5F-5F', in which an angle formed between a rotational plane and each of the movable vanes is zero;

[0017] FIG. 4 is a perspective view of the unmanned vehicle in FIG. 1B, according to an embodiment of the disclosure;

[0018] FIG. 5 is a perspective view of the unmanned vehicle in FIG. 1B, according to an embodiment of the disclosure;

[0019] FIG. 6 is a block diagram of the components of an unmanned vehicle according to an embodiment of the disclosure;

[0020] FIG. 7A is a perspective view of an unmanned vehicle according to an embodiment of the disclosure, in which rotating axes of propellers are parallel to a first axial direction;

[0021] FIG. 7B is a perspective view of the unmanned vehicle in FIG. 7A, in which the rotating axes of the propellers are parallel to a second axial direction;

[0022] FIG. 7C is a side view of the unmanned vehicle in FIG. 7B;

[0023] FIG. 8 is a flow chart of a method for controlling an unmanned vehicle according to an embodiment of the disclosure;

[0024] FIG. 9 is a flow chart of a method for controlling an unmanned vehicle according to another embodiment of the disclosure;

[0025] FIG. 10 is a flow chart of a method for wirelessly receiving a control instruction for controlling an unmanned vehicle according to another embodiment of the disclosure; and

[0026] FIG. 11 is a flow chart of a method for generating and using a navigation route for controlling an unmanned vehicle according to another embodiment of the disclosure.

#### DETAILED DESCRIPTION

[0027] The disclosure can be more fully understood by reading the following detailed description of the embodiments, with reference to the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

[0028] Reference is made to FIG. 1A to FIG. 1D. The unmanned vehicle 1 includes a vehicle body 10 and arm assemblies 12. The vehicle body 10 includes a main module 10a and connecting members 10b. The connecting members 10b are detachably connected to the opposite sides of the main module 10a, respectively. Each of the arm assemblies 12 includes an arm 120, a first rotating member 121, a second rotating member 122, and a propeller 123. The arm 120 is coupled to the corresponding connecting member 10b and configured to move about a shoulder joint 124. The first rotating member 121 is coupled to the arm 120 at a distal end to the shoulder joint 124. The second rotating member 122 is coupled to the adjoining first rotating member 121. The propeller 123 includes a propeller rim 123a encircling an outer edge of the propeller 123 and a rotatable axle 123b coupled to the adjoining second rotating member 122. The rotatable axle 123b extends along a rotating axis R. The second rotating member 122 is configured to turn the propeller 123 by rotating the rotatable axle 123b about the rotating axis R, and the first rotating member 121 is configured to rotate and effect a movement of the second rotating member 122 so as to selectively adjust the rotatable axle 123b to align the rotating axis R at least with a first axial direction A1 (shown in FIG. 1B) and a second axial direction A2 (shown in FIG. 1C). Each of the propeller rims 123a is disposed on the outer edge of the corresponding propeller 123.

[0029] The arm assemblies 12 further include shoulder joints 124 connecting the arms 120 to the connection members 10b of the vehicle body 10. The arms 120 of the arm assemblies 12 are configured to pivot about the shoulder joints 124 and rotate relative to the vehicle body 10. Accordingly, the distance between any two of the propellers 123 can be adjusted and thus the operation of the propellers 123 can be prevented from structural interference.

[0030] As shown in FIGS. 1B to 1D, the main module 10a has a top surface 100. The first axial direction A1 is substantially perpendicular to the top surface 100, and the second axial direction A2 is substantially orthogonal to the first axial direction A1. In one embodiment, the first axial direction A1 is substantially vertical and the second axial direction A2 is substantially horizontal. When the rotatable axles 123b of the propellers 123 are adjusted to generally align the rotating axes R with the first axial direction A1, the propelling forces provided by the propellers 123 can make the unmanned vehicle 1 levitate, or move up or down, allowing the unmanned vehicle 1 to be configured as an aerial vehicle and capable of flight. When the rotatable axle 123b of the propellers 123 are adjusted to generally align the

rotating axes R with the second axial direction A2, the rotating propellers 123 with the propeller rims 123a can function as wheels, configuring the unmanned vehicle 1 into a land vehicle capable of wheeling motion and moving the unmanned vehicle 1 on land by the propeller rims 123a contact with a ground.

