CLAIMS:

1. A method for use in determination of the orientation of an aerospace platform with respect to a first rotation axis, the method comprising measuring a direction of a rotation rate vector of said aerospace platform within a lateral plane intersecting with said first rotation axis and analyzing said measured direction and determining an orientation angle of said aerospace platform about said first rotation axis, said measuring comprising:

a. providing a predetermined-dynamic state movement of said aerospace platform with respect to an external reference frame, said predetermined-dynamic state movement being characterized by a certain direction of the rotation rate of the platform in said lateral plane, and/or of any time derivative thereof associated with a certain known direction within said external reference frame,

b. while the aerospace platform is in said predetermined-dynamic state movement, determining said certain direction by measuring a direction of the rotation rate of the aerospace platform within said lateral plane by a sensor assembly mounted on said platform and comprising at least one rotation rate sensor, and generating measured data indicative thereof,

c. determining an orientation of the platform with respect to said first axis by determining a relation between said certain direction and said known direction within said external reference frame.

2. The method of claim 1, wherein said first axis is substantially perpendicular to said lateral plane.

3. The method of claim 1 or 2, wherein said at least one rotation rate sensor revolves with respect to said external reference frame about a revolution axis intersecting with said lateral plane, said measured data being thereby modulated by an angular velocity (ω)of said revolution of said at least one rotation rate sensor.

4. The method of claim 3, wherein said revolution axis is substantially perpendicular to said lateral plane.

5. The method of any one of the preceding claims, wherein said analyzing of the measured direction comprises utilizing said angular velocity (ω) to de-modulate said measured data and to determine said direction within the lateral plane.

6. The method of any one of the preceding claims, wherein said analyzing of the measured direction comprises utilizing said direction within the lateral plane for determining the orientation angle of the platform with respect to said first rotation axis.

7. The method of any one of the preceding claims, wherein said angular velocity (ω) of said revolution motion is determined from readout data of the at least one rotation rate sensor, by determining prominent frequencies in said readout data corresponding to the revolution.

8. The method of any one of the preceding claims, wherein said first rotation axis corresponds to a roll orientation axis of said aerospace platform, and said sensor assembly is configured and operable for measuring rotation rates of said platform about two rotation axes associated with pitch and yaw orientation axes of the aerospace platform.

9. The method of any one of the preceding claims, comprising utilizing an angle of said orientation of the aerospace platform with respect to the first axis to compensate a bias drift effect of an additional rotation rate sensor associated with measurement of a rotation rate of said aerospace platform with respect to said first rotation axis.

10. The method of any one of the preceding claims, wherein said sensor assembly comprises at least two of the rotation rate sensors configured to measure the platform's rotation rates about two directions in the lateral plane, and to thereby enable determination of the platform's rotation rates about pitch and yaw rotation axes.

11. The method of any one of the preceding claims, wherein said sensor assembly comprises a single rotation rate sensor configured to perform the revolution about said revolution axis and to consecutively measure the platform rotation rates about various directions in said lateral plane and to thereby enable determination of the platform rotation rates about pitch and yaw rotation axes.

12. The method of any one of the preceding claims, wherein the angular velocity (ω) reduces a bias effect of said at least one rotation rate sensors, thereby increasing accuracy of the measurement of said direction in the lateral plane.

13. The method of any one of claims 5 to 12, wherein said de-modulation reduces a bias effect of said at least one rotation rate sensor, thereby increasing accuracy of the measurement of said direction in the lateral plane.

~~14. The method of any one of the preceding claims, wherein said at least one~~ rotation rate sensor is fixed with respect to said aerospace platform and said revolution motion is obtained by a rotation of said aerospace platform about an axis substantially perpendicular to said lateral plane.

15. The method of claim 14, wherein said analyzing of the measured data provides compensation for a yaw of repose effect associated with said rotation of said aerospace platform.

16. The method of any one of the preceding claims, wherein said at least one rotation rate sensor is mounted on said aerospace platform in a manner enabling a relative rotational motion between said at least one rotation rate sensor and said aerospace platform about an axis substantially perpendicular to said lateral plane.

