Description

Title of Invention: UNMANNED AERIAL VEHICLE, FLIGHT CONTROL MECHANISM FOR UNMANNED AERIAL VEHICLE, AND METHOD FOR USING UNMANNED AERIAL VEHICLE AND MECHANISM FOR UNMANNED AERIAL VEHICLE

Technical Field

[0001]

The present disclosure relates to an unmanned aerial vehicle, a flight control mechanism for an unmanned aerial vehicle, and a method for using an unmanned aerial vehicle and a mechanism for an unmanned aerial vehicle. More specifically, the present disclosure relates to a flight control mechanism for controlling flight of an unmanned aerial vehicle, an unmanned aerial vehicle with the mechanism and a method using them in an environment including the inside of a closed-type space such as the inside of a tubular space or the inside of a rectangular space where collisions with some boundary surface may occur.

Background Art

[0002]

The useful life of a sewage pipeline (sewer conduit) is set to approximately 50 years, and it is assumed that facilities that have reached the end of their useful life will exponentially increases in the future. For efficient maintenance and management, it is essential to grasp a state of the sewage pipeline.

[0003]

As a method of inspecting the state of the sewage pipeline, a method

of an inspector moving in a pipe to perform direct visual inspection, a method of arranging a television camera connected to the ground via a cable in a pipe to perform shooting, a method of loading a television camera connected to the ground via a cable into a self-propelled vehicle and arranging the television camera in a pipe to perform shooting while traveling, and the like have been used. However, in the method of the direct visual inspection by the inspector, there are various problems such as a risk of a toxic gas being produced in the sewage pipeline to affect a human body and a risk from immersion at the time of sudden rainfall. In the method of arranging the television camera in the pipe, there are also problems that a sufficient inspection speed is not obtained and a vehicle is difficult to control when a water level in the sewage pipeline rises.

[0004]

In flying an unmanned aerial vehicle in not only the sewage pipeline but also an environment where a collision with any boundary surface such as a wall surface or a ceiling may occur, controllability of the unmanned aerial vehicle may be deteriorated by the collision with the boundary surface, or an vehicle body may be damaged in some cases.

Citation List

Patent Literature

[0005]

Patent Literature 1: Japanese Patent Laid-Open No. 2017-087917

Patent Literature 2: Japanese Patent Laid-Open No. 2017-226259

Patent Literature 3: Japanese Patent Laid-Open No. 2018-001967

Summary

[0006]

An object of the present disclosure is to provide a flight control

mechanism for controlling flight of an unmanned aerial vehicle by controlling collisions with boundary surfaces, an unmanned aerial vehicle with the mechanism and a method using them.

[0007]

To solve the above-described problems, the present disclosure provides a flight control mechanism for an unmanned aerial vehicle comprising: a first preceding collision member; a second preceding collision member; and a holding member which holds the first and the second preceding collision members with a distance above a vehicle body of an unmanned aerial vehicle, wherein the holding member can be inclined with respect to the vehicle body by rotating toward the lateral side of the vehicle body around a predetermined position in the vehicle body or on the vehicle body, and the holding member rotates responsive to one of the first and the second preceding collision members colliding with a boundary surface.

[0007a]

In a first aspect, the present disclosure provides an unmanned aerial vehicle comprising two or more flight control mechanisms in front and behind with a distance, each flight control mechanism comprising:

a first preceding collision member;

a second preceding collision member; and

a holding member which holds the first and the second preceding collision members with a distance above a vehicle body of an unmanned aerial vehicle, wherein the holding member can be inclined with respect to the vehicle body by rotating toward the lateral side of the vehicle body around a predetermined position in the vehicle body or on the vehicle body, and the holding member rotates responsive to one of the first and the second preceding collision members colliding with a boundary surface, where the holding member is configured to rotate responsive to one of the first and the second preceding collision members colliding with the boundary surface and

both of the first and the second preceding collision members touch the boundary surface according to ascension of the vehicle body, wherein the unmanned aerial vehicle is configured to fly along the boundary surface by flying with the first and the second preceding collision members of the respective flight control mechanisms touching the boundary surface.

[0007b]

In a second aspect, the present disclosure provides a method for flying an unmanned aerial vehicle along a boundary surface, the unmanned aerial vehicle comprises two or more flight control mechanisms in front and behind with a distance, each flight control mechanism comprises: a first preceding collision member; a second preceding collision member; and a holding member which holds the first and the second preceding collision members separately above a vehicle body of an unmanned aerial vehicle, wherein the holding member can be inclined with respect to the vehicle body by rotating toward the lateral side of the vehicle body around a predetermined position in the vehicle body or on the vehicle body, and the holding member rotates responsive to one of the first and the second preceding collision members colliding with a boundary surface and makes both of the first and the second preceding collision members touch the boundary surface according to ascension of the vehicle body, the method comprises flying the unmanned aerial vehicle in a state where the first and the second preceding collision members of the respective flight control mechanisms are touching the boundary surface.

