

for each of the waypoints.

[0004]

In some cases, a structure that can be an obstacle to a flight of an unmanned aerial vehicle, such as a tall building, exists on the ground surface. When an unmanned aerial vehicle flies over a place with such a structure, it is necessary to cause the unmanned aerial vehicle to climb and avoid collision, or to divert right or left for circumvention. To cause the unmanned aerial vehicle to appropriately climb, it is necessary to appropriately set waypoints in three dimensions, and to appropriately set altitudes above ground level of the waypoints. At the time, it is also necessary to carefully set the altitudes above ground level such that an altitude limit is not exceeded. When the unmanned aerial vehicle is caused to divert right or left for circumvention, it is necessary to appropriately set waypoints. In such a case, it is convenient if positional relationships of a 3D flight plan route with the ground surface and the structure are displayed in an easily perceived manner.

Summary of Invention

Technical Problem

[0005]

However, no systems exist that, when a 3D flight plan route of an unmanned aerial vehicle is set, automatically set altitudes without needing inputs of the altitudes. No systems exist either that, in a case where a structure exists near a 3D flight plan route, display such a structure in an easily perceived manner when the 3D flight plan route is set. No systems exist either that, in a case where a structure exists near a 3D flight plan route, automatically set the 3D flight plan route that avoids such a structure when the 3D flight plan route is set.

Solution to Problem

[0005a]

In a first aspect, the present disclosure provides a system for setting a 3D flight plan route of an unmanned aerial vehicle, the system comprising: a horizontal-plane position data input section that inputs data indicating a scheduled flight route of the unmanned aerial vehicle on a horizontal plane as horizontal-plane data on the flight plan route; a proximate place identification section that identifies, on any entity on the ground surface, a proximate place at which a distance from the flight plan route is equal to or less than a predetermined safe distance; a height reference value input section that acquires a height reference value indicating an elevation of a surface under each of a plurality of positions on the flight plan route; and a flight plan route altitude determination section that determines values obtained by adding flight altitudes corresponding to the positions to the height reference values, respectively, as altitude data on the flight plan route; wherein the height reference value input section acquires an elevation of a ground surface under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value by reading from a geographic database; wherein the proximate place identification section reads an altitude above ground level of a structure existing under the flight plan route from a structure shape database, and identifies, on the structure, a place at which an altitude difference obtained by subtracting the altitude above ground level of the structure from an altitude above ground level of a portion of the flight plan route above the structure is equal to or less than the predetermined safe distance, as the proximate place; and wherein when the proximate place identification section reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database, the proximate place identification section widens the flight plan route based on a predetermined width and reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database.

[0006]

In a second aspect, the present disclosure provides a computer program that implements the system according to the first aspect when the computer program is executed by a computer.

5 [00067]

The present inventiondisclosure is made in light of the above-described problems and has characteristics as follows. Specifically, the present inventiondisclosure is characterized by, in a system for setting a 3D flight plan route of an unmanned aerial vehicle, inputting data indicating a scheduled flight route of the unmanned aerial vehicle on a horizontal plane; acquiring a height reference value indicating an elevation of a surface under each of a plurality of positions on the flight plan route; and determining values obtained by adding flight altitudes corresponding to the positions to the height reference values, respectively, as altitude data on the flight plan route, may include a component that reads, from a geographic database, an elevation of a ground surface under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value, may include a component that identifies, on any entity on the ground surface, a proximate place at which a distance from the flight plan route is equal to or less than a predetermined safe distance, may include a component that reads an altitude above ground level of a structure existing under the flight plan route from a structure shape database, and identifies, on the structure, a place at which an altitude difference obtained by subtracting the altitude above ground level of the structure from an altitude above ground level of a portion of the flight plan route above the structure is equal to or less than the predetermined safe distance as the proximate place, and may include a component that, when reading the altitude above ground level of the structure existing under the flight plan route from the structure shape database, widens the flight plan route based on a predetermined width and reads the altitude above ground level of the

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structure existing under the flight plan route from the structure shape database.