17. The method of any one of the preceding claims, wherein said direction in the lateral plane is substantially perpendicular to a direction, in said external reference frame, of gravitational force acting on said aerospace platform.

18. The method of claim 14, wherein said direction in the lateral plane is associated with gravity-turn effect.

19. The method of claim 14, wherein said direction in the lateral plane is associated with the motion of a geostationary satellite.

20. The method of any one of the preceding claims wherein said time derivative of the platform rotation rate is the first-order derivative corresponding to the rate of change of the rotation rate of the platform within the lateral plane.

21. The method of claim 20, wherein said rate of change is provided by an external moment acting on said aerospace platform.

22. A measurement system for use in determining orientation of an aerospace platform with respect to a first rotation axis of the platform relative to an external reference frame, the measurement system comprising:

- a sensor assembly mounted on said platform and comprising at least one rotation rate sensor configured and operable for measuring the rotation rates of the aerospace platform within a lateral plane intersecting with said first rotation axis and for generating measured data indicative thereof; and a control system configured and ~~operable for carrying out the following:~~

- analyzing the measured data to determine a certain direction corresponding to at least one of a direction of the rotation rate of the platform in said lateral plane and a direction of any time derivative of the rotation rate of the platform in said lateral plane;

- obtaining a relation between said certain direction and a known direction within said external reference frame; said relation corresponding to a predetermined dynamic state movement of the platform with respect to said external reference frame; and

- utilizing said certain direction and said relation to determine the orientation angle of the platform with respect to said first rotation axis.

23. The system of claim 22 wherein said first axis is substantially perpendicular to said lateral plane.

24. The system of claim 22 or 23, wherein said at least one rotation rate sensor revolves with respect to said external reference frame about a revolution axis intersecting with said lateral plane, said measured data being thereby indicative of the rotation rates within said lateral plane of the aerospace platform modulated by an angular velocity (ω) of said revolution of the at least one rotation rate sensor.

25. The system of claim 24, wherein said revolution axis is substantially perpendicular to said lateral plane.

26. The system of claim 24 or 25, wherein the control unit comprises:

a de-modulation module associated with said sensor assembly and configured and operable for receiving and analyzing the measured data and to utilize said angular velocity (ω) to generate de-modulated data indicative of the direction of the rotation rate of the aerospace platform in said lateral plane.

27. The system of claim 26, wherein the control unit comprises an orientation determination module configured and operable for carrying out the following: receiving said de-modulated data from said de-modulation module; processing the de-modulated data corresponding to a predetermined-dynamic state movement of the aerospace platform to determine said certain direction; obtaining said relation associating said certain direction , during said predetermined-dynamic state movement, with a known direction in the external reference frame; and determining the orientation angle of the platform with respect to said first rotation axis.

28. The system of any one of the claims 22 to 27, wherein the control unit comprises an orientation determination module configured and operable for carrying out

~~the following: receiving said measured data from said sensor assembly; processing the~~ measured data corresponding to a predetermined-dynamic state movement of the aerospace platform to determine said certain direction; obtaining said relation associating said certain direction, during said predetermined-dynamic state movement, with a known direction in the external reference frame; and determining the orientation angle of the platform with respect to said first rotation axis by utilizing said relation.

29. The system of any one of the claim s 22 to 28, wherein one or more said two rotation rate sensors of said sensor assembly are a part of an Inertial Navigation System (INS).

30. The system of any one of the claims 22 to 29, wherein the control system is an integral part of said aerospace platform.

31. The system of any one of the claims 22 to 30, wherein at least one module of said control system is located on a ground station or on another aerospace platform, and wherein said control system comprises a transceiver utility for transmitting signals corresponding to said measured data to the ground station or to said another aerospace platform.

32. The system of Claim 31, wherein said at least one rotation rate sensor is actuated for generation of said measured data in response to a signal from said control system.

33. The system of any one of the claims 22 to 32, wherein said first rotation axis corresponds to a roll orientation axis of said aerospace platform.