[0031] As shown in FIGS. 1A to 1D, there are two connecting members 10b and four arm assemblies 12, with each of the connecting members 10b connecting to two arm assemblies 12. The disclosure is not limited in this regard, for example, it is envisaged that the unmanned vehicle 1 can include one or more connecting members 10b, each having one or more arm assemblies 12.

[0032] In an embodiment each of the second rotating members 122 is a power motor, capable to turn the propeller 123 to provide a propelling force by rotating the rotatable axle 123b about the rotating axis R.

[0033] As shown in the embodiments of FIG. 1B and also in FIG. 6, the unmanned vehicle 1 further includes a controller 160 and a power unit 161 (illustrated by dotted lines in FIG. 1B). The controller 160 is disposed on the main module 10a and configured to control movements of the first rotating members 121 and movements of the second rotating members 122. The power unit 161 is disposed on the main module 10a and configured to supply power to move the first rotating members 121 and the second rotating members 122. Alternatively, the power unit 161 can be disposed on the connecting member 10b, so as to reduce the weight of the main module 10a or improve weight distribution across the unmanned vehicle 1.

[0034] In some embodiments, the controller 160 is disposed on the vehicle body 10 (e.g., on the main body 10a or the connecting member 10b) and the power unit 161 is disposed on the arm assembly 12. In some embodiments, the power unit 161 is disposed on the vehicle body 10 (e.g., on the main body 10a or the connecting member 10b) and the controller 160 is disposed on the arm assembly 12. In some embodiments, the controller 160 and the power unit 161 are both disposed on the arm assembly 12.

[0035] In some embodiments, the controller 160 is further configured to individually control the first rotating member 121 of each arm assembly 12 to individually adjust each rotatable axle 123b and align with one of a plurality of axial directions. For example, the controller 160 can adjust the rotatable axles 123b of two of the propellers 123 to align their rotating axes R with the first axial direction A1, and adjust the rotatable axles 123b of the other propellers 123 to align their rotating axes R with the second axial direction A2. Further, the controller 160 is configured to control the first rotating members 121 to adjust the rotatable axles 123b of the propellers 123 to change the rotating axes R to different alignments and angles with respect to the first axial direction A1 and second axial direction A2. Other combinations to control and rotate the rotatable axles 123b of the propellers 123 are envisaged, to provide different motion capabilities of the unmanned vehicle 1.

[0036] In some embodiments, the shoulder joints 124 provide for lateral movement of the arms 120 and the arm assemblies 12. Specifically, the controller 160 is configured to individually control the rotation of each arm assembly 12 about the shoulder joint 124 to align the rotatable axle 123b with one of a plurality of axial directions. The moving direction of the unmanned vehicle 1 can be changed by adjusting the rotatable axle 123b of at least one propeller 123

by rotating the corresponding arm **120** about the corresponding shoulder joint **124**, as shown in FIGS. **1C** and **1D**.

**[0037]** It is appreciated that the extension and retraction of the arm **120** allows for a variety of operational modes and flexibility for controlling the unmanned vehicle **1**. By extending/retracting the arms **120** in different configurations and combinations about the shoulder joints **124**, the unmanned vehicle **1** may achieve improved maneuverability. Further, when navigating the unmanned vehicle **1** through more confined spaces, the retraction of the arms **120** transforms the unmanned vehicle **1** into a smaller size vehicle and able to fit through tighter spaces. Further, when the unmanned vehicle **1** is not in use, the retracted arms allow the unmanned vehicle **1** to occupy a smaller space for transport and storage.

**[0038]** In some other embodiments, to control vehicular movement of the unmanned vehicle **1**, the controller **160** is configured to individually control the second rotating member **122** of each arm assembly **12** to individually cause each propeller **123** to rotate with a different rotational speed or to rotate in a different direction. Therefore, the moving direction of the unmanned vehicle **1** can also be changed by adjusting the differences between the rotational speeds of the propellers **123** when the unmanned vehicle **1** operates as an aerial or land vehicle. In this manner, structural interferences among the propellers **123** during any operation of the unmanned vehicle **1** can be considered in advance, and the shoulder joints **124** can be omitted in some embodiments.