[00078]

5 ~~The present invention may include a component that reads, from a geographic database, an elevation of a ground surface under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value. The present invention may include a component that reads, from a database, an altitude of a floor surface inside a building under each of the plurality of positions on the flight plan route in the~~
10 ~~horizontal plane as the height reference value. The present invention may include a component that identifies, on any entity on the ground surface, a proximate place at which a distance from the flight plan route is equal to or less than a predetermined safe distance. The present invention~~disclosure
15 ~~may include a component that outputs a distance and an orientation from a position on the flight plan route corresponding to the identified proximate place to the identified proximate place. The present invention~~disclosure
~~may include a component that issues a warning when the proximate place is identified.~~

[00089]

20 The present inventiondisclosure may include a component that corrects the flight plan route such that the proximate place is avoided. The present inventiondisclosure may include a component that automatically corrects the flight

plan route such that a distance between the flight plan route and the proximate place becomes the safe distance or greater. The present inventiondisclosure may include a component that corrects the flight plan route such that the proximate place is circumvented on the horizontal plane.

5 The present inventiondisclosure may include a component that corrects the flight plan route such that the proximate place is avoided above the proximate place. The present inventiondisclosure may include a component that corrects the flight plan route such that the proximate place is circumvented on the horizontal plane so as to prevent the flight plan route
10 from exceeding a predetermined altitude limit.

[0009]

~~———— The present invention may include a component that reads an altitude above ground level of a structure existing under the flight plan route from a structure shape database, and identifies, on the structure, a place at
15 which an altitude difference obtained by subtracting the altitude above ground level of the structure from an altitude above ground level of a portion of the flight plan route above the structure is equal to or less than the predetermined safe distance as the proximate place. The present invention may include a component that, when reading the altitude above ground level
20 of the structure existing under the flight plan route from the structure shape database, widens the flight plan route based on a predetermined width and reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database.~~

[0010]

25 The present inventiondisclosure may include a component that causes the flight plan route to be three-dimensionally displayed in a screen. The present inventiondisclosure may include a component that causes the proximate place to be further displayed in a superimposed manner. The present inventiondisclosure may include a component that acquires data on

a video of an external scene during a flight shot by the unmanned aerial vehicle, acquires data on an

actual flight route of the unmanned aerial vehicle, and reproduces the data on the video of the external scene while showing a position where the video is shot by the unmanned aerial vehicle.

[0011]

5 The present ~~invention~~disclosure may be a system including the above-described characteristics, may be a method executed by the system, may be a computer program that, when executed by a computer, implements the system, or may be a storage medium (CD-ROM, DVD, or the like) recording or a program product providing such a computer program.

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~~Advantageous Effects of Invention~~

[0012]

15 The present ~~invention~~disclosure has an advantageous effect that a 3D flight plan route can be determined only by inputting positions of waypoints on a horizontal plane, because data indicating a scheduled flight route of an unmanned aerial vehicle on a horizontal plane is inputted; a height reference value indicating an elevation of a surface under each of a plurality of positions on the flight plan route is acquired; and values obtained by adding flight altitudes corresponding to the positions to the height reference values, respectively, are determined as altitude data on the flight plan route.

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[0013]

25 The present ~~invention~~disclosure has an advantageous effect that a 3D flight plan route can be determined without needing inputs of elevations of ground surfaces along the flight plan route when the present ~~invention~~disclosure includes the component that reads, from the geographic database, an elevation of a ground surface under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value. The present ~~invention~~disclosure has an advantageous effect that a flight plan route can be set within a room inside a building when

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the present ~~invention~~disclosure includes the component that reads, from the database, an altitude of a floor surface inside

a building under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value. The present inventiondisclosure has an advantageous effect that a proximate position that is at risk for collision if a flight is conducted along a flight plan route can be identified when the present inventiondisclosure includes the component that identifies, on any entity on the ground surface, a proximate place at which a distance from the flight plan route is equal to or less than a predetermined safe distance. The present inventiondisclosure has an advantageous effect that a positional relationship between a flight plan route and a proximate place can be appropriately communicated to a user when the present inventiondisclosure includes the component that outputs a distance and an orientation from a position on the flight plan route corresponding to the identified proximate place to the identified proximate place. The present inventiondisclosure has an advantageous effect that existence of a proximate place at risk for collision can be reliably communicated to a user when the present inventiondisclosure includes the component that issues a warning when the proximate place is identified.