34. The system of any one of the claims 22 to 33, wherein said control system comprises a bias compensation module associated with a first rotation rate sensor which is adapted for measurement of rotation rates of said aerospace platform with respect to said first rotation axis, said bias compensation module being configured and operable for receiving said determined orientation angle of the platform with respect to said first rotation axis and for correcting a bias drift effect of said first rotation rate sensor by utilizing said orientation angle.

35. The system of any one of the claims 22 to 34, wherein said sensor assembly is configured and operable for measuring rotation rates of said platform about two rotation axes associated with the pitch and yaw orientation axes of the aerospace ~~platform.~~

~~36. The system of any one of the claims 22 to 35, wherein said at least one~~ rotation rate sensor is fixed with respect to said aerospace platform and wherein said revolution of the least one rotation rate sensor is obtained by a rotation of said aerospace platform about an axis substantially perpendicular to said lateral plane.

37. The system of any one of Claims 24 to 27 comprising an actuation utility connected to said at least one rotation rate sensor and configured and operable to provide a revolution of a relative angular velocity between said at least one rotation rate sensor and said aerospace platform about an axis substantially perpendicular to said ~~lateral plane.~~

CLAIMS

The invention claimed is:

1. A method for use in determination of the orientation of an aerospace platform with respect to a roll rotation axis thereof, the method comprising:

a. providing a predetermined-dynamic state movement of said aerospace platform with respect to an external reference frame, said predetermined-dynamic state movement being characterized in that a direction of lateral rotation rate of the platform within a lateral plane substantially orthogonal to the roll rotation axis, and/or of any time derivative of the lateral rotation rate, is substantially perpendicular to a reference direction within said external reference frame,

b. while the aerospace platform is in said predetermined-dynamic state movement, measuring said direction of the lateral rotation rate and generating measured data indicative thereof,

c. analyzing Said measured data indicative of the direction of the lateral rotation rate being substantially perpendicular to said reference direction, and determining an orientation angle of said aerospace platform with respect to said roll rotation axis.

2. The method of claim 1, wherein said predetermined-dynamic state movement is associated with a gravity-turn effect acting on said platform, and wherein said reference direction is a direction of gravity force.

3. The method of claim 1, wherein said measuring of the direction of the lateral rotation axis utilizes at least one rotation rate sensor revolving with respect to said external reference frame about a revolution axis substantially parallel to said roll rotation axis, said measured data being thereby modulated by an angular velocity (ω) of the revolution motion of said at least one rotation rate sensor.

4. The method of claim 3, wherein said revolution motion is obtained by at least one of the following:

i. a rotation of said aerospace platform about an axis substantially parallel to said roll axis; and

ii. a relative rotational motion between said at least one rotation rate sensor and said aerospace platform about an axis substantially parallel to said roll axis.

5. The method of claim 4, wherein said revolution motion is at least partially obtained by the relative rotational motion between said at least one rotation rate sensor and said aerospace platform and wherein said analyzing of the measured data provides

compensation for a yaw of repose effect associated with said rotation of said aerospace platform.

6. The method of claim 3, wherein said analyzing of the measured direction comprises determining angular velocity (ω) by identifying prominent frequencies in readout data obtained from the at least one rotation rate sensor.

7. The method of claim 3, wherein said analyzing of the measured direction comprises utilizing said angular velocity (ω) to de-modulate said measured data and to determine said direction within the lateral plane.

8. The method of claim 7, wherein in said de-modulate measured data, a bias effect of said at least one rotation rate sensors is suppressed due to said angular velocity (ω), thereby increasing accuracy of the measurement of said direction of the rotation rate of the platform in the lateral plane.

9. The method of claim 1, comprising utilizing the angle of orientation of the aerospace platform with respect to the roll rotation axis to compensate a bias drift effect of an additional rotation rate sensor associated with measurement of a rotation rate of said aerospace platform with respect to said roll rotation axis.