**[0039]** As shown in FIG. **2**, FIG. **3A** and FIG. **3B**, each of the propellers **123** has a rotational plane **P** and includes a propeller rim **123a**, a rotatable axle **123b**, an angle-adjusting member **123c**, and a plurality of movable vanes **123d**. The rotatable axle **123b** is coupled to the corresponding second rotating member **122**. The angle-adjusting member **123c** is coupled to the rotatable axle **123b**. The movable vanes **123d** are coupled to the angle-adjusting member **123c**. The angle-adjusting member **123c** is configured to adjust an angle  $\theta$  formed between the rotational plane **P** and a movable vane **123d**. When the angle  $\theta$  is not zero, the rotating propellers **123'** can generate a propelling force, such that the unmanned vehicle **1'** moves due to the propelling force and can operate as an aerial or a navel vehicle. When the angle  $\theta$  is zero, the rotating propellers **123'** do not generate a propelling force. In this configuration, the unmanned vehicle **1'** operates as a land vehicle which moves by the rotation of the propeller rims **123a** as wheels rolling on a ground surface. With this configuration, because the angle  $\theta$  is zero, there is no propelling force lateral to the rotational plane **P**, and therefore improves the stability of the land vehicle running on the ground.

**[0040]** Other details regarding the unmanned vehicle **1'** of FIG. **2** are similar to the unmanned vehicle **1** of FIG. **1B** and are not repeated here to avoid duplicity.

**[0041]** Reference is made to FIGS. **4** and **5**. The unmanned vehicle **1** further includes protection shields **14**. The protection shields **14** extend from the propeller rims **123a** and envelop wholly the propeller **123** (shown in FIG. **5**). Alternatively, for example in a lighter weight unmanned vehicle version, the protection shield **14** may only envelop a portion of the propeller **123** (shown in FIG. **4**). During the rotation of the propellers **123**, the protection shields **14** can protect the propellers **123** from objects that may cause damages to the propellers **123**. The embodiments in FIGS. **4** and **5** show each of the protection shields **14** as a net structure. Alter-

native forms include a mesh with larger or smaller apertures, as well as different shapes of apertures (for example diamond, rectangle, circle, elliptical, and polyhedral). Also, although each of the protection shields **14** is shown in a spherical shape, other design shapes are envisaged, such as having irregular, uneven, edged, or jagged surface. Preferably, each of the protection shields **14** has shape and form that is aerodynamic to reduce air resistance as the unmanned vehicle **1** moves in air. Further, it is preferred that each of the protection shields **14** has suitable apertures size and shapes for airflow through the apertures so as to not diminish the propelling force and effectiveness of the propellers **123**. Accordingly, different embodiments are envisaged here, which incorporates previously described protection shield **14** designs.

**[0042]** In some embodiments, the protection shields **14** are detachably connected to the propeller rims **123a**. In some embodiments the protection shield **14** and the propeller rim **123a** are integral. In some embodiments, the protection shields **14** are coupled to the arm assemblies **12** without connecting to the propeller rims **123a**. Specifically, the protection shields **14** are coupled to the first rotating members **121** of the arm assemblies **12**, as shown in FIG. **4**.

**[0043]** Reference is made to FIG. **6**. The unmanned vehicle **1** further includes a wireless communication module **162**, a location positioning module **163** (for example a GPS), a camera **164**, a mini PCB **165**, and a processor module **166**. Although shown as separate units, the mini PCB **165** and the controller **160** can also be the same unit. The wireless communication module **162** is disposed on the main module **10a** and electrically connected to the controller **160**. The wireless communication module **162** is configured to receive a control instruction for operating the controller **160**. The location positioning module **163** is disposed on the main module **10a** and electrically connected to the processor module **166**. The location positioning module **163** is configured to generate a location data, and the processor module **166** is configured to generate a navigation route according to the location data and generate a navigation instruction for operating the controller **160** to effect a movement of the unmanned vehicle **1** according the navigation route. The camera **164** is disposed on the main module **10a** and may also be disposed on the connecting member **10b**). The camera **164** is configured to generate a video data. The mini PCB **165** is disposed on the main module **10a**. The mini PCB **165** is configured to process the video stream. The wireless communication module **162** is further configured to transmit the processed video data to a remote device.

