(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
07 June 2018 (07.06.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/098906 A1

(51) International Patent Classification:
G05D 1/10 (2006.01) *G08C 17/02* (2006.01)
G05D 1/08 (2006.01)

(21) International Application Number:
PCT/CN2017/074161

(22) International Filing Date:
20 February 2017 (20.02.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201611079824.8 29 November 2016 (29.11.2016) CN

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: Unmanned aerial vehicle control method and unmanned aerial vehicle control apparatus

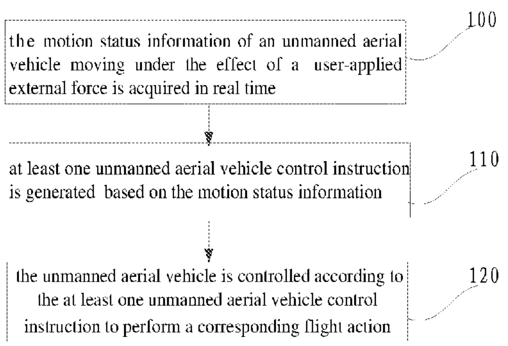

FIG. 1

(57) Abstract: An unmanned aerial vehicle control method and apparatus are provided. The method includes: obtaining, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force (100); generating at least one unmanned aerial vehicle control instruction based on the motion status information (110) and controlling the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction (120). After an unmanned aerial vehicle moves under the effect of a user-applied external force, the control method further controls the unmanned aerial vehicle to perform a corresponding flight action according to the current motion tendency of the unmanned aerial vehicle, thus freeing the user from mastering a complicated unmanned aerial vehicle control technology, reducing the difficulty of the control over the unmanned aerial vehicle and making the unmanned aerial vehicle more applicable.

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Unmanned aerial vehicle control method and unmanned aerial vehicle control apparatus

Technical field of the invention

The present disclosure relates to the field of unmanned aerial vehicle technologies, and in particular to an unmanned aerial vehicle control method and an unmanned aerial vehicle control apparatus.

Background of the invention

With the continuous development of unmanned aerial vehicle technologies, unmanned aerial vehicles have been widely used in plant protection, aerial survey and aerial photography. Generally, an unmanned aerial vehicle is controlled in the following way: a remote control acquires a control operation of the user on the unmanned aerial vehicle, generates a corresponding unmanned aerial vehicle control instruction and then sends the unmanned aerial vehicle control instruction to the unmanned aerial vehicle in a wireless signal transmission manner so as to control the unmanned aerial vehicle to perform a corresponding action. Existing unmanned aerial vehicle control methods requires an unmanned aerial vehicle controller to be good at operating an unmanned aerial vehicle and is therefore not suitable for ordinary users.

Summary of the invention

The embodiment of the present disclosure provides an unmanned aerial vehicle control method to address the problem that existing unmanned aerial vehicle control methods which at least request the user of an unmanned aerial vehicle to master a high-standard control technology are not applicable to ordinary users.

In a first aspect, the embodiment of the present disclosure provides an unmanned aerial vehicle control method, including:

obtaining (or acquiring), in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force;

generating at least one unmanned aerial vehicle control instruction based on the motion status information; and

controlling the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction.

In a second aspect, the embodiment of the present disclosure provides an unmanned aerial vehicle control apparatus, including:

a motion status information acquisition module configured to obtain (or acquire), in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force;

a control instruction generation module configured to generate at least one unmanned aerial vehicle control instruction based on the motion status information acquired by the motion status information acquisition module; and

a flight control module configured to control the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction generated by the control instruction generation module.

By acquiring, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force; generating at least one unmanned aerial vehicle control instruction based on the motion status information and controlling the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction, the unmanned aerial vehicle control method disclosed herein addresses the problem that existing unmanned aerial vehicle control methods which at least request the user of an unmanned aerial vehicle to master a high-standard control technology are not applicable to ordinary users. After an unmanned aerial vehicle starts moving under the effect of a user-applied external force, the control method disclosed herein further controls the unmanned aerial vehicle to perform a corresponding flight action according to the current motion tendency of the unmanned aerial vehicle, thus freeing the user from mastering a complicated unmanned aerial vehicle control technology, reducing the difficulty of the control over the unmanned aerial vehicle and making the unmanned aerial vehicle more applicable.

Brief description of the drawings

To make the technical solutions of the present invention understood better, the accompanying drawings needed for the description of embodiments of the present disclosure are introduced below briefly. Apparently, the accompanying drawings are merely illustrative of certain embodiments of the present disclosure, and other drawings can be devised by those of ordinary skill in the art based on the accompanying drawings without making creative efforts.

Fig. 1 is a flowchart illustrating an unmanned aerial vehicle control method according to embodiment 1 of the present disclosure;

Fig. 2 is a flowchart illustrating an unmanned aerial vehicle control method according to embodiment 2 of the present disclosure;

Fig. 3 is a schematic diagram 1 illustrating the structure of an unmanned aerial vehicle control apparatus according to embodiment 3 of the present disclosure;

Fig. 4 is a schematic diagram 2 illustrating the structure of an unmanned aerial vehicle control apparatus according to embodiment 3 of the present disclosure; and

Fig. 5 is a schematic diagram 3 illustrating the structure of an unmanned aerial vehicle control apparatus according to embodiment 3 of the present disclosure.

Detailed description of the embodiments

The technical solutions provided herein will be described below clearly and completely with reference to accompanying drawings, and apparently, the embodiments described herein are a part of but not all of the embodiments of the present disclosure. Any embodiment that is devised by those of ordinary skill in the art based on those mentioned herein without making creative efforts should fall within the scope of protection of the present disclosure.

Embodiment 1

An unmanned aerial vehicle control method is disclosed in the embodiment which, as shown in Fig. 1, includes the following steps 100-120.

Step 100: the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force is acquired in real time.

The motion status information of an unmanned aerial vehicle includes at least one of: the linear acceleration, the angular velocity and the angular acceleration of the unmanned aerial vehicle. The user-applied external force refers to a force applied by the user to the unmanned aerial vehicle when the user touches the unmanned aerial vehicle, for example, a pulling/pushing force applied by the user to the unmanned aerial vehicle, a rotary force applied by the user to the unmanned aerial vehicle, or a force the user applies to grab the unmanned aerial vehicle. In specific implementations, the direction of the linear acceleration of the unmanned aerial vehicle is the direction of the user-applied external force and therefore can be any spatial direction, that is, the linear acceleration includes, but is not limited to be: a horizontal linear acceleration and a vertical linear acceleration. The acquired motion status information of an unmanned aerial vehicle reflects the magnitude and the direction of the external force applied by the controller to the unmanned aerial vehicle. For example, when the user rotates the unmanned aerial vehicle, the external force applied to the unmanned aerial vehicle causes the unmanned aerial vehicle from a hovering state to rotate, and an angular velocity sensor (e.g. gyroscope) arranged on the unmanned aerial vehicle acquires the real-time angular velocity and/or the real-time angular acceleration of the rotating unmanned aerial vehicle; when the user pushes/pulls the unmanned aerial vehicle towards a certain direction, the unmanned aerial vehicle moves linearly along the direction of the pushing/pulling force, and an acceleration sensor arranged on the unmanned aerial vehicle acquires the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle; when the user rotationally pushes the unmanned aerial vehicle towards a certain direction, the external force applied to the unmanned aerial vehicle causes the unmanned aerial vehicle in a hovering state to rotate, at the same time, the unmanned aerial vehicle moves linearly along the pushing force applied by the user to the unmanned aerial vehicle, in this case, an acceleration sensor arranged on the unmanned aerial vehicle acquires the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle, and an angular velocity sensor (e.g. gyroscope) arranged on the unmanned aerial vehicle acquires the real-time angular velocity and/or the real-time angular acceleration of the rotating unmanned aerial vehicle. Moreover, the magnitude of the external force applied by the user to the unmanned aerial vehicle directly affects the initial speed of the unmanned aerial vehicle. Thus, when the external force applied by the user to the unmanned aerial vehicle changes in direction or magnitude, the motion status of the unmanned aerial vehicle changes, and so does the motion status information of the unmanned aerial vehicle acquired. In specific implementations, after the unmanned aerial vehicle starts moving under the user-applied external force, the motion status information of the unmanned aerial vehicle acquired may be included: the angular velocity and the angular acceleration of the unmanned aerial vehicle; the horizontal linear acceleration of the unmanned aerial vehicle; the vertical linear acceleration of the unmanned aerial vehicle; the angular velocity, the angular acceleration and the horizontal linear acceleration of the unmanned aerial vehicle; the angular velocity, the angular acceleration and the vertical linear acceleration of the unmanned aerial vehicle; the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle; or the angular velocity, the angular acceleration, the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle.

After the unmanned aerial vehicle starts moving under the user-applied external force, the motion status information of the unmanned aerial vehicle further includes the linear velocity of the unmanned aerial vehicle. The direction of the linear velocity of the unmanned aerial vehicle is the direction of the user-applied external force and therefore can be any spatial direction, that is, the linear velocity includes, but is not limited to be: a horizontal linear velocity and a vertical linear velocity of the unmanned aerial vehicle.

Obtaining (or Acquiring), in real time, the motion status information of the unmanned aerial vehicle moving under the effect of a user-applied external force includes: according to a preset period to acquire the motion status information of the unmanned aerial vehicle moving under the effect of the user-applied external force. Generally, the preset period is very short, for example, 30ms or less than 30ms, thus, the acquisition of the motion status information of the unmanned aerial vehicle acquired every the preset period can be deemed as the real-time acquisition of the motion status information of the unmanned aerial vehicle.

Step 110: at least one unmanned aerial vehicle control instruction is generated based on the motion status information.