10. The method of claim 1, wherein said at least one rotation rate sensor is configured in one of the following configurations:

i. the at least one rotation rate sensor comprises at least two of the rotation rate sensors configured to measure the platform's rotation rates about two directions in the lateral plane;

ii. the at least one rotation rate sensor comprises a single rotation rate sensor adapted to revolve about a revolution axis substantially parallel to said roll axis and to consecutively measure the platform rotation rates about various directions in said lateral plane;

thereby enabling determination of the platform rotation rates about pitch and yaw rotation axes.

11. The method of claim 1, wherein said time derivative of the platform rotation rate is the first-order derivative corresponding to the rate of change of the rotation rate of the platform within the lateral plane.

12. A measurement system for use in determining orientation of an aerospace platform with respect to a roll rotation axis of the platform relative to an external reference frame, the measurement system comprising:

a sensor assembly mounted on said platform and comprising at least one rotation rate sensor configured and operable for measuring the rotation rates of the aerospace

platform within a lateral plane orthogonal to said roll rotation axis and for generating measured data indicative thereof; and

a control system configured and operable for carrying out the following:
analyzing the measured data to determine a certain direction corresponding to a direction of a lateral rotation rate of the platform within said lateral plane and/or to a direction of any time derivative of said lateral rotation rate of the platform in said lateral plane;

obtaining a perpendicularity relation between said direction and a reference direction within said external reference frame; said relation corresponding to a predetermined dynamic state movement of the platform with respect to said external reference frame; and

utilizing said certain direction and said perpendicularity relation and determining an orientation angle of the platform with respect to said roll rotation axis.

13. The system of claim 12, wherein said predetermined-dynamic state movement is associated with a gravity-turn effect acting on said platform; and said reference direction is a direction of gravity force.

14. The system of claim 12, wherein said at least one rotation rate sensor revolves with respect to said external reference frame about a revolution axis substantially parallel to

said roll rotation axis, said measured data being thereby indicative of the rotation rates within said lateral plane of the aerospace platform modulted by an angular velocity (ω) of said revolution of the at least one rotation rate sensor.

15. The system of claim 12, wherein said sensor assembly comprises at least one of the following:

i. at least one rotation rate sensor fixed with respect to said aerospace platform, and wherein said revolution of the least one rotation rate sensor is obtained by a rotation of said aerospace platform about said revolution axis;

ii. an actuation utility connected to said at least one rotation rate sensor and configured and operable to provide a revolution of a relative angular velocity between said at least one rotation rate sensor and said aerospace platform about said revolution axis; and

iii. at least two rotation rate sensors configured to measure the platform's rotation rates about two directions in the lateral plane.

16. The system of claim 12, wherein the control system comprises a de-modulation module associated with said sensor assembly and configured and operable for receiving and analyzing the measured data and to utilize said angular velocity (ω) to generate de-modulated data indicative of said certain direction of the rotation rate of the aerospace platform.

17. The system of claim 16, wherein the de-modulation module is capable of determining said angular velocity (ω) by identifying prominent frequencies in said measured data obtained from the at least one rotation rate sensor.

18. The system of claim 12, wherein at least one module of said control system is located on a ground station or on another aerospace platform, and wherein said control system comprises a transceiver utility for transmitting signals corresponding to said measured data to the ground station or to said another aerospace platform.

19. The system of claim 12, wherein said control system comprises:
an orientation determination module adapted for operating, during said predetermined-dynamic state movement of the platform, and to determine said orientation angle of the platform with respect to said roll rotation axis based on said certain direction of the lateral rotation rate of the platform and said perpendicularity relation; and

a bias compensation module associated with a roll rotation rate sensor, which is adapted for measurement of rotation rates of said aerospace platform with respect to said roll rotation axis, said bias compensation module being configured and operable for receiving said determined orientation angle of the platform with respect to said roll rotation axis and for correcting a bias drift effect of said first rotation rate sensor by utilizing said orientation angle.

20. The system of claim 12, wherein said sensor assembly is configured and operable for measuring rotation rates of said platform about two rotation axes associated with the pitch and yaw orientation axes of the aerospace platform.