**[0044]** According to the data received from the camera **164**, the Wireless communication module **162**, or the location positioning module **163**, the unmanned vehicle **1** can control the arm assembly **12** and/or the power unit **161** powering the arm assembly **12** to configure/reconfigure the unmanned vehicle to an aerial or land vehicle. The unmanned vehicle **1** then power/control the unmanned vehicle's operations and motions according to that configuration. For example, in a situation the unmanned vehicle configured as an aerial vehicle propelling across the air may be reaching shore. The approach to shore may be plotted by the location positioning module **163** and/or notified by received wireless information and/or detected by the camera **164**. In response to this, the processor module **166** can operate the controller **160** to instruct the arm assembly **12** to reconfigure the

unmanned vehicle 1 to a land vehicle to move on wheels, to continue proceeding along the planned pathway.

[0045] As another example, the location positioning module 163 may plot a course through a more confined space terrain, which is confirmed by visual detection by the camera 164. In response to this, the arm assembly 12 is turned about the shoulder joint 124 and retracted to make the unmanned vehicle 1 into a smaller size. Additionally, power can be reduced to navigate the unmanned vehicle 1 slower and more carefully through this narrow space.

[0046] Reference is made to FIGS. 7A and FIG. 7B. The unmanned vehicle 2 includes a vehicle body 20 and arm assemblies 22. Each of the arm assemblies 22 includes an arm 220, a propeller rotating member 222, a propeller 223, and a propeller rim 223a encircling the periphery of the propeller 223. The arm 220 is rotatably coupled to the vehicle body 20. Specifically, each of the arms 220 is an elongate cylinder having an elongate curved surface 220a, and a part of the elongate curved surface 220a is rotatably coupled to the vehicle body 20. In more detail, the arm 220 is disposed in a cavity extending along the periphery of the vehicle body 20 such that a portion of an elongate curved surface 220a of the arm 220 is enshrouded in the cavity. The propeller rotating member 222 is disposed on an exposed curved portion of the elongate curved surface 220a of the arm 220. The propeller 223 is coupled to the adjoining propeller rotating member 222 and has a rotatable axle 223b extending along a rotating axis R. The rotatable axle 223b is connected to the propeller rotating member 222 and extends perpendicularly from the exposed elongate curved surface 220a. The propeller rotating member 222 is configured to turn the propeller 223 by rotating the rotatable axle 223b about the rotating axis R. The arm 220 is configured to rotate relative to the vehicle body 20, so as to selectively adjust the rotating axis R at least to a first axial direction A1 and a second axial direction A2. When the arm 220 rotates relative to the vehicle body 20, a portion of the elongate curved surface enshrouded in the cavity becomes exposed, whereas another portion becomes enshrouded within the cavity. In other words, the arm 220 is able to roll/turn about the vehicle body's cavity which is holding the arm 220. Each of the propeller rims 223a is coupled to the outer edge of the corresponding propeller 123 and forms a wheel rim.

[0047] Similar to the previously described embodiments, when the rotatable axle 223b of the propellers 223 are adjusted to generally align the rotating axes R with the first axial direction A1, the propelling forces provided by the propellers 223 can make the unmanned vehicle 2 levitate, or move up or down, allowing the unmanned vehicle 2 to be configured as an aerial vehicle. When the rotatable axle 223b of the propellers 223 are adjusted to generally align the rotating axes R with the second axial direction A2, the rotating propellers 223 with the propeller rims 223a can function as wheels, transforming the unmanned vehicle 2 into a land vehicle.

[0048] In some embodiments, the unmanned vehicle 2 can also include a controller 160 shown in FIG. 1B. The controller 160 is disposed in the vehicle body 20 and configured to control the arm 220 and the propeller rotating members 222. Specifically, as also had been previously discussed, in some embodiments, the controller 160 is further configured to individually control the arm 220 to rotate relative to the vehicle body 20 to selectively adjust the rotating axes R to the first axial direction A1 or the second axial direction A2.