Different unmanned aerial vehicle control instructions are generated based on different motion status information. The unmanned aerial vehicle control instruction generated in the embodiment of the present disclosure includes all the unmanned aerial vehicle control instructions generated by existing controls for remote unmanned aerial vehicle, for example, the instruction for controlling the flight of the unmanned aerial vehicle to a specific position, the instruction for controlling the flight of the unmanned aerial vehicle at a specific linear velocity, the instruction for controlling the flight of the unmanned aerial vehicle to a specific height, the instruction for controlling the hovering of the unmanned aerial vehicle at a specific height, the instruction for controlling the rotation of the unmanned aerial vehicle at a specific angular velocity and an instruction for controlling the orientation of the head of the unmanned aerial vehicle towards a specific direction. The specific position refers to any spatial position that can be represented by coordinates used in the international coordinate system or by relative coordinates which take the unmanned aerial vehicle as the origin of coordinates. In specific implementations, an unmanned aerial vehicle control instruction can be generated according to the change tendency of one or more of the linear acceleration, the linear velocity, the angular acceleration and the angular velocity of the unmanned aerial vehicle that are acquired in real time. For example, an instruction for controlling the unmanned aerial vehicle to flight back to the initial position of the unmanned aerial vehicle is generated according to the change tendency of the horizontal linear acceleration of the unmanned aerial vehicle, and an instruction for controlling the orientation of the head of the unmanned aerial vehicle or the rotation of the unmanned aerial vehicle is generated according to the change tendency of the angular velocity or angular acceleration of the unmanned aerial vehicle.

Step 120: the unmanned aerial vehicle is controlled according to the at least one unmanned aerial vehicle control instruction to perform the corresponding flight action.

Because the tendency of the motion of the unmanned aerial vehicle changes when the direction and the magnitude of the external force applied by the user to the unmanned aerial vehicle change, at least one unmanned aerial vehicle control instruction can be generated based on the motion status information of the unmanned aerial vehicle. The unmanned aerial vehicle can be controlled according to the unmanned aerial vehicle control instruction generated in the foregoing steps to perform a corresponding flight action such as hovering, rotation, fly-up, fly-down, horizontal flight and horizontal rotation. How to control the unmanned aerial vehicle to perform the corresponding flight action according to the at least one unmanned aerial vehicle control instruction can be realized used existing technologies which are not described here repeatedly.

By obtaining (or acquiring), in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force; generating at least one unmanned aerial vehicle control instruction based on the motion status information and controlling the unmanned aerial vehicle to perform the corresponding flight action according to the at least one unmanned aerial vehicle control instruction, the unmanned aerial vehicle control method disclosed herein addresses the problem that existing unmanned aerial vehicle control methods which at least request the user of an unmanned aerial vehicle to master a high-standard control technology are not applicable to ordinary users. After an unmanned aerial vehicle moves under the effect of a user-applied external force, the control method disclosed herein further controls the unmanned aerial vehicle to perform a corresponding flight action according to the current motion tendency of the unmanned aerial vehicle, thus freeing the user from mastering a complicated unmanned aerial vehicle control technology, reducing the difficulty of the control over the unmanned aerial vehicle and making the unmanned aerial vehicle more applicable.

Embodiment 2

An unmanned aerial vehicle control method is provided in the embodiment which, as shown in Fig. 2, includes the following steps 200-230.

Step 200: the hovering status information of an unmanned aerial vehicle is acquired.

The hovering status information includes: the initial position of the unmanned aerial vehicle and the initial direction of the head of the unmanned aerial vehicle, wherein the initial position of the unmanned aerial vehicle includes the initial horizontal position and the initial height of the unmanned aerial vehicle. The unique initial position of unmanned aerial vehicle can be determined by the initial horizontal position and the initial height of the unmanned aerial vehicle, and the initial direction of the head of the unmanned aerial vehicle is the direction of the head of the unmanned aerial vehicle in a hovering state.

When not subjected to a manually-applied external force, the unmanned aerial vehicle stays in a hovering state, that is, the unmanned aerial vehicle hovers at a specific height with the direction of its head unchanged so as to stay at the initial horizontal position. In specific implementations, the current position, for example, the horizontal position and the height, of the unmanned aerial vehicle is acquired by a GPS module, a camera, a laser sensor or the like that is installed on the unmanned aerial vehicle, and the linear velocity of the unmanned aerial vehicle in motion is measured. The angular velocity and the angular acceleration of the unmanned aerial vehicle are measured by a gyroscope, a magnetometer or an accelerometer that are arranged on the unmanned aerial vehicle. In specific implementations, the initial position of the unmanned aerial vehicle can be represented with coordinates of a GPS.

The hovering state information of the unmanned aerial vehicle can be acquired used existing related methods which are not described here repeatedly.

Step 210: the motion status information of the unmanned aerial vehicle moving under the effect of a user-applied external force is acquired in real time.

The motion status information of the unmanned aerial vehicle includes at least one of: the linear acceleration and the angular velocity of the unmanned aerial vehicle. In specific implementations, the direction of the linear acceleration of the unmanned aerial vehicle is the direction of the user-applied external force and therefore can be any spatial direction. The linear acceleration of the unmanned aerial vehicle can be directly represented to the magnitude and the direction of a linear acceleration or by the horizontal direction and the magnitude of a horizontal linear acceleration plus the vertical direction and the magnitude of a vertical linear acceleration or by the magnitude of a linear acceleration in the X-axis direction, the magnitude of a linear acceleration in the Y-axis direction and the magnitude of a linear acceleration in the Z-axis direction in a spatial coordinate system. No limitations are given here to the specific representation of a linear acceleration, in specific implementations, the linear acceleration mentioned herein may be represented with any linear acceleration representation form. In the embodiment, to make the unmanned aerial vehicle control method understood better, the unmanned aerial vehicle control method is described in detail based on an example of the representation of a linear acceleration with a horizontal linear acceleration and a linear acceleration. The motion status information of the unmanned aerial vehicle acquired reflects the magnitude and the direction of the external force applied by the user to the unmanned aerial vehicle, and in specific implementations, an unmanned aerial vehicle control instruction is generated according to the change tendency of the motion status information of the unmanned aerial vehicle acquired.

When the external force applied by the user to the unmanned aerial vehicle changes in direction or magnitude, the motion status of the unmanned aerial vehicle changes, so does the motion status information of the unmanned aerial vehicle acquired. In specific implementations, after the unmanned aerial vehicle starts moving under an external force applied by the controller, the motion state information of the unmanned aerial vehicle acquired may be included: the angular velocity of the unmanned aerial vehicle; the horizontal linear acceleration of the unmanned aerial vehicle; the vertical linear acceleration of the unmanned aerial vehicle; the angular velocity and the horizontal linear acceleration of the unmanned aerial vehicle; the angular velocity and the vertical linear acceleration of the unmanned aerial vehicle; the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle; and the angular velocity, the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle.

In specific implementations, the angular velocity of the unmanned aerial vehicle can be acquired by a gyroscope installed on the unmanned aerial vehicle, and the acceleration of the unmanned aerial vehicle can be acquired by an acceleration sensor installed on the unmanned aerial vehicle. The linear acceleration of the unmanned aerial vehicle includes the horizontal linear acceleration and the vertical linear acceleration of the unmanned aerial vehicle. The horizontal linear acceleration includes the accelerations in two dimensions of a horizontal plane, and in specific implementations, for the sake of convenience of control, a horizontal linear acceleration can be generated according to the accelerations in two dimensions of a horizontal plane. The generated horizontal acceleration has two attributes: acceleration magnitude and acceleration direction.

Step 220: at least one unmanned aerial vehicle control instruction is generated based on the motion status information.

Different unmanned aerial vehicle control instructions are generated based on different motion status information. The unmanned aerial vehicle control instruction generated in the embodiment includes all the unmanned aerial vehicle control instructions generated by existing remote controls for unmanned aerial vehicles. The generation of at least one unmanned aerial vehicle control instruction based on the motion status information is described below in detail. The motion status information acquired includes one or more of: the horizontal linear acceleration, the vertical linear acceleration and the angular velocity of the unmanned aerial vehicle. The embodiment of the present disclosure, the motion status information is described based on a linear motion and a rotation motion. The motion status information of the unmanned aerial vehicle performed a linear action includes: the linear acceleration and the linear velocity of the unmanned aerial vehicle. The motion status information of the unmanned aerial vehicle performed a rotation action includes: the angular velocity and the angular acceleration of the unmanned aerial vehicle. The motion status information of the unmanned aerial vehicle synchronously performing a linearly action and a rotation action includes the linear acceleration, the linear velocity, the angular velocity and the angular acceleration of the unmanned aerial vehicle. In specific implementations, the unmanned aerial vehicle can be controlled to perform corresponding flight actions by separately generating a linear motion control instruction and a rotation motion control instruction. To be understood better, the motion status information of the unmanned aerial vehicle is described by type.

Type 1: the motion status information of the unmanned aerial vehicle includes: the linear velocity and the linear acceleration of the unmanned aerial vehicle.

Generating at least one unmanned aerial vehicle control instruction based on the motion status information includes: determining, according to the change tendency of the linear acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force, if so, generating a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof, otherwise, generating an unmanned aerial vehicle control instruction according to the linear velocity of the unmanned aerial vehicle acquired in real time.

By taking the motion status information being the horizontal linear acceleration of the unmanned aerial vehicle as an example, the step of determining, according to the change tendency of the linear acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force includes: determining that the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force if the interval between a first time point at which the horizontal linear acceleration of the unmanned aerial vehicle increases to a first acceleration threshold and a second time point at which the peak horizontal linear acceleration of the unmanned aerial vehicle is attenuated to the first acceleration threshold is smaller than a first time threshold, or determining that the user-applied external force under which the unmanned aerial vehicle starts moving is not an interferential external force if the interval between the first time point and the second time point is equal to or greater than the first time threshold.

