

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for navigating an aerial vehicle, comprising:
flying the aerial vehicle along a flight path;
acquiring, by a camera carried by the aerial vehicle, an image of a ground area along the flight path;
sending the image to a base station;
receiving navigation data for the aerial vehicle from the base station, wherein the navigation data is determined based upon a comparison of the image of the ground area to at least one terrestrial map of the flight path; and
adjusting a flight course based at least in part upon the navigation data.
2. The method of claim 1, wherein the aerial vehicle is an unmanned aerial vehicle (UAV).
3. The method of claim 2, further comprising
identifying a correspondence between a plurality of pixels of the image and a plurality of characteristic points of the at least one terrestrial map;
assigning X, Y, Z coordinates to the plurality of pixels of the image; and
determining the navigation data based on the plurality of pixels of the image.
4. The method of claim 2, further comprising:
navigating the UAV based upon a GPS signal when the GPS signal provides sufficient accuracy for navigation; and
navigating the UAV based upon the navigation data when the GPS signal does not provide sufficient accuracy for navigation.
5. The method of claim 2, wherein navigating the UAV based upon the navigation data is a backup navigation scheme.
6. The method of claim 1, wherein the navigation data comprises location data of the UAV.

7. The method of claim 1, wherein the navigation data comprises orientation data of the UAV.

8. The method of claim 1, wherein the camera is carried by a pivot mechanism, the method further comprising:

determining an orientation of the aerial vehicle based on an orientation of the camera with respect to the aerial vehicle and an orientation of the pivot mechanism with respect to the aerial vehicle.

9. The method of claim 2, further comprising:

the UAV wirelessly communicating with a ground based transceiver, wherein the at least one terrestrial map is selected based upon a location of the ground based transceiver.

10. The method of claim 1, wherein the camera is configured to work in a visible spectrum of light during a daytime and in an infrared spectra of light during a nighttime.

11. The method of claim 1, further comprising:

before sending the image to the base station, analyzing the image and filtering the image by removing a portion of the image deemed related to movable or changeable objects in the image to improve a match between the image and the terrestrial map.

12. The method of claim 11, wherein the navigation data is determined in part by the UAV.

13. The method of claim 2, further comprising:

in conjunction with sending the image to the base station, sending a unique alpha-numerical image tag to the base station;

receiving the unique alpha-numerical image tag from the base station; and

based on the unique alpha-numerical image tag, determining a time lapse between sending the image to the base station and receiving the navigation data from the base station.

14. The method of claim 13, wherein the navigation data is a final location data or a final orientation data, the method further comprising:

before receiving at least one of the final aerial vehicle location data or the final aerial vehicle orientation data from the base station, receiving an intermediate location data or an intermediate orientation data from the base station.

15. The method of claim 2, further comprising:
generating a timestamp upon acquiring the image;
calculating a time lapse between the timestamp and when a location data is received by the UAV; and
determining a present location of the UAV based at least in part upon the location data, the time lapse, and a velocity of the UAV during the time lapse.

16. A method for determining navigation data of an aerial vehicle, comprising:
receiving an image of a ground area by a base station in communication with the aerial vehicle in flight;
comparing the image with a terrestrial map of the ground area;
identifying a section of the terrestrial map that corresponds to the image;
based on the section that is identified, determining the navigation data of the aerial vehicle; and
transmitting the navigation data to the aerial vehicle.

17. The method of claim 16, further comprising:
receiving the image by at least one transceiver on the ground;
forwarding the image to the base station; and
selecting the terrestrial map by the base station based on a proximity to the at least one transceiver.

18. The method of claim 16, further comprising:
detecting a difference between the image and the section of the terrestrial map that corresponds to the image; and
updating the map by replacing the section of the map with the image.

19. The method of claim 16, further comprising:
receiving a unique alpha-numerical image tag by the base station.

20. The method of claim 16, wherein the aerial vehicle is an unmanned aerial vehicle (UAV).

21. An Unmanned Autonomous Vehicle (UAV), comprising:
a camera configured to acquire an image of a ground area along a flight path of the UAV;
a pivot mechanism configured to orient the camera toward the ground area;
a communication interface configured to:
 send the image to a base station, and
 receive UAV location information from the base station; and
a controller coupled to the communication interface to adjust the flight path of the UAV based, at least in part, on the UAV location information.

22. The UAV of claim 21, further comprising an inertial measurement unit (IMU) in communication with the pivot mechanism, wherein an orientation of the pivot mechanism depends at least in part on a signal from the IMU.

23. The UAV of claim 21, wherein the camera is a first camera, the UAV comprising a second camera, wherein the first camera operates in a visible spectrum of light, and wherein the second camera operates in an infrared spectrum of light.

24. A non-transitory computer readable medium having computer executable instructions stored thereon that, in response to execution by one or more processors of a computing device, cause the computing device to perform actions comprising:

 receiving an image of a ground area by a base station, wherein the image is acquired by a camera carried by the UAV;
 comparing the image with a terrestrial map of the ground area;
 identifying a section of the terrestrial map that corresponds to the image;
 identifying a correspondence between a plurality of pixels of the image and a plurality of characteristic points of the section;
 assigning X, Y, Z coordinates to the plurality of pixels of the image; and
 determining navigation data of the UAV based on the plurality of pixels of the image; and
transmitting navigation data from the base station to the UAV.

25. The method of claim 24, further comprising:
 detecting a difference between the image and the section of the terrestrial map that corresponds to the image; and

replacing the section of the map with the image.

26. The method of claim 24, wherein the terrestrial map is selected at least in part based on a proximity between the base station and a transceiver that received the image from the UAV.