Moreover, in some embodiments, to control vehicular movement of the unmanned vehicle 1, the controller 160 is further configured to individually control the propeller rotating members 222 to adjust rotational speeds of the propellers 223. Therefore, the moving direction of the unmanned vehicle 2 can be changed by adjusting the differences between the rotational speeds of the propellers 223 when the unmanned vehicle 2 operates as an aerial or land vehicle.

[0049] In some embodiments, the propellers 223 of the unmanned vehicle 2 can be replaced by the propellers 123' shown in FIG. 2, FIG. 3A and FIG. 3B, so as to improve the stability of the land vehicle running on the ground as previously discussed.

[0050] As shown in FIGS. 7A and 7B, there are two arm assemblies 22, with each of the arm assemblies 22 having two adjoining propeller rotating members 222. The disclosure is not limited in this regard, for example, it is envisaged that the unmanned vehicle 2 can include more arm assemblies 22 disposed peripherally of the vehicle body 20, each adjoining one or more propeller rotating members 222. That is, although the vehicle body 20 as a rectangular shaped, the vehicle body 20 could be polygon-shaped with three or more sides.

[0051] As shown in FIGS. 7A and 7B, the unmanned vehicle 2 further includes legs, for example stands 23, coupled to the vehicle body 20. When the unmanned vehicle 2 lands with the configuration of an aerial vehicle, the stands 23 can support the vehicle body 20 and prevent the bottom surface 200 of the vehicle body 20 from directly contacting the ground. Reference is made to FIG. 7C. When the unmanned vehicle 2 is configured as a land vehicle, a height of the propeller rims 223a relative to the bottom surface 200 of the vehicle body 20 is larger than a height of the stands 23 relative to the bottom surface 200, so that the stands 23 does not obstruct the movement of the unmanned vehicle 2 wheeling on propeller rims 223a.

[0052] In some embodiments, the unmanned vehicle 2 can further include the power unit 161 shown in FIG. 1B, the protection shields 14 shown in FIGS. 4 and 5, the wireless communication module 162, the location positioning module 163, the camera 164, the mini PCB 165, and the processor module 166 shown in FIG. 9. The functions of these components and connecting relationships among these components have been previously described and are not repeated here to avoid duplicity.

[0053] Reference is made to FIG. 8. FIG. 8 is a flow chart of a method for controlling an unmanned vehicle according to an embodiment of the disclosure. The unmanned vehicle includes a vehicle body and at least one arm assembly coupled to the vehicle body. The arm assembly includes a rotating member and a propeller. The rotating member is configured to turn the propeller by rotating the rotatable axle about the rotating axis. The propeller includes a propeller rim encircling an outer edge of the propeller and a rotatable axle. The rotatable axle of the propeller is coupled to the rotating member and extends along a rotating axis. The method begins with operation S101 in which a movement of the rotating member is rotated to adjust the rotatable axle to align the rotating axis with a first axial direction substantially perpendicular from a top surface of the vehicle body, to configure the unmanned vehicle to an aerial vehicle capable of flight by a propelling force of the propeller. The method continues with operation S102 in which a movement of the rotating member is rotated to adjust the rotatable axle

to align the rotating axis with a second axial direction substantially orthogonal to first axial direction to reconfigure the unmanned vehicle to a land vehicle capable of wheeling by the propeller rim contacting a ground. It is envisaged that the method may also be performed by first configuring the unmanned vehicle to a land vehicle as described in step S102, and then reconfiguring the unmanned vehicle to an aerial vehicle as described in step S101.

[0054] Reference is made to FIG. 9. FIG. 9 is a flow chart of a method for controlling an unmanned vehicle according to another embodiment of the disclosure. The unmanned vehicle includes a vehicle body and at least one arm assembly coupled to the vehicle body. The arm assembly includes an arm and a propeller. The arm is rotatably connected to the vehicle body. The propeller includes a propeller rim encircling an outer edge of the propeller and a rotatable axle. The rotatable axle of the propeller extends along a rotating axis perpendicular to a surface of the arm. The method begins with operation S201 in which the arm is rotated relative to the vehicle body to adjust the rotatable axle to align the rotating axis with a first axial direction substantially perpendicular from a top surface of the vehicle body, to configure the unmanned vehicle to an aerial vehicle capable of flight by a propelling force of the propeller. The method continues with operation S202 in which the arm is rotated relative to the vehicle body to adjust the rotatable axle to align the rotating axis with a second axial direction substantially orthogonal to first axial direction, to reconfigure the unmanned vehicle to a land vehicle capable of wheeling by the propeller rim contacting a ground. Similar to the embodiment described with reference to FIG. 8, the order of the method may be reversed, with the first configuration of the unmanned vehicle being a land vehicle and then reconfigured to an aerial vehicle.