The horizontal linear acceleration of the unmanned aerial vehicle is nearly zero when the unmanned aerial vehicle is in the hovering state. If the user horizontally pushes the unmanned aerial vehicle in a hovering state, then the unmanned aerial vehicle starts moving under the horizontal pushing force and obtains a relatively large acceleration in the horizontal direction, thus, the horizontal linear acceleration of the unmanned aerial vehicle increases rapidly from 0 and attenuates gradually after the external force is released. In specific implementations, the horizontal linear acceleration of the unmanned aerial vehicle is acquired in real time during the process the unmanned aerial vehicle moves under the effect of an external force. First, the time point at which the horizontal linear acceleration of the unmanned aerial vehicle increases to the first acceleration threshold is marked as T1; then, the horizontal linear acceleration of the unmanned aerial vehicle increases gradually, reaches the peak when the external force is released and starts to attenuating; the time point at which the horizontal linear acceleration of the unmanned aerial vehicle is attenuated to the first acceleration threshold is marked as T2; at last, an unmanned aerial vehicle control instruction is generated according to the change tendency of the horizontal linear acceleration of the unmanned aerial vehicle. For example, the current external force is considered as an interferential external force if the interval between T2 and T1 is smaller than a first time threshold or not considered as an interferential external force if the interval between T2 and T1 is equal to or greater than the first time threshold. A first instruction for controlling the unmanned aerial vehicle to fly back to the initial horizontal position thereof is generated if the user-applied external force is an interferential external force. If the user-applied external force is not an interferential external force, an unmanned aerial vehicle control instruction, for example, an instruction for controlling the unmanned aerial vehicle to stop flying along the horizontal direction or an instruction for controlling the unmanned aerial vehicle to fly at the current linear velocity, is generated according to the linear velocity acquired in real time. By setting the condition of the change tendency of the horizontal linear acceleration, the interference caused by an external force and the interference or the error caused by the measurement of acceleration can be eliminated effectively. In specific implementations, the linear velocity of the unmanned aerial vehicle in motion can be measured by a device, for example, a GPS module, a camera and a laser sensor, arranged on the unmanned aerial vehicle. The acquisition of the current linear velocity of the unmanned aerial vehicle can be realized used existing related methods which are not described here repeatedly.

By taking the motion status information being the vertical linear acceleration of the unmanned aerial vehicle as an example, determining, according to the change tendency of the linear acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force includes: determining that the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force if the interval between a third time point at which the vertical linear acceleration of the unmanned aerial vehicle increases to a second acceleration threshold and a fourth time point at which the peak vertical linear acceleration of the unmanned aerial vehicle is attenuated to the second acceleration threshold is smaller than a second time threshold, or determining that the external force applied by the user to the unmanned aerial vehicle is not an interferential external force if the interval between the third time point and the fourth time point is equal to or greater than the second time threshold. In the embodiment, the vertical linear acceleration of the unmanned aerial vehicle is a linear acceleration generated under the effect of the user-applied external force, not including the acceleration of gravity. In specific implementations, if the vertical linear velocity measured by the acceleration sensor of the unmanned aerial vehicle includes the acceleration of gravity, the vertical linear acceleration generated under the effect of an external force applied by the user can be calculated by adding or subtracting the acceleration of gravity to or from the vertical linear acceleration obtained by the acceleration sensor in the direction of the vertical linear acceleration.

Because the vertical linear acceleration of the unmanned aerial vehicle in a hovering state is 0, the flight control system of the unmanned aerial vehicle generates, for the unmanned aerial vehicle, a force equal in magnitude to but opposite in direction to the gravity to counteract the gravity. When the user vertically pushes/pulls the unmanned aerial vehicle in a hovering state, the unmanned aerial vehicle starts moving under the vertical pushing/pulling force and obtains, in the vertical direction, an acceleration different from the acceleration of gravity, thus, the vertical acceleration of the unmanned aerial vehicle increases gradually from 0 under the user-applied external force and attenuates gradually after the external force is released. In specific implementations, the vertical linear acceleration of the unmanned aerial vehicle is acquired in real time during the process the unmanned aerial vehicle moves under the effect of an external force. First, the time point at which the vertical linear acceleration of the unmanned aerial vehicle increases to the second acceleration threshold is marked as T3; then, the vertical linear acceleration of the unmanned aerial vehicle increases gradually, reaches the peak when the external force is released and then starts to attenuate; the time point at which the vertical linear acceleration of the unmanned aerial vehicle is attenuated to the second acceleration threshold is marked as T4; at last, an unmanned aerial vehicle control instruction is generated according to the change tendency of the vertical linear acceleration of the unmanned aerial vehicle. For example, the current user-applied external force is considered as an interferential external force if the interval between T3 and T4 is smaller than the second time threshold or not considered as an interferential external force if the interval between T3 and T4 is equal to or greater than the second time threshold. If the user-applied external force is not an interferential external force, an unmanned aerial vehicle control instruction, for example, an instruction for controlling the unmanned aerial vehicle to stop flying up or down or an instruction for controlling the unmanned aerial vehicle to fly at the current linear velocity, is generated according to the linear velocity acquired in real time. By setting the condition of the change tendency of the vertical linear acceleration, the interference of an external force and the interference or the error caused by the measurement of acceleration can be eliminated effectively. In specific implementations, the height of the unmanned aerial vehicle in motion can be measured by a device, for example, a GPS module, a camera and a laser sensor, arranged on the unmanned aerial vehicle. The acquisition of the current height of the unmanned aerial vehicle can be realized using existing related methods which are not described here repeatedly.

In specific implementations, the step of generating an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time includes: generating a second instruction for controlling the unmanned aerial vehicle to fly at the linear velocity acquired in real time if the linear velocity acquired in real time is greater than a preset linear velocity threshold; or generating a third instruction for controlling the unmanned aerial vehicle to stop flying in the direction of the current linear velocity if the linear velocity acquired in real time is smaller than or equal to the preset linear velocity threshold. The motion status information of the unmanned aerial vehicle moving under the effect of a user-applied external force is acquired in real time when the unmanned aerial vehicle is in a hovering state or the unmanned aerial vehicle in a hovering state starts moving under the effect of the user-applied external force. If the acquired motion status information includes the linear velocity of the unmanned aerial vehicle, then in the embodiment based on an example of the inclusion of the horizontal linear velocity of the unmanned aerial vehicle in the linear velocity acquired in real time, an unmanned aerial vehicle control instruction is generated according to the linear velocity of the unmanned aerial vehicle acquired in real time after the user-applied external force is determined not to be an interferential external force. For example, if the horizontal linear velocity of the unmanned aerial vehicle corresponding to the second time point is greater than a preset linear velocity threshold, then an instruction for controlling the unmanned aerial vehicle to fly at the horizontal linear velocity of the unmanned aerial vehicle corresponding to the second time point is generated, otherwise, a third instruction for controlling the unmanned aerial vehicle to stop flying in the direction of the current linear velocity is generated to keep the unmanned aerial vehicle at the current horizontal position. In a case where the linear acceleration acquired in real time is represented with the magnitude and the direction of the linear acceleration of the unmanned aerial vehicle, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force can be determined directly according to the change tendency of the magnitude of the linear acceleration of the unmanned aerial vehicle; if the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force, then an instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof in the direction of the linear acceleration is generated, otherwise, an unmanned aerial vehicle control instruction is generated according to the linear velocity acquired in real time. In the generation of an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time, if the linear velocity acquired in real time is smaller than or equal to a preset linear velocity threshold, a third instruction for controlling the unmanned aerial vehicle to stop flying in the direction of the current linear velocity is generated, otherwise, an instruction for controlling the unmanned aerial vehicle to fly in the direction and the magnitude of the linear velocity acquired in real time is generated.

Type 2: the motion status information of the unmanned aerial vehicle includes: the angular velocity and the angular acceleration of the unmanned aerial vehicle.

If the motion status information of the unmanned aerial vehicle includes the angular velocity and the angular acceleration of the unmanned aerial vehicle, then the step of generating at least one unmanned aerial vehicle control instruction according to the motion status information of the unmanned aerial vehicle includes: determining whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force according to the change tendency of the angular velocity or angular acceleration acquired in real time, if so, generating a fourth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle, otherwise, generating an unmanned aerial vehicle control instruction according to the angular velocity acquired in real time.

By taking the inclusion of the angular velocity of the unmanned aerial vehicle in the motion status information as an example, the step of determining whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force according to the change tendency of the angular velocity acquired in real time includes: determining that the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force if the interval between a fifth time point at which the angular velocity of the unmanned aerial vehicle increases to a first angular velocity threshold and a sixth time point at which the angular velocity reaches the peak is smaller than a third time threshold, or determining that the user-applied external force under which the unmanned aerial vehicle starts moving is not an interferential external force if the interval between the fifth time point and the sixth time point is equal to or greater than the third time threshold.

The angular velocity of the unmanned aerial vehicle in a hovering state is zero. When the user rotates the unmanned aerial vehicle, the unmanned aerial vehicle starts rotating under the user-applied external force and rotates at a gradually increased speed, the rotation speed of the unmanned aerial vehicle reaches the peak when the user-applied external force is released and then starts attenuating. The real-time angular velocity of the unmanned aerial vehicle can be obtained by an angular velocity sensor, for example, a gyroscope, arranged on the unmanned aerial vehicle during the rotation process of the unmanned aerial vehicle. The angular velocity of the unmanned aerial vehicle is acquired in real time during the process the unmanned aerial vehicle in a hovering state starts rotating. First, the time point at which the angular velocity of the unmanned aerial vehicle increases to a first angular velocity threshold is marked as T5; then, the angular velocity of the unmanned aerial vehicle increases gradually and reaches the peak when the user-applied external force is released and then starts attenuating; the time point at which the angular velocity of the unmanned aerial vehicle reaches the peak, that is, the time point at which the angular velocity of the unmanned aerial vehicle starts attenuating, is marked as T6; at last, an unmanned aerial vehicle control instruction is generated according to the change tendency of the angular velocity of the unmanned aerial vehicle. For example, the current user-applied external force is considered as an interferential external force if the interval between T6 and T5 is smaller than a third time threshold or not considered as an interferential external force if the interval between T6 and T5 is equal to or greater than the third time threshold. If the current user-applied external force is an interferential external force, then a fourth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle is generated, otherwise, a sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time is generated to control the unmanned aerial vehicle to rotate along the direction from which the user applies the external force.

The angular velocity of the unmanned aerial vehicle moving under the effect of the user-applied external force is acquired in real time when the unmanned aerial vehicle is in a hovering state and when the unmanned aerial vehicle in a hovering state starts moving under the effect of a user-applied external force. After the user-applied external force is determined not to be an interferential external force, the step of generating an unmanned aerial vehicle control instruction according to the angular velocity acquired in real time includes: generating a fifth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the current direction if the angular velocity acquired in real time is smaller than or equal to a preset angular velocity threshold; or generating a sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time if the angular velocity acquired in real time is greater than the preset angular velocity threshold. For example, an instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity of the unmanned aerial vehicle corresponding to the sixth time point is generated after the rotational angular velocity of the unmanned aerial vehicle corresponding to the sixth time point is acquired in real time. By setting the condition of the change tendency of the angular velocity, the interference of an external force and the interference or the error caused by the measurement of an angular velocity can be eliminated effectively. In specific implementations, the acquisition of the angular velocity of the unmanned aerial vehicle can be realized using existing related methods which are not described here repeatedly.