[0014]

The present inventiondisclosure has an advantageous effect that a possibility of collision of an unmanned aerial vehicle against an obstacle such as a structure can be easily and reliably reduced when the present inventiondisclosure includes the component that corrects the flight plan route such that the proximate place is avoided. The present inventiondisclosure has an advantageous effect that a flight plan route can be automatically set such that an unmanned aerial vehicle keeps a distance that is not less than a safe distance from an obstacle such as a structure when the present inventiondisclosure includes the component that automatically corrects the flight plan route such that a distance between the flight plan route and the proximate place becomes the safe distance or greater. The present inventiondisclosure has an advantageous effect that a

flight plan route can be corrected without changing a flight altitude when the present ~~invention~~disclosure includes the

component that corrects the flight plan route such that the proximate place is circumvented on the horizontal plane. The present inventiondisclosure has an advantageous effect that a flight plan route can be corrected without changing the flight plan route on a horizontal plane when the present
5 inventiondisclosure includes the component that corrects the flight plan route such that the proximate place is avoided above the proximate place. The present inventiondisclosure has an advantageous effect that a flight plan route can be corrected by making as small a change as possible in the flight plan route on a horizontal plane while it is assured that an altitude
10 limit is not exceeded when the present inventiondisclosure includes the component that corrects the flight plan route such that the proximate place is circumvented on the horizontal plane so as to prevent the flight plan route from exceeding a predetermined altitude limit.

[0015]

15 The present inventiondisclosure has an advantageous effect that a proximate place can be identified simply by altitude comparison when the present inventiondisclosure includes the component that reads an altitude above ground level of a structure existing under the flight plan route from a structure shape database, and identifies, on the structure, a place at which
20 an altitude difference obtained by subtracting the altitude above ground level of the structure from an altitude above ground level of a portion of the flight plan route above the structure is equal to or less than the predetermined safe distance as the proximate place. The present inventiondisclosure has an advantageous effect that a proximate place on a
25 structure that is not vertically under a flight plan route can be appropriately identified when the present inventiondisclosure includes the component that, when reading the altitude above ground level of the structure existing under the flight plan route from the structure shape database, widens the flight plan route based on a predetermined width and reads the altitude above
30 ground level of the structure existing under the flight plan route from the

structure shape

database.

[0016]

The present inventiondisclosure has an advantageous effect that a flight plan route can be displayed in such a manner that can be easily perceived by a user when the present inventiondisclosure includes the component that causes the flight plan route to be three-dimensionally displayed in a screen. The present inventiondisclosure has an advantageous effect that a proximate place can be displayed in such a manner that can be easily perceived by a user when the present inventiondisclosure includes the component that causes the proximate place to be further displayed in a superimposed manner. The present inventiondisclosure has an advantageous effect that a shot video, associated with positions where the video is shot, can be provided to a user in real time during a flight or after completion of the flight when the present inventiondisclosure includes the component that acquires data on a video of an external scene during a flight shot by the unmanned aerial vehicle, acquires data on an actual flight route of the unmanned aerial vehicle, and reproduces the data on the video of the external scene while showing a position where the video is shot by the unmanned aerial vehicle.

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Brief Description of Drawings

[0017]

[Figure 1] Figure 1 shows a relation of a flight plan route setting system with a database server cooperating with the flight plan route setting system and an unmanned aerial vehicle.

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[Figure 2] Figure 2 is an external view of a multicopter that is an example of the unmanned aerial vehicle for which a flight plan route is set.

[Figure 3] Figure 3 is a block diagram showing a functional configuration of the unmanned aerial vehicle.

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[Figure 4] Figure 4 is a block diagram showing a functional configuration of

the flight plan route setting system that is an embodiment of the present

Claims

[Claim 1]

5 A system for setting a 3D flight plan route of an unmanned aerial vehicle, the system comprising:

 a horizontal-plane position data input section that inputs data indicating a scheduled flight route of the unmanned aerial vehicle on a horizontal plane as horizontal-plane data on the flight plan route;

10 a proximate place identification section that identifies, on any entity on the ground surface, a proximate place at which a distance from the flight plan route is equal to or less than a predetermined safe distance;

 a height reference value input section that acquires a height reference value indicating an elevation of a surface under each of a plurality of positions on the flight plan route; and

15 a flight plan route altitude determination section that determines values obtained by adding flight altitudes corresponding to the positions to the height reference values, respectively, as altitude data on the flight plan route;

20 wherein the height reference value input section acquires an elevation of a ground surface under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value by reading from a geographic database;

25 wherein the proximate place identification section reads an altitude above ground level of a structure existing under the flight plan route from a structure shape database, and

30 identifies, on the structure, a place at which an altitude difference obtained by subtracting the altitude above ground level of the structure from an altitude above ground level of a portion of the flight plan route above the structure is equal to or less than the predetermined safe distance, as the proximate place; and

wherein when the proximate place identification section reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database, the proximate place identification section widens the flight plan route based on a predetermined width and reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database.