[0055] Reference is made to FIG. 10. FIG. 10 is a flow chart of a method for wirelessly receiving a control instruction for controlling an unmanned vehicle according to another embodiment of the disclosure. In some embodiments in addition to the vehicle body and the at least one arm assembly, the unmanned vehicle further includes a controller and a wireless communication module. To perform the foregoing operations (i.e., the operations in FIG. 8 or the operations in FIG. 9), the method begins with operation S301 in which a control instruction for operating the controller is received by the wireless communication module. The method continues with operation S302 in which the control instruction is executed by the controller to adjust the rotatable axle and configure the unmanned vehicle to an aerial vehicle or a land vehicle.

[0056] Reference is made to FIG. 11. FIG. 11 is a flow chart of a method for generating and using a navigation route for controlling an unmanned vehicle according to another embodiment of the disclosure. In some embodiments, in addition to the vehicle body and the at least one arm assembly, the unmanned vehicle further includes a location positioning module. The method begins with operation S401 in which a location data is generated using the location positioning module. The method continues with operation S402 in which a navigation route is generated using at least the location data. The method continues with operation S403 in which the unmanned vehicle is configured to an aerial vehicle or a land vehicle (e.g., by performing the operations in FIG. 8 or the operations in FIG. 9), according to the

navigation route. The method continues with operation S404 in which the unmanned vehicle moves according to the navigation route.

[0057] According to the foregoing recitations of the embodiments of the disclosure, it can be seen that the unmanned vehicle of the disclosure can be a kind of amphibious vehicle (e.g., able to move both in the sky and on the land). As shown in the Figures, the unmanned vehicle includes modularized parts/units. The modularized design provides for ease of transport, storage, and parts replacement or parts upgrade. It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present disclosure without departing from the scope or spirit of the disclosure.

What is claimed is:

1. An unmanned vehicle, comprising a vehicle body and at least one arm assembly coupled to the vehicle body, the arm assembly comprising:

- a first rotating member;
- a second rotating member coupled to the first rotating member; and
- a propeller comprising a propeller rim encircling an outer edge of the propeller, the propeller further comprising a rotatable axle coupled to the second rotating member; wherein the rotatable axle extends along a rotating axis, and the second rotating member is configured to turn the propeller by rotating the rotatable axle about the rotating axis; and

wherein the first rotating member is configured to rotate and effect a movement of the second rotating member so as to selectively adjust the rotatable axle to align the rotating axis at least with a first axial direction and a second axial direction.

2. The unmanned vehicle of claim 1, wherein the vehicle body comprises:

- a main module; and
- a connecting member detachably connected to the main module, wherein the arm assembly is connected to the connecting member.

3. The unmanned vehicle of claim 1, further comprising: a controller configured to control a movement of the first rotating member and a movement of the second rotating member; and

a power unit configured to supply power to move the first rotating member and the second rotating member.

4. The unmanned vehicle of claim 3, further comprising a plurality of the arm assemblies, wherein the controller is configured to individually control the movement of the first rotating member of each arm assembly to individually adjust each rotatable axle to align with one of a plurality of axial directions.

5. The unmanned vehicle of claim 3, further comprising a plurality of the arm assemblies, wherein the controller is configured to individually control the movement of the second rotating member of each arm assembly to individually cause each propeller to rotate with a different rotational speed or to rotate in a different direction.

6. The unmanned vehicle of claim 3, further comprising a shoulder joint connecting the arm assembly to the vehicle body, wherein the arm assembly is configured to pivot about the shoulder joint and rotate relative to the vehicle body.

7. The unmanned vehicle of claim 6, wherein a plurality of the arm assemblies is provided and the controller is configured to individually control the rotation of each arm

assembly about the shoulder joint to align the rotatable axle with one of a plurality of axial directions.