In a case where the motion status information includes the angular acceleration of the unmanned aerial vehicle, determining whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force according to the change tendency of the angular acceleration acquired in real time includes: determining that the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force if the interval between a seventh time point at which the angular acceleration of the unmanned aerial vehicle increases to a first angular acceleration threshold and an eight time point at which the peak angular acceleration of the unmanned aerial vehicle is attenuated to the first angular acceleration threshold is smaller than a fourth time threshold, or determining that the user-applied external force under which the unmanned aerial vehicle starts moving is not an interferential external force if the interval between the seventh time point and the eight time point is equal to or greater than the fourth time threshold. The process of determining whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force according to the change tendency of the angular acceleration of the unmanned aerial vehicle can be understood with reference to the process of determining whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force according to the change tendency of the linear acceleration of the unmanned aerial vehicle and is therefore not described here repeatedly.

In specific implementations, the first and the second time threshold can be set according to a user-desired control sensitivity. In specific implementations, the first and the second acceleration threshold and the angular velocity threshold can also be set according to the user-desired control sensitivity. For example, the first time threshold may be set to be above 200ms, and the first acceleration threshold may be set to be 0.2g, wherein g represents the acceleration of gravity. The preset linear velocity threshold may be 0 or a value greater than 0, depending on the requirement of the user on control sensitivity.

Step 230: the unmanned aerial vehicle is controlled according to the at least one unmanned aerial vehicle control instruction to perform a corresponding flight action.

Because the tendency of the motion of the unmanned aerial vehicle changes when the external force applied by the user to the unmanned aerial vehicle changes in magnitude or direction, at least one unmanned aerial vehicle control instruction can be generated based on the motion status information of the unmanned aerial vehicle. In the embodiment, the unmanned aerial vehicle control instructions generated in the foregoing steps include, but are not limited to: a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof, an instruction for controlling the unmanned aerial vehicle to fly at a certain linear velocity, an instruction for controlling the unmanned aerial vehicle to stop flying at a certain linear velocity, an instruction for controlling the unmanned aerial vehicle to hover, an instruction for controlling the unmanned aerial vehicle to stay at the current position, an instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle and an instruction for controlling the unmanned aerial vehicle to rotate at a certain angular velocity.

In specific implementations, each of the instructions is sent to a flight control module arranged on the unmanned aerial vehicle to control the unmanned aerial vehicle to perform a corresponding flight action under the effect of a user-applied external force. How to control the unmanned aerial vehicle to perform a corresponding flight action according to an unmanned aerial vehicle control instruction can be realized using existing technologies which are not described here repeatedly.

According to the flight control instruction generated in the Step 220, the unmanned aerial vehicle performs a flight action corresponding to the user-applied external force, for example, under a horizontal pushing/pulling force, the unmanned aerial vehicle flies horizontally along the direction of the external force; under a rotational external force, the unmanned aerial vehicle flies rotationally along the direction of the external force; under a vertical external force, the unmanned aerial vehicle flies up or down to a certain height along the direction of the external force; and under a horizontal pushing/pulling force and a rotational external force, the unmanned aerial vehicle flies horizontally and rotationally along the direction of the horizontal external force.

The flight status information of the unmanned aerial vehicle is acquired in real time when the unmanned aerial vehicle flies under the effect of a user-applied external force so as to acquire the real-time linear velocity, the real-time angular velocity, the linear acceleration, the current position and other flight status information of the unmanned aerial vehicle, and at least one unmanned aerial vehicle control instruction is generated based on the motion status information acquired in real time. In specific implementations, the flight status information of the unmanned aerial vehicle can be acquired using existing related methods which are not described here repeatedly.

By controlling the unmanned aerial vehicle to perform a corresponding flight action under the effect of a user-applied external force, more flight actions can be realized, for example, the unmanned aerial vehicle can be controlled to fly at a gradually attenuated linear velocity in response to a user-applied external force, or rotate at a gradually attenuated angular velocity, or rotationally fly at a gradually attenuated linear velocity and a gradually attenuated angular velocity. In specific implementations, during the process the unmanned aerial vehicle flies according to the second instruction for controlling the unmanned aerial vehicle to fly at the linear velocity acquired in real time, the method further includes: attenuating the linear velocity of the unmanned aerial vehicle acquired in real time by a first attenuation factor based on every preset period; and generating a second instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity. In specific implementations, the preset period may be set to be 30ms, that is, the linear velocity of the unmanned aerial vehicle acquired in real time is attenuated every 30ms. If the linear velocity of the unmanned aerial vehicle acquired in real time is greater than the first linear velocity threshold, then the linear velocity is attenuated by the first attenuation factor, and the second instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity is generated, otherwise, the third instruction for controlling the unmanned aerial vehicle to stop flying in the direction of the current linear velocity is generated.

In specific implementations, the rate at which the linear velocity of the unmanned aerial vehicle attenuation is a fixed value set by the user or set in advance, the larger the attenuation factor is, the faster the linear velocity attenuates. the smaller the attenuation factor is, the slower the linear velocity attenuates. The larger the external force applied by the user is, the further the unmanned aerial vehicle flies. The smaller the external force applied by the user is, the closer the unmanned aerial vehicle flies. The linear velocity V of the unmanned aerial vehicle is acquired in real time when the unmanned aerial vehicle flies under the effect of a user-applied external force, and the acquired linear velocity is attenuated by the preset first attenuation factor when the linear velocity V is greater than a first linear velocity threshold V_{th}. By taking the acquired real-time linear velocity V as an example, if the first attenuation factor is set to be a_1, then the attenuated linear velocity may be $(V- a_1*t)$, in which t represents the preset period. The unmanned aerial vehicle is controlled to fly at a velocity of $(V- a_1*t)$. The unmanned aerial vehicle is controlled to stay at the current position when the linear velocity V of the unmanned aerial vehicle is smaller than or equal to the first linear velocity threshold V_{th}. The first linear velocity threshold V_{th} may be 10cm/s. The linear velocity of the unmanned aerial vehicle being smaller than or equal to the first linear velocity threshold V_{th} indicates that the unmanned aerial vehicle faces an obstacle or is caught by the user, or that the linear velocity cannot be attenuated any more.

During the process the unmanned aerial vehicle rotates according to the sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time, the method further includes: attenuating, by a second attenuation factor, the angular velocity of the unmanned aerial vehicle acquired in real time every a preset period; and generating the sixth instruction for controlling the unmanned aerial vehicle to rotate at the attenuated angular velocity. In specific implementations, the preset period may be set to be 30ms or less than 30ms, that is, the angular velocity of the unmanned aerial vehicle acquired in real time is attenuated every 30ms. If the angular velocity of the unmanned aerial vehicle acquired in real time is greater than a second angular velocity threshold, then the angular velocity is attenuated by the second attenuation factor, and an instruction for controlling the unmanned aerial vehicle to fly at the attenuated angular velocity is generated, otherwise, an instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction is generated, or a fifth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the current direction is generated.

Similarly, the rate at which the angular velocity attenuation is a fixed value set by the user or set in advance, the higher the attenuation factor is, the faster the angular velocity attenuates. The angular velocity ω of the unmanned aerial vehicle is acquired in real time when the unmanned aerial vehicle rotationally flies under the effect of a user-applied external force, and the acquired angular velocity is attenuated according to a preset second attenuation factor a_2 when the angular velocity ω is greater than a second angular velocity threshold ω_{th}, the attenuated angular velocity can be (ω- a_2*t), and then, the unmanned aerial vehicle is controlled to fly rotationally at the speed of (ω-a_2*t). The unmanned aerial vehicle is controlled to stop rotating when the angular velocity ω is smaller than or equal to the second angular velocity threshold ω_{th}. The second angular velocity threshold ω_{th} may be 3°/s. The angular velocity of the unmanned aerial vehicle being smaller than or equal to the second angular velocity threshold ω_{th}, indicates that the unmanned aerial vehicle faces an obstacle or is caught by the user, or that the angular velocity cannot attenuate any more.

In specific implementations, if the unmanned aerial vehicle flies linearly at a certain linear velocity and synchronously flies rotationally at a certain angular velocity, then the attenuation rate of the angular velocity of the unmanned aerial vehicle can be determined according to the initial linear velocity of the unmanned aerial vehicle and a linear velocity attenuation rate so that the linear velocity and the angular velocity of the unmanned aerial vehicle are attenuated to 0 at the same time. For example, the second attenuation factor is determined according to the linear velocity of the unmanned aerial vehicle corresponding to the second time point at which the horizontal linear acceleration of the unmanned aerial vehicle is attenuated to the first acceleration threshold, the first attenuation factor and the angular velocity of the unmanned aerial vehicle corresponding to the fourth time point at which the angular velocity of the unmanned aerial vehicle increases to the peek. If the initial linear velocity of the unmanned aerial vehicle is V_0 and the first attenuation factor is a_0, then the time t needed for the attenuation of the linear velocity of the unmanned aerial vehicle from an initial value V_0 to 0 can be calculated using the following formula: $t=V_0/a_0$; and if the initial rotational angular velocity of the unmanned aerial vehicle is ω_0 and the second attenuation factor is ω_0/t, then the angular velocity of the unmanned aerial vehicle is attenuated to 0 when the linear velocity of the unmanned aerial vehicle is attenuated to 0.