~~[Claim 2]~~

~~The system according to claim 1, wherein the height reference value input section acquires an elevation of a ground surface under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value by reading from a geographic database.~~

~~[Claim 3]~~

~~The system according to claim 1, wherein the height reference value input section acquires an altitude of a floor surface inside a building under each of the plurality of positions on the flight plan route in the horizontal plane as the height reference value by reading from a structure shape database.~~

~~[Claim 4]~~

~~The system according to claim 2, further comprising a proximate place identification section that identifies, on any entity on the ground surface, a proximate place at which a distance from the flight plan route is~~

~~equal to or less than a predetermined safe distance.~~

[Claim 52]

The system according to claim 41, wherein the proximate place identification section further outputs a distance and an orientation from a position on the flight plan route corresponding to the identified proximate place to the identified proximate place.

[Claim 63]

The system according to claim 41 or 52, wherein the proximate place identification section issues a warning when the proximate place is identified.

[Claim 74]

The system according to any one of claims 41 to 63, further comprising a flight plan route correction section that, when the proximate place is identified by the proximate place identification section, corrects the flight plan route such that the proximate place is avoided.

[Claim 85]

The system according to claim 74, wherein when the proximate place is identified by the proximate place identification section, the flight plan route correction section automatically corrects the flight plan route such that a distance between the flight plan route and the proximate place becomes the safe distance or greater.

[Claim 96]

The system according to claim 74 or 85, wherein when the proximate place is identified by the proximate place identification section, the flight plan route correction section corrects the flight plan route such that the proximate place is circumvented on the horizontal plane.

[Claim 107]

The system according to claim 74 or 85, wherein when the proximate place is identified by the proximate place identification section, the flight plan route correction section corrects the flight plan route such that the

proximate place is avoided above the proximate place.

[Claim 118]

The system according to claim 107, wherein if the flight plan route exceeds a predetermined altitude limit when an attempt is made to avoid the proximate place above the proximate place, the flight plan route correction section corrects the flight plan route such that the proximate place is circumvented on the horizontal plane so as to prevent the flight plan route from exceeding the predetermined altitude limit.

~~[Claim 12]~~

~~———— The system according to any one of claims 4 to 11, wherein the proximate place identification section~~
~~———— reads an altitude above ground level of a structure existing under the flight plan route from a structure shape database, and~~
~~———— identifies, on the structure, a place at which an altitude difference obtained by subtracting the altitude above ground level of the structure from an altitude above ground level of a portion of the flight plan route above the structure is equal to or less than the predetermined safe distance, as the proximate place.~~

~~[Claim 13]~~

~~———— The system according to claim 12, wherein when the proximate place identification section reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database, the proximate place identification section widens the flight plan route based on a predetermined width and reads the altitude above ground level of the structure existing under the flight plan route from the structure shape database.~~

~~[Claim 14]~~⁹

The system according to any one of claims 41 to 138, further comprising a 3D display section that causes the flight plan route to be three-dimensionally displayed in a screen.

[Claim ~~15~~10]

The system according to claim ~~14~~9, wherein the 3D display section causes the proximate place to be further displayed in a superimposed manner.

5 **[Claim ~~16~~11]**

The system according to claim ~~14~~9 or ~~15~~10, further comprising a video data reproduction section that acquires data on a video of an external scene during a flight shot by the unmanned aerial vehicle, acquires data on an actual flight route of the unmanned aerial vehicle, and reproduces the
10 data on the video of the external scene while showing a position where the video is shot by the unmanned aerial vehicle.

[Claim ~~17~~12]

A computer program that implements the system according to any one of claims 1 to ~~16~~11 when the computer program is executed by a
15 computer.