**8.** The unmanned vehicle of claim **3**, wherein the controller and the power unit have one of the following configurations:

- the controller and the power unit are both disposed on the vehicle body;

- the controller is disposed on the vehicle body and the power unit is disposed on the arm assembly;

- the power unit is disposed on the vehicle body and the controller is disposed on the arm assembly; and

- the controller and the power unit are both disposed on the arm assembly.

**9.** The unmanned vehicle of claim **1**, further comprising a protection shield extending from the propeller rim and enveloping at least a part of the propeller.

**10.** The unmanned vehicle of claim **1**, wherein the first rotating member is an elongate cylinder disposed in a cavity extending along the vehicle body's periphery such that a portion of an elongate curved surface of the elongate cylinder is enshrouded in the cavity; and wherein the second rotating member is disposed on an exposed curved surface of the elongate cylinder, and the rotatable axle is connected to the second rotating member and extends perpendicularly from the exposed curved surface.

**11.** The unmanned vehicle of claim **1**, wherein the first axial direction is substantially perpendicular from a top surface of the vehicle body, and the second axial direction is substantially orthogonal to the first axial direction.

**12.** The unmanned vehicle of claim **3**, further comprising a wireless communication module configured to receive a control instruction for operating the controller.

**13.** The unmanned vehicle of claim **12**, further comprising a camera configured to generate a video data, wherein the wireless communication module is further configured to transmit the video data to a remote device.

**14.** The unmanned vehicle of claim **3**, further comprising a location positioning module configured to generate a location data, and the unmanned vehicle further comprising a processor module configured to:

- generate a navigation route according to the location data; and

- generate a navigation instruction for operating the controller to effect a movement of the unmanned vehicle according to the navigation route.

**15.** An unmanned vehicle, comprising:

- a vehicle body;

- at least one arm assembly comprising:

- an arm rotatably coupled to the vehicle body;

- a propeller rotating member disposed on a surface of the arm;

- a propeller coupled to the propeller rotating member, the propeller having a rotatable axle extending along a rotating axis perpendicular to the surface of the arm; and

- a rim coupled to the outer edge of the propeller;

wherein the propeller rotating member is configured to turn the propeller by rotating the rotatable axle about the rotating axis and wherein the arm is configured to rotate relative to the vehicle body, so as to selectively adjust the rotating axis at least to a first axial direction and a second axial direction.

**16.** The unmanned vehicle of claim **15**, further comprising a controller disposed in the vehicle body, wherein a plurality of the arm assemblies is provided, and wherein the controller is configured to individually control the propeller rotating members of the arm assemblies to adjust a rotational speed of each propeller.

**17.** The unmanned vehicle of claim **16**, wherein the arm is an elongate cylinder and the surface of the arm is an elongate curved surface; and wherein the elongate curved surface is rotatably coupled to the vehicle body.

**18.** A method for controlling an unmanned vehicle comprising a vehicle body and at least one arm assembly having a propeller comprising a propeller rim encircling an outer edge of the propeller, the propeller further comprising a rotatable axle extending along a rotating axis, the method comprising at least one of:

- adjusting the rotatable axle to align the rotating axis with a first axial direction substantially perpendicular from a top surface of the vehicle body, to configure the unmanned vehicle to an aerial vehicle capable of flight by a propelling force of the propeller; and

- adjusting the rotatable axle to align the rotating axis with a second axial direction substantially orthogonal to the first axial direction, to configure the unmanned vehicle to a land vehicle capable of wheeling by the propeller rim contacting a ground.

**19.** The method of claim **18**, wherein the unmanned vehicle further comprises a controller and a wireless communication module, the method further comprising:

- receiving, by the wireless communication module, a control instruction for operating the controller; and

- executing the control instruction, by the controller, to adjust the rotatable axle and configure the unmanned vehicle to an aerial vehicle or a land vehicle.

**20.** The method of claim **18**, wherein the unmanned vehicle further comprises a location position module, the method further comprising:

- generating a location data using the location positioning module;

- generating a navigation route using at least the location data;

- configuring the unmanned vehicle to an aerial vehicle or a land vehicle, according to the navigation route; and
- moving the unmanned vehicle according to the navigation route.

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