The unmanned aerial vehicle can be controlled by more than one user to perform corresponding flight actions under user-applied external forces, for example, after being pushed to a second user from a first user, the unmanned aerial vehicle hovers when the linear velocity thereof attenuates to the first linear velocity threshold and then performs a corresponding flight action under the effect of an external force applied by the second user. In specific implementations, if the second user applies an external force to the flying unmanned aerial vehicle when the attenuated linear velocity of the unmanned aerial vehicle fails to reach the first linear velocity threshold, then the unmanned aerial vehicle performs a corresponding flight action under the effect of the external force applied by the second user. Alternatively, the velocity of the unmanned aerial vehicle drops to 0 when the unmanned aerial vehicle is caught by the second user during the process the unmanned aerial vehicle pushed from the first user to the second user is in motion, that is, when the velocity of the unmanned aerial vehicle fails to attenuate to the first linear velocity threshold. Then, an instruction for controlling the unmanned aerial vehicle to hover is generated to make the unmanned aerial vehicle hover at the current position; if the second user applies an external force vertical in direction to the direction of the motion of the unmanned aerial vehicle, then the unmanned aerial vehicle moves along the direction of the external force applied by the second user under the effect of the external force applied by the second user, in this case, an acceleration and a linear velocity which are identical in direction to the external force applied by the second user can be acquired, and then an instruction for controlling the unmanned aerial vehicle to fly at the current linear velocity is generated.

In another embodiment of the present disclosure, the unmanned aerial vehicle can be controlled to perform a flight action of simulating the movement of a boomerang. The unmanned aerial vehicle control method further includes a step of setting the flight mode of the unmanned aerial vehicle to be a boomerang mode before the step of acquiring, in real time, the motion status information of the unmanned aerial vehicle moving under the effect of a user-applied external force. The boomerang mode refers to a mode in which the unmanned aerial vehicle starts flying under the effect of a user-applied external force, flies along the direction of the user-applied external force at a gradually decreased speed and then flies back to the initial position of the unmanned aerial vehicle when the speed of the unmanned aerial vehicle is reduced to a preset threshold. The step of generating an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time further includes: generating a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the linear velocity of the unmanned aerial vehicle acquired in real time is smaller than or equal to a preset linear velocity threshold and the flight mode of the unmanned aerial vehicle is the boomerang mode. In specific implementations, during the process the unmanned aerial vehicle flies according to a second instruction for controlling the unmanned aerial vehicle to fly at the linear velocity acquired in real time, the linear velocity of the unmanned aerial vehicle acquired in real time is attenuated according to a first attenuation factor every a preset period. Then, a determination is made on the attenuated linear velocity of the unmanned aerial vehicle, if the attenuated linear velocity of the unmanned aerial vehicle is smaller than or equal to a preset linear velocity threshold and the flight mode of the unmanned aerial vehicle is the boomerang mode, then the first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof is generated, wherein the initial position refers to the position where the unmanned aerial vehicle hovers last time; if the attenuated linear velocity is smaller than or equal to the preset linear velocity threshold but the flight mode of the unmanned aerial vehicle is not the boomerang mode, the third instruction for controlling the unmanned aerial vehicle to stop flying along the direction of the current linear velocity is generated; and if the attenuated linear velocity is greater than the preset linear velocity threshold, then the second instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity is generated. If the unmanned aerial vehicle flies at the current linear velocity and synchronously rotates at a certain angular velocity, then the angular velocity of the unmanned aerial vehicle, after being acquired, is attenuated by a third attenuation factor when the acquired angular velocity is greater than the second angular velocity threshold, and an instruction for controlling the unmanned aerial vehicle to fly at the attenuated angular velocity is generated, or an instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle or the current direction is generated when the acquired angular velocity is not greater than the second angular velocity threshold.

For example, if the user applies a horizontal external force to the unmanned aerial vehicle in a hovering state and synchronously rotates the unmanned aerial vehicle, then the unmanned aerial vehicle moves fast in the direction of the horizontal external force and synchronously rotates at a certain angular velocity under the effect of the horizontal external force. The linear velocity V of the unmanned aerial vehicle is acquired in real time when the unmanned aerial vehicle flies under the effect of the user-applied external force, and the acquired linear velocity is attenuated by the preset first attenuation factor when the linear velocity V is greater than the first linear velocity threshold V_{th}. By taking the acquired real-time linear velocity V as an example, if the first attenuation factor is set to be a_1, then the attenuated linear velocity may be ($V- a_1*t$). Then, the unmanned aerial vehicle is controlled to fly at the velocity of ($V- a_1*t$). The unmanned aerial vehicle is controlled to fly back to the initial position thereof, that is, fly along the direction opposite to the direction of the user-applied external force, to get back to the position where the unmanned aerial vehicle hovers last time, when the linear velocity V of the unmanned aerial vehicle is smaller than or equal to the first linear velocity threshold V_{th}. The unmanned aerial vehicle may be controlled to fly back to the initial position thereof at an unchanged speed, or initially at the linear velocity of the unmanned aerial vehicle corresponding to the time point at which the horizontal linear acceleration of the unmanned aerial vehicle is attenuated to the first acceleration threshold and then at a gradually attenuated linear velocity which is calculated by attenuating the initial linear velocity by the first attenuation factor. Meanwhile, the angular velocity ω of the unmanned aerial vehicle is acquired in real time, and the acquired angular velocity is attenuated by a preset third attenuation factor a_3 when the angular velocity ω is greater than the second angular velocity threshold ω_{th}, the attenuated angular velocity can be (ω- a_3*t), and then, the unmanned aerial vehicle flies rotationally at the speed of (ω- a_3*t) until the angular velocity thereof is below the second angular velocity threshold. In specific implementations, the third attenuation factor is determined according to the linear velocity of the unmanned aerial vehicle corresponding to the time point at which the horizontal linear acceleration of the unmanned aerial vehicle is attenuated to the first acceleration threshold, the first attenuation factor, the angular velocity of the unmanned aerial vehicle corresponding to the time point at which the angular velocity of the unmanned aerial vehicle increases to the peek and the linear velocity of the unmanned aerial vehicle back to the initial position thereof. In specific implementations, the first attenuation factor is below the initial linear velocity of the unmanned aerial vehicle corresponding to the time point at which the external force is released, and the second attenuation factor is below the initial linear acceleration of the unmanned aerial vehicle corresponding to the time point at which the external force is released. No limitations are given here to the setting of the attenuation factors of the linear velocity and the angular velocity of the unmanned aerial vehicle in a flying state.

In specific implementations, the flight modes of the unmanned aerial vehicle may be set to control the flight actions the unmanned aerial vehicle performs under the effect of a user-applied external force. For example, in a case where the flight modes of the unmanned aerial vehicle is set to be the boomerang mode, if the user applies a relatively large external force to the unmanned aerial vehicle, then the unmanned aerial vehicle flies at a gradually reduced speed under the effect of the user-applied external force until the speed thereof is attenuated to the first linear velocity threshold, and then the unmanned aerial vehicle flies back to the initial position thereof at a gradually increased linear velocity or at an unchanged speed. In a case where the flight modes of the unmanned aerial vehicle is set to be a drift mode, if the user applies a relatively large external force to the unmanned aerial vehicle, then the unmanned aerial vehicle flies at a gradually reduced speed under the effect of the user-applied external force until the speed thereof is attenuated to the first linear velocity threshold, and then the unmanned aerial vehicle hovers at the current position. That is, when the unmanned aerial vehicle flies under the effect of a user-applied external force, the linear velocity and the angular velocity of the flying unmanned aerial vehicle can be controlled in real time according to the set flight mode so that the unmanned aerial vehicle performs a flight action corresponding to the external force.

During an unmanned aerial vehicle control process, the unmanned aerial vehicle moves under a user-applied external force, the motion status information, for example, the linear acceleration, the linear velocity, and the angular velocity, of the unmanned aerial vehicle is acquired in real time, and an unmanned aerial vehicle control instruction is generated according to the motion status information acquired.

The preset period, the preset velocity threshold, the acceleration threshold and the time threshold mentioned herein can be experientially set in a control program in advance or set by the user on the operation interface of the unmanned aerial vehicle as needed before the user controls the unmanned aerial vehicle to perform a corresponding flight action, and no limitations are given to the setting of the thresholds and periods mentioned herein.

By obtaining (or acquiring), in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force; generating at least one unmanned aerial vehicle control instruction based on the motion status information and controlling the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction, the unmanned aerial vehicle control method disclosed herein addresses the problem that existing unmanned aerial vehicle control methods which at least request the user of an unmanned aerial vehicle to master a high-standard control technology are not applicable to ordinary users. After an unmanned aerial vehicle moves under the effect of a user-applied external force, the control method disclosed herein further controls the unmanned aerial vehicle to perform a corresponding flight action according to the current motion tendency of the unmanned aerial vehicle, thus freeing the user from mastering a complicated unmanned aerial vehicle control technology, reducing the difficulty of the control over the unmanned aerial vehicle and making the unmanned aerial vehicle more applicable. Moreover, the method and the apparatus disclosed herein enable more than one user to control the same unmanned aerial vehicle, thus improving the operability and the controllability of the unmanned aerial vehicle.

Embodiment 3

As shown in Fig. 3, an unmanned aerial vehicle control apparatus is provided which includes:

a motion status information acquisition module 310 configured to acquire, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force;

a control instruction generation module 320 configured to generate at least one unmanned aerial vehicle control instruction based on the motion status information acquired by the motion status information acquisition module 310; and

a flight control module 330 configured to control the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction generated by the control instruction generation module 320.

Optionally, as shown in Fig. 4, the unmanned aerial vehicle control apparatus further includes:

a hovering state information acquisition module 300 configured to acquire the hovering status information of the unmanned aerial vehicle, wherein

the hovering status information includes: the initial position of the unmanned aerial vehicle and the initial direction of the head of the unmanned aerial vehicle, wherein the initial position of the unmanned aerial vehicle includes the initial horizontal position and the initial height of the unmanned aerial vehicle. A unique initial horizontal position can be determined using the initial horizontal position and the initial height of the unmanned aerial vehicle, and the initial direction of the head of the unmanned aerial vehicle is the direction of the head of the unmanned aerial vehicle in a hovering state. In specific implementations, the initial position of the unmanned aerial vehicle can be represented with coordinates of a GPS.

Optionally, the motion status information includes: the linear acceleration and the linear velocity of the unmanned aerial vehicle, and as shown in Fig. 4, the control instruction generation module 320 includes:

a first user-applied external force determination unit 3201 configured to determine, according to the change tendency of the linear acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force;

a first interference processing unit 3202 configured to generate a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the user-applied external force is an interferential external force; and

a first external force response unit 3203 configured to generate an unmanned aerial vehicle control instruction according to the linear velocity of the unmanned aerial vehicle acquired in real time if the user-applied external force is not an interferential external force.