[0008]

In the flight control mechanism, the holding member may be configured to rotate responsive to one of the first and the second preceding collision members colliding with the boundary surface so that both of the first and the second preceding collision members touch the boundary surface according to ascension of the vehicle body.

[0009]

In the flight control mechanism, the first and the second preceding collision members may be rotary members, and the flight control mechanism may be configured so that the first and the second rotary members rotate when the unmanned aerial vehicle flies while the first and the second rotary members are touching the boundary surface.

[0010]

In addition, the present disclosure provides the unmanned aerial vehicle comprising two or more flight control mechanisms in front and behind with a distance, wherein the unmanned aerial vehicle is configured to fly along the boundary surface by flying with first and the second preceding collision members of the respective flight control mechanisms touching the boundary surface.

[0011]

The unmanned aerial vehicle may be configured as an unmanned aerial vehicle comprising: at least four rotary wings; a drive device which drives the rotary wings; and a control signal generation unit which generates a control signal for causing the drive device to drive the rotary wings.

[0012]

The unmanned aerial vehicle may comprise: two sets of rotary wings as the at least four rotary wings where each set consists of two rotary wings distanced in left and right; and the flight control mechanism for each one set of the two sets wherein in each set, the predetermined position is below the positions of the two rotary wings included in that set in a state where the vehicle body is not inclined.

[0013]

The control signal may include an attitude control signal, and the unmanned aerial vehicle may be configured to control the attitude of the unmanned aerial vehicle by causing the drive device to drive the rotary wings with the attitude control signal to reduce the number of rotations of at least one or some of the rotary wings when the unmanned aerial vehicle is inclined.

[0014]

In the unmanned aerial vehicle, the drive device may include a

plurality of motors which respective motors provide the respective rotary wings with motive powers, respectively, and respective motors may be configured to provide respective rotary wings with motive powers, respectively, at a position with a higher gravitational potential than the rotary wing which receives motive power from the each motor.

[0015]

The unmanned aerial vehicle may further comprise a thrust generation propeller, and the unmanned aerial vehicle may be configured to propel by rotations of the thrust generation propeller while floating by rotations of the at least four rotary wings.

[0016]

The unmanned aerial vehicle may further comprise a shooting camera and may be configured to fly inside a closed-type space by driving the rotary wings while shooting inside the closed-type space using the shooting camera.

[0017]

The unmanned aerial vehicle may further comprises a traveling direction shooting camera and a traveling direction shooting data transmission unit, and the unmanned aerial vehicle may be configured to fly while shooting in the traveling direction by means of the traveling direction shooting camera and transmitting obtained traveling direction shooting data from the traveling direction shooting data transmission unit to the outside.

[0018]

In addition, the present disclosure provides a method for flying an unmanned aerial vehicle along a boundary surface, the unmanned aerial vehicle comprises two or more flight control mechanisms in front and behind with a distance, each flight control mechanism comprises:

a first preceding collision member;

a second preceding collision member; and

a holding member which holds the first and the second preceding collision members separately above a vehicle body of an unmanned aerial vehicle, wherein the holding member can be inclined with respect to the vehicle body by rotating toward the lateral side of the vehicle body around a predetermined position in the vehicle body or on the vehicle body, and the holding member rotates responsive to one of the first and the second preceding collision members colliding with a boundary surface and makes both of the first and the second preceding collision members touch the boundary surface according to ascension of the vehicle body,

the method comprises flying the unmanned aerial vehicle in a state where the first and the second preceding collision members of the respective flight control mechanisms are touching the boundary surface.

[0019]

By controlling flight of an unmanned aerial vehicle according to the present disclosure, the risk of damages to the vehicle body, reduction of controllability etc. according to collisions when flying the unmanned aerial vehicle in an environment where collisions with a boundary surface may occur, is at least reduced.

Brief Description of Drawings

[0020]

[Figure 1A] Figure 1A is a perspective view of an unmanned aerial vehicle according to an embodiment of the present embodiment.

[Figure 1B] Figure 1B is a diagram of the unmanned aerial vehicle illustrated in Figure 1A in a positive direction of z.

[Figure 1C] Figure 1C is a diagram of the unmanned aerial vehicle illustrated in Figure 1A in a positive direction of y.

[Figure 1D] Figure 1D is a perspective view of the unmanned aerial vehicle illustrated in Figure 1A from behind in a traveling direction.