By setting the condition of the change tendency of the linear acceleration of the unmanned aerial vehicle, the interference of an external force and the interference or the error caused by the measurement of acceleration can be eliminated effectively.

Optionally, as shown in Fig. 4, the first external force response unit 3203 includes:

a first control instruction generation sub-unit 32031 configured to generate a second instruction for controlling the unmanned aerial vehicle to fly at the linear velocity acquired in real time if the linear velocity acquired in real time is greater than a preset linear velocity threshold; and

a second control instruction generation sub-unit 32032 configured to generate a third instruction for controlling the unmanned aerial vehicle to stop flying in the direction of the current linear velocity if the linear velocity acquired in real time is smaller than or equal to the preset linear velocity threshold.

Optionally, during the process the unmanned aerial vehicle flies according to the instruction generated by the second control instruction generation sub-unit 32032, the first external force response unit 3203 further includes:

a linear velocity attenuation sub-unit 32033 configured to attenuate, by a first attenuation factor, the linear velocity of the unmanned aerial vehicle acquired by the motion status information acquisition module 310 in real time every a preset period; and

a third control instruction generation sub-unit 32034 configured to generate a second instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity.

Optionally, the motion status information of the unmanned aerial vehicle includes: the angular acceleration and the angular velocity of the unmanned aerial vehicle, and as shown in Fig. 4, the control instruction generation module 320 further includes:

a second user-applied external force determination unit 3204 configured to determine, according to the change tendency of the angular velocity or angular acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force;

a second interference processing unit 3205 configured to generate a fourth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle if the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force; and

a second external force response unit 3206 configured to generate an unmanned aerial vehicle control instruction according to the angular velocity acquired in real time if the user-applied external force under which the unmanned aerial vehicle starts moving is not an interferential external force.

By setting the condition of the change tendency of the linear velocity and the angular velocity of the unmanned aerial vehicle, the interference of an external force and the interference or the error caused by the measurement of acceleration can be eliminated effectively.

Optionally, as shown in Fig. 4, the second external force response unit 3206 includes:

a fifth control instruction generation sub-unit 32061 configured to generate a fifth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the current direction if the angular velocity acquired in real time is smaller than or equal to a preset angular velocity threshold; and

a sixth control instruction generation sub-unit 32062 configured to generate a sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time if the angular velocity acquired in real time is greater than the preset angular velocity threshold.

Optionally, during the process the unmanned aerial vehicle rotates according to the sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time, the second external force response unit 3206 further includes:

an angular velocity attenuation sub-unit 32063 configured to attenuate, by a second attenuation factor, the angular velocity of the unmanned aerial vehicle acquired by the motion status information acquisition module 310 in real time every a preset period; and

a seventh control instruction generation sub-unit 32064 configured to generate a sixth instruction for controlling the unmanned aerial vehicle to fly at the attenuated angular velocity.

The embodiment of the present disclosure, the motion status information is described based on a linear motion and a rotation motion. The motion status information of the unmanned aerial vehicle performing a linear action includes: the linear acceleration, the linear velocity and the real-time position of the unmanned aerial vehicle; and the motion status information of the unmanned aerial vehicle performing a rotation action includes: the angular velocity and the angular acceleration of the unmanned aerial vehicle and the current direction of the head of the unmanned aerial vehicle. When the unmanned aerial vehicle performs a linear action and a rotation action synchronously, the motion status information of the unmanned aerial vehicle includes: the linear acceleration, the linear velocity, the angular velocity, the angular acceleration and the real-time position of the unmanned aerial vehicle and the current direction of the head of the unmanned aerial vehicle. In specific implementations, related linear motion information can be processed by the first user-applied external force determination unit 3201, the first interference processing unit 3202 and the first external force response unit 3203 to generate a linear motion control instruction, and related rotation motion information can be processed by the second user-applied external force determination unit 3204, the second interference processing unit 3205 and the second external force response unit 3206 to generate a rotation motion control instruction.

Optionally, as shown in Fig. 5, the unmanned aerial vehicle control apparatus further includes:

a flight mode setting module 340 configured to set the flight mode of an unmanned aerial vehicle to be a boomerang mode, wherein

the first external force response unit 3203 further includes:

a fourth control instruction generation sub-unit 32035 configured to generate a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the linear velocity of the unmanned aerial vehicle acquired in real time is smaller than or equal to a preset linear velocity threshold and the flight mode of the unmanned aerial vehicle is the boomerang mode. In specific implementations, the flight modes of an unmanned aerial vehicle can be set to control the flight actions the unmanned aerial vehicle performed under the effect of a user-applied external force. For example, in a case where the flight mode of an unmanned aerial vehicle is set to be the boomerang mode, if the user applies a relatively large external force to the unmanned aerial vehicle, then the unmanned aerial vehicle flies at a gradually reduced speed under the effect of the user-applied external force until the speed thereof is attenuated to a first linear velocity threshold and then flies back to the initial position thereof at a gradually increased linear velocity or at a fixed speed. In a case where the flight mode of an unmanned aerial vehicle is set to be a drift mode, if the user applies a relatively large external force to the unmanned aerial vehicle, then the unmanned aerial vehicle flies at a gradually reduced speed under the effect of the user-applied external force until the speed thereof is attenuated to the first linear velocity threshold and then stops flying in the direction of the current velocity. That is, when the unmanned aerial vehicle flies under the effect of a user-applied external force, the linear velocity and the angular velocity of the flying unmanned aerial vehicle can be controlled in real time according to the set flight mode of the unmanned aerial vehicle so that the unmanned aerial vehicle performs a flight action corresponding to the external force.

By obtaining (or acquiring), in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force, generating at least one unmanned aerial vehicle control instruction based on the motion status information and controlling the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction, the unmanned aerial vehicle control apparatus disclosed herein addresses the problem that existing unmanned aerial vehicle control methods which at least request the user of an unmanned aerial vehicle to master a high-standard control technology are not applicable to ordinary users. After an unmanned aerial vehicle moves under the effect of a user-applied external force, the control method disclosed herein further controls the unmanned aerial vehicle to perform a corresponding flight action according to the current motion tendency of the unmanned aerial vehicle, thus freeing the user from mastering a complicated unmanned aerial vehicle control technology, reducing the difficulty of the control over the unmanned aerial vehicle and making the unmanned aerial vehicle more applicable. Moreover, the apparatus disclosed herein enable more than one user to control the same unmanned aerial vehicle, thus improving the operability and the controllability of the unmanned aerial vehicle.

Embodiments of the apparatus disclosed herein are corresponding to the method disclosed herein, thus, the specific implementation forms of the modules in the embodiments of the apparatus can be understood with reference to embodiments of the method disclosed herein and are therefore not described here repeatedly.

Correspondingly, an unmanned aerial vehicle is disclosed which is provided with at least one acceleration measurer such as an acceleration sensor or a gyroscope; at least one velocity measurer such as a GPS module; a flight control module, a central processing unit and a memory, wherein the memory is configured to store programs for executing the unmanned aerial vehicle control methods described in embodiments 1 and 2, the central processing unit which comprises each module and each unit described in embodiment 3 executes the programs stored in the memory to execute the steps of the unmanned aerial vehicle control methods described in embodiments 1 and 2.

It should be appreciated by those of ordinary skill in the art that the units, the algorithms and the steps involved in the embodiments of the present disclosure can be realized by hardware, software or the combination thereof. Whether to realize these functions by hardware or software depends upon the specific application of a technical solution and restrictions in design. The realization of the same functions by those skilled in the art using other methods should fall within the scope of protection of the present disclosure.

It should be appreciated by those of ordinary skill in the art that the separate members involved in the embodiments of the present disclosure may be physically separated or not, or located at the same place or distributed in a plurality of network units. Moreover, the functional units involved in the embodiments of the present disclosure may be integrated in a processing unit or exist physically separately, or two or more of these functions are integrated in one unit.

These functions, when implemented as software units and sold or used as independent products, can be stored in a computer-readable storage medium. Based on the appreciation, the technical solutions of the present disclosure can be implemented as software products which can be stored in a storage medium and which comprise a plurality of instructions to execute a part of or all the steps of the methods described herein on one computer device (e.g. personal computer, server, or network device).The storage medium may be a U disk, a mobile hard disk drive, an ROM, an RAM, a diskette, a compact disc or another medium capable of storing program codes.

While certain embodiments have been described, these embodiments are not intended to limit the scope of the present disclosure. Indeed, any transformation or substitution that can be devised by those of ordinary skill in related arts without departing from the spirit of the disclosures and without making creative efforts should fall within the scope of protection of the present disclosure which is defined by the appended claims.

Claims

1. An unmanned aerial vehicle control method, comprising:

obtaining, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force;

generating at least one unmanned aerial vehicle control instruction based on the motion status information; and

controlling the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction.

2. The method according to claim 1, further comprising a step of acquiring the hovering state information of the unmanned aerial vehicle prior to the step of:

acquiring, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force, wherein the hovering state information comprises the initial position of the unmanned aerial vehicle and the initial direction of the head of the unmanned aerial vehicle.

3. The method according to claim 2, wherein the motion status information comprises the linear velocity and the linear acceleration of the unmanned aerial vehicle, and the step of generating at least one unmanned aerial vehicle control instruction based on the motion status information comprises:

determining, according to the change tendency of the linear acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force;

generating a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the user-applied external force is the interferential external force; or

generating an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time if the user-applied external force is not the interferential external force.

4. The method according to claim 3, wherein the step of generating an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time comprises:

generating a second instruction for controlling the unmanned aerial vehicle to fly at the linear velocity acquired in real time if the linear velocity acquired in real time is greater than a preset linear velocity threshold; or generating a third instruction for controlling the unmanned aerial vehicle to stop flying in the direction of the current linear velocity if the linear velocity acquired in real time is smaller than or equal to the preset linear velocity threshold.

5. The method according to claim 4, wherein during the process the unmanned aerial vehicle flies according to the second instruction acquired in real time, the method further comprises:

attenuating the linear velocity of the unmanned aerial vehicle acquired in real time by a first attenuation factor every a preset period; and

generating the second instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity.

6. The method according to claim 5, further comprising: a step of setting the flight mode of the unmanned aerial vehicle to be a boomerang mode prior to the step of:

obtaining, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force, wherein

the step of generating an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time further comprises:

generating a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the linear velocity acquired in real time is smaller than or equal to the preset linear velocity threshold and the flight mode of the unmanned aerial vehicle is the boomerang mode.

7. The method according to claim 1, wherein if the motion status information comprises the angular velocity and the angular acceleration of the unmanned aerial vehicle, then the step of generating at least one unmanned aerial vehicle control instruction based on the motion status information comprises:

determining, according to the change tendency of the angular velocity or the angular acceleration acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an interferential external force;

generating a fourth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle if the user-applied external force is an interferential external force; or

generating an unmanned aerial vehicle control instruction according to the angular velocity acquired in real time if the user-applied external force is not an interferential external force.

8. The method according to claim 7, wherein the step of generating an unmanned aerial vehicle control instruction according to the angular velocity acquired in real time comprises:

generating a fifth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the current direction if the angular velocity acquired in real time is smaller than or equal to a preset angular velocity threshold; or

generating a sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time if the angular velocity acquired in real time is greater than the preset angular velocity threshold.

9. The method according to claim 8, wherein during the process the unmanned aerial vehicle rotates according to the sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time, the method further comprises:

attenuating the angular velocity of the unmanned aerial vehicle acquired in real time by a second attenuation factor every a preset period; and

generating the sixth instruction for controlling the unmanned aerial vehicle to rotate at the attenuated angular velocity.

10. An unmanned aerial vehicle control apparatus, comprising:

a motion status information acquisition module configured to acquire, in real time, the motion status information of an unmanned aerial vehicle moving under the effect of a user-applied external force;

a control instruction generation module configured to generate at least one unmanned aerial vehicle control instruction based on the motion status information acquired by the motion status information acquisition module; and

a flight control module configured to control the unmanned aerial vehicle to perform a corresponding flight action according to the at least one unmanned aerial vehicle control instruction generated by the control instruction generation module.

11. The apparatus according to claim 10, further comprising:

a hovering state information acquisition module configured to acquire the hovering state information of the unmanned aerial vehicle,

wherein the hovering state information comprises the initial position of the unmanned aerial vehicle and the initial direction of the head of the unmanned aerial vehicle.

12. The apparatus according to claim 10, wherein the motion status information

comprises the linear velocity and the linear acceleration of the unmanned aerial vehicle, and the control instruction generation module comprises:

a first user-applied external force determination unit configured to determine, according to the change tendency of the linear acceleration acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is the external interference force;

a first interference processing unit configured to generate a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the user-applied external force is the external interference force; and

a first external force response unit configured to generate an unmanned aerial vehicle control instruction according to the linear velocity acquired in real time if the user-applied external force is not an external interference force.

13. The apparatus according to claim 12, wherein the first external force response unit comprises:

a first control instruction generation sub-unit configured to generate a second instruction for controlling the unmanned aerial vehicle to fly at the linear velocity acquired in real time if the linear velocity acquired in real time is greater than a preset linear velocity threshold; and

a second control instruction generation sub-unit configured to generate a third instruction for controlling the unmanned aerial vehicle to stop flying in the current direction at the current linear velocity if the linear velocity acquired in real time is smaller than or equal to the preset linear velocity threshold.

14. The apparatus according to claim 13, wherein during the process the unmanned aerial vehicle flies according to the instruction generated by the second control instruction generation sub-unit, the first external force response unit further comprises:

a linear velocity attenuation sub-unit configured to attenuate, by a first attenuation factor, the linear velocity of the unmanned aerial vehicle acquired by the motion status information acquisition module in real time every a preset period; and

a third control instruction generation sub-unit configured to generate the second instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity.

15. The apparatus according to claim 14, further comprising:

a flight mode setting module configured to set the flight mode of an unmanned aerial vehicle to be a boomerang mode, wherein

the first external force response unit further comprises:

a fourth control instruction generation sub-unit configured to generate a first instruction for controlling the unmanned aerial vehicle to fly back to the initial position thereof if the linear velocity acquired in real time is smaller than or equal to the preset linear velocity threshold and the flight mode of the unmanned aerial vehicle is the boomerang mode.

16. The apparatus according to claim 10, wherein if the motion status information comprises the angular velocity and the angular acceleration of the unmanned aerial vehicle, then the control instruction generation module comprises:

a second user-applied external force determination unit configured to determine, according to the change tendency of the angular velocity or angular acceleration of the unmanned aerial vehicle acquired in real time, whether or not the user-applied external force under which the unmanned aerial vehicle starts moving is an external interference force;

a second interference processing unit configured to generate a fourth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the initial direction of the head of the unmanned aerial vehicle if the user-applied external force is an external interference force; and

a second external force response unit configured to generate an unmanned aerial vehicle control instruction according to the angular velocity acquired in real time if the user-applied external force is not an interferential external force.

17. The apparatus according to claim 16, wherein the second external force response unit comprises:

a fifth control instruction generation sub-unit configured to generate a fifth instruction for controlling the orientation of the head of the unmanned aerial vehicle towards the current direction if the angular velocity acquired in real time is smaller than or equal to a preset angular velocity threshold; and

a sixth control instruction generation sub-unit configured to generate a sixth instruction for controlling the unmanned aerial vehicle to rotate at the angular velocity acquired in real time if the angular velocity acquired in real time is greater than the preset angular velocity threshold.

18. The apparatus according to claim 17, wherein during the process the unmanned aerial vehicle rotates according to the sixth instruction for controlling the

unmanned aerial vehicle to rotate at the angular velocity acquired in real time, the second external force response unit further comprises:

an angular velocity attenuation sub-unit configured to attenuate, by a second attenuation factor, the angular velocity of the unmanned aerial vehicle acquired by the motion status information acquisition module in real time every a preset period; and

a seventh control instruction generation sub-unit configured to generate the sixth instruction for controlling the unmanned aerial vehicle to fly at the attenuated linear velocity.

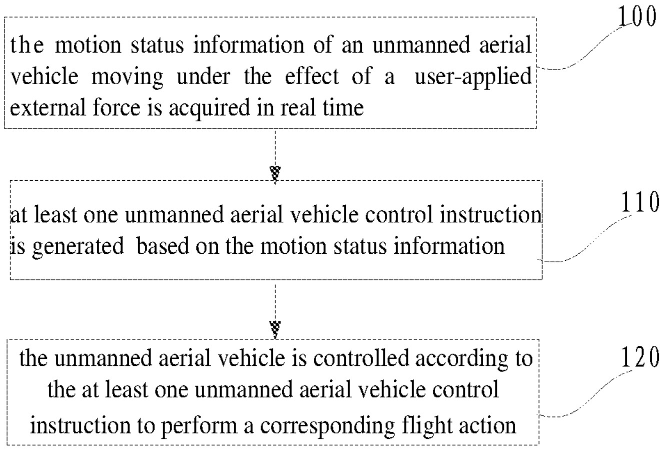

FIG. 1

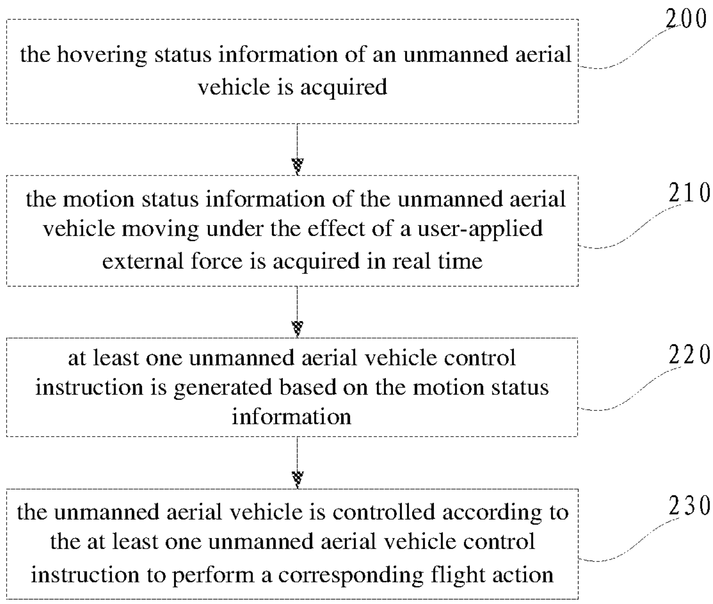

FIG. 2

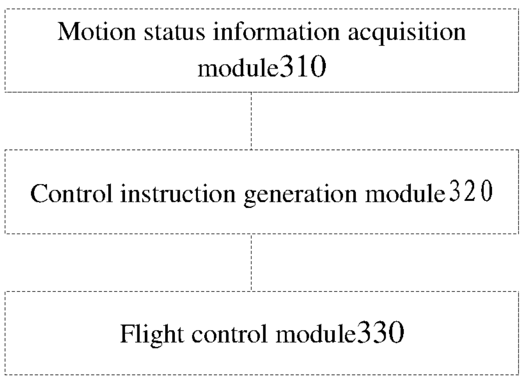

FIG. 3

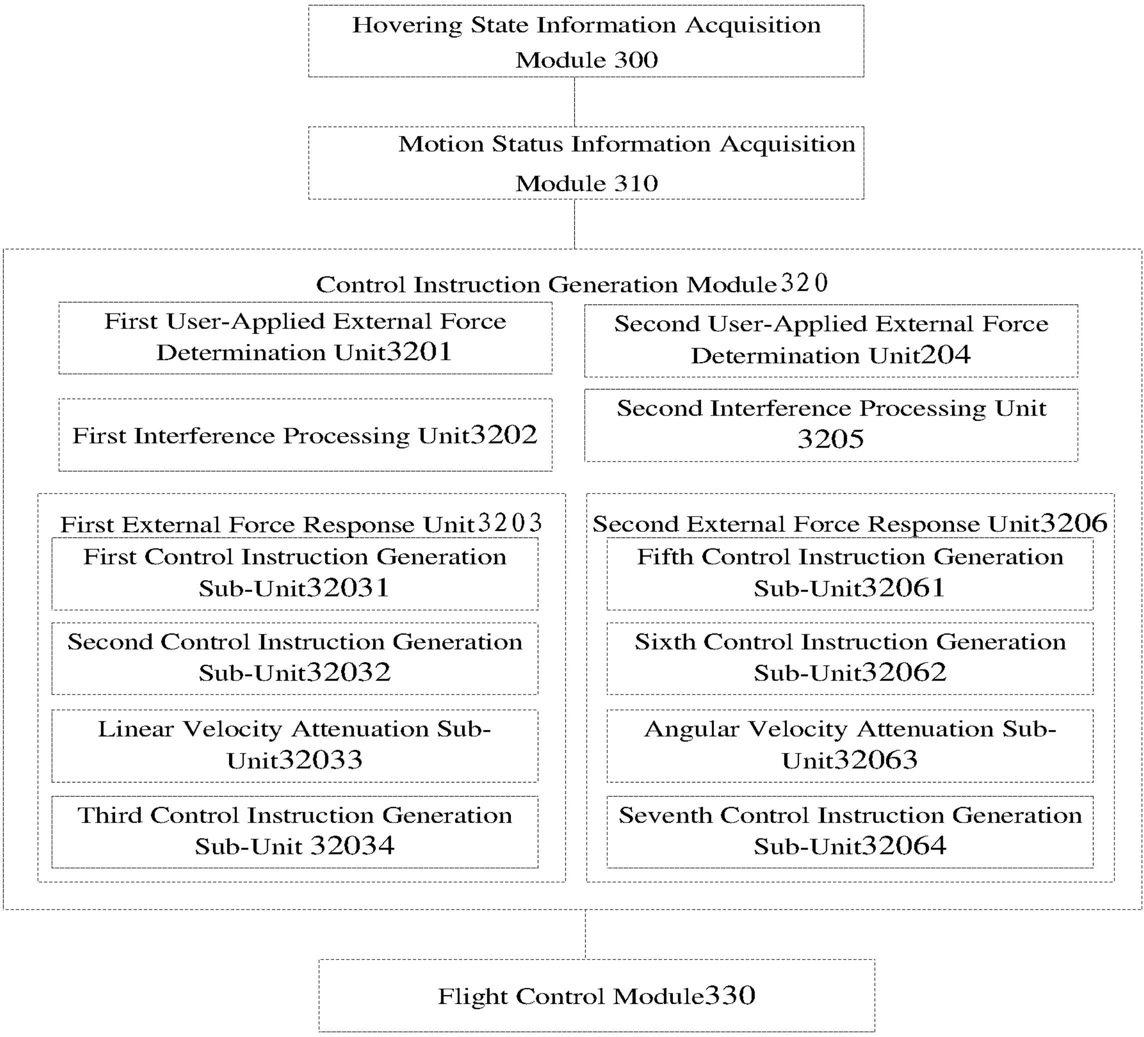
Hovering State Information Acquisition Module 300
Motion Status Information Acquisition Module 310
Control Instruction Generation Module320
First User-Applied External Force Determination Unit3201
Second User-Applied External Force Determination Unit204
First Interference Processing Unit3202
Second Interference Processing Unit 3205
First External Force Response Unit3203
First Control Instruction Generation Sub-Unit32031
Second Control Instruction Generation Sub-Unit32032
Linear Velocity Attenuation Sub-Unit32033
Third Control Instruction Generation Sub-Unit 32034
Second External Force Response Unit3206
Fifth Control Instruction Generation Sub-Unit32061
Sixth Control Instruction Generation Sub-Unit32062
Angular Velocity Attenuation Sub-Unit32063
Seventh Control Instruction Generation Sub-Unit32064
Flight Control Module330

FIG. 4

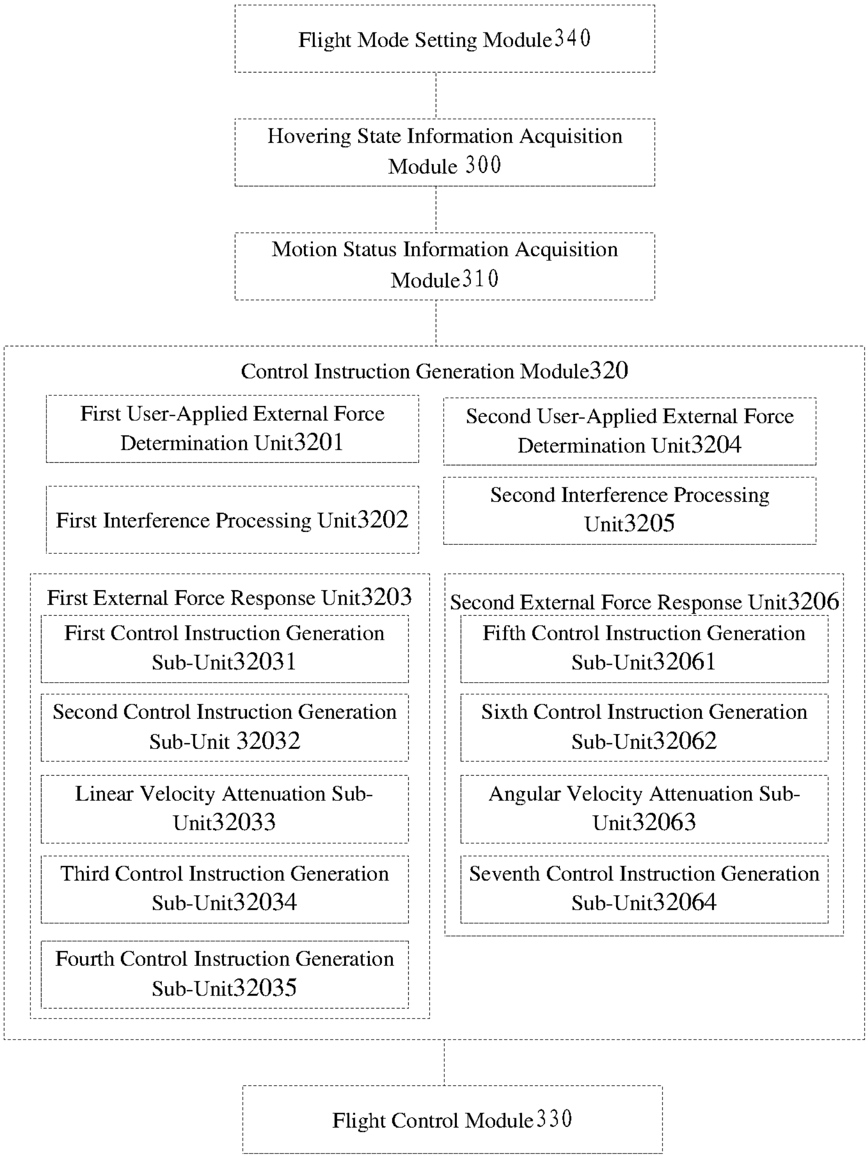
Flight Mode Setting Module340
Hovering State Information Acquisition Module 300
Motion Status Information Acquisition Module310
Control Instruction Generation Module320
First User-Applied External Force Determination Unit3201
Second User-Applied External Force Determination Unit3204
First Interference Processing Unit3202
Second Interference Processing Unit3205
First External Force Response Unit3203
First Control Instruction Generation Sub-Unit32031
Second Control Instruction Generation Sub-Unit 32032
Linear Velocity Attenuation Sub-Unit32033
Third Control Instruction Generation Sub-Unit32034
Fourth Control Instruction Generation Sub-Unit32035
Second External Force Response Unit3206
Fifth Control Instruction Generation Sub-Unit32061
Sixth Control Instruction Generation Sub-Unit32062
Angular Velocity Attenuation Sub-Unit32063
Seventh Control Instruction Generation Sub-Unit32064
Flight Control Module330

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/074161

A. CLASSIFICATION OF SUBJECT MATTER

G05D 1/10(2006.01)i; G05D 1/08(2006.01)i; G08C 17/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G05D, A63H, G08C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, VEN, CNKI: UAV, unmanned aerial vehicle, unmanned plane, aircraft, aircraft, speed, velocity, acceleration, angular velocity, hover, touch, force, interferential

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016313742 A1 (SZ DJI TECHNOLOGY CO LTD) 27 October 2016 (2016-10-27) paragraph [0056] in the description; figure 8	1, 7, 10, 12, 16
Y	US 2016313742 A1 (SZ DJI TECHNOLOGY CO LTD) 27 October 2016 (2016-10-27) paragraph [0056] in the description; figure 8	2, 3, 11
Y	CN 105739533 A (PRODRONE CRAFT TECHNOLOGY CO LTD) 06 July 2016 (2016-07-06) pages 4-7 in the description; figures 1-7	2, 3, 11
A	CN 105182986 A (BEIJING ZERO ZERO INFINITY TECHNOLOGY CO LTD) 23 December 2015 (2015-12-23) the whole document	1-18
A	CN 105159321 A (BEIJING QIHOO TECHNOLOGY CO ET AL.) 16 December 2015 (2015-12-16) the whole document	1-18
A	CN 105843241 A (ZERO UAV BEIJING INTELLIGENCE TECH CO LTD) 10 August 2016 (2016-08-10) the whole document	1-18

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 2017	**05 September 2017**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**WU,Juan**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62084090**

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 2016043927 A (PARROT) 04 April 2016 (2016-04-04) the whole document	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/074161

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				US	9696725	B2	04 July 2017
				EP	2906468	A1	19 August 2015
				JP	2017502879	A	26 January 2017
				WO	2015085598	A1	18 June 2015
				EP	2906468	A4	29 June 2016
CN	105739533	A	06 July 2016	None			
CN	105182986	A	23 December 2015	US	2017045891	A1	16 February 2017
				WO	2017024761	A1	16 February 2017
CN	105159321	A	16 December 2015	None			
CN	105843241	A	10 August 2016	CN	106371450	A	01 February 2017
				US	9632501	B1	25 April 2017
CN	105446356	A	30 March 2016	None			
JP	2016043927	A	04 April 2016	US	2016062364	A1	03 March 2016
				EP	2998818	A1	23 March 2016
				CN	105388901	A	09 March 2016
				FR	3025114	A1	04 March 2016
				US	9671787	B2	06 June 2017