AIRCRAFT WITH TILTING FAN ASSEMBLIES

RELATED APPLICATIONS

[0001] This application claims benefit under 35 USC§ 119(e) to U.S. Provisional Patent Application No. 62/968,852 filed January 31, 2020 and entitled "Aircraft with Tilting Fans", the disclosure of which is incorporated by reference herein in their entirety for all purposes.

FIELD

[0002] The described embodiments relate generally to an aircraft with vertical takeoff and landing capability. In particular, the embodiments provide an aircraft with one or more tilting fan assemblies which provide vertical and horizontal thrust in a controlled fashion for hover, transition and cruise flight.

BACKGROUND

[0003] Aircrafts with vertical takeoff and landing capability need lift fans to be able to hover, takeoff and land vertically. However, such aircrafts also need forward thrust to be able to cruise in the air. Thrust produced in the vertical direction provides lift to the vehicle; thrust produced horizontally provides forward movement. A vertical takeoff and landing (VTOL) aircraft should produce both vertical and horizontal thrust, and be able to control these forces in a balanced fashion.

SUMMARY

[0004] According to a first aspect of the present invention, there is provided an aircraft configured for vertical takeoff and landing, the aircraft including: a fuselage; a pair of wings coupled to opposite sides of the fuselage; a plurality of lift fan assemblies coupled to the pair of wings, wherein the plurality of lift fan assemblies are configured to create a vertical lift; a plurality of tilting fan assemblies configured to move between a vertical lift position and a forward flight position; a plurality of support structures coupled to each of the pair of wings, wherein each lift fan assembly among the plurality of lift fan assemblies is non-tiltably mounted to a top surface of a first end of each support structure, wherein each tilting fan assembly among the plurality of tilting fan assemblies is mounted to a second end of each support structure via a tilting mechanism, wherein the plurality of lift fan assemblies are provided at a trailing edge of the pair of wings and the plurality of tilting fan assemblies are provided at a leading edge of the pair of wings; and a control system configurable to control the plurality of tilting fan assemblies between the vertical lift position and the forward flight position.

[0005] According to a second aspect of the present invention, there is provided an aircraft including: a fuselage; a pair of wings coupled to opposite sides of the fuselage; a plurality of tilting fan assemblies coupled to the pair of wings, wherein the plurality of tilting fan assemblies are configured to move between a vertical lift position and a forward flight position, wherein the plurality of tilting fan assemblies are configured to create a vertical lift

when in the vertical lift position; at least three support structures coupled to each one of the pair of wings, wherein a lift fan assembly is non-tiltably mounted to a top surface of a first end of each support structure, and each tilting fan assembly among the plurality of tilting fan assemblies is mounted to a second end of each support structure via a tilting mechanism, wherein the lift fan assemblies are provided at a trailing edge of the pair of wings and the plurality of tilting fan assemblies are provided at a leading edge of the pair of wings; and a control system configured to control the plurality of tilting fan assemblies between the vertical lift position and the forward flight position.

[0006] According to a third aspect of the present invention, there is provided a method for controlling one or more tilting fan assemblies of an aircraft, the method including: receiving, by a control system coupled to an aircraft, a flight instruction, wherein the aircraft includes a fuselage, a pair of wings and at least three support structures coupled to each of the pair of wings, wherein each lift fan assembly among a plurality of lift fan assemblies is non-tiltably mounted to a first end of each support structure, and each tilting fan assembly among a plurality of tilting fan assemblies is mounted to a second end of each support structure via a tilting mechanism; determining, by the control system, a position of a plurality of tilting fan assemblies coupled to the aircraft, wherein the aircraft is configured for vertical takeoff and landing; controlling, by the control system, one or more of the plurality of tilting fan assemblies between a vertical lift position and a forward flight position based on the flight instruction, wherein the plurality of lift fan assemblies are provided at a trailing edge of the pair of wings and the plurality of tilting fan assemblies are provided at a leading edge of the pair of wings; and continuously monitoring, by the control system, the position of the plurality of tilting fan assemblies in view of the flight instruction to ensure that: the plurality of tilting fan assemblies are in the forward flight position during the forward flight of the aircraft, and the plurality of tilting fan assemblies that are in the vertical lift position during liftoff, hover or landing of the aircraft.

[0007] If the flight instruction is a takeoff instruction or a landing instruction, the control system controls the one or more of the plurality of tilting fan assemblies that are in the forward flight position to the vertical lift position. If the flight instruction is a forward flight instruction, the control system controls the one or more of the plurality of tilting fan assemblies that are in the vertical lift position to the forward flight position.

[0008] These and other embodiments are described in further detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1A depicts a simplified schematic of an exemplary VTOL aircraft, according to various embodiments.

[0010] FIG. 1B illustrates top, planar, side and front views (clockwise starting from the top left corner) of the VTOL aircraft with a pair of tilting fan assemblies in the forward flight position, according to various embodiments.

[0011] FIG. 1C illustrates top, planar, side and front views (clockwise starting from the top

CLAIMS

1. An aircraft configured for vertical takeoff and landing, the aircraft comprising:

a fuselage;

a pair of wings coupled to opposite sides of the fuselage;

a plurality of lift fan assemblies coupled to the pair of wings, wherein the plurality of lift fan assemblies are configured to create a vertical lift;

a plurality of tilting fan assemblies configured to move between a vertical lift position and a forward flight position;

a plurality of support structures coupled to each of the pair of wings,

wherein each lift fan assembly among the plurality of lift fan assemblies is non-tiltably mounted to a top surface of a first end of each support structure,

wherein each tilting fan assembly among the plurality of tilting fan assemblies is mounted to a second end of each support structure via a tilting mechanism,

wherein the plurality of lift fan assemblies are provided at a trailing edge of the pair of wings and the plurality of tilting fan assemblies are provided at a leading edge of the pair of wings; and

a control system configurable to control the plurality of tilting fan assemblies between the vertical lift position and the forward flight position.

2. The aircraft of claim 1 further comprising: a tailplane in form of a V-tail coupled to a rear end of the fuselage.

3. The aircraft of claim 1, wherein the pair of wings are coupled to the fuselage in a high-wing configuration.

4. The aircraft of claim 1, wherein the plurality of lift fan assemblies are mounted in a fixed position relative to the pair of wings to move the aircraft in a vertical direction.

5. The aircraft of claim 4, wherein one or more of the plurality of lift fan assemblies are configurable to stop operating during a forward flight of the aircraft.

6. The aircraft of claim 4, wherein each of the plurality of lift fan assemblies comprise an electric motor-driven rotor.

7. The aircraft of claim 4, wherein at least three lift fan assemblies are coupled to each of the pair of wings.

8. The aircraft of claim 1, wherein at least three tilting fan assemblies are coupled to each of the pair of wings.

9. The aircraft of claim 1, wherein a combined number of lift fan assemblies and tilting fan assemblies is at least 12.

10. The aircraft of claim 1, wherein the plurality of support structures are coupled to an underside of the pair of wings.

11. The aircraft of claim 1, wherein the control system is configurable to:

receive a flight instruction;

determine a position of the plurality of tilting fan assemblies;

control one or more of the plurality of tilting fan assemblies between the vertical lift position and the forward flight position based on the flight instruction; and

continuously monitor the position of the plurality of tilting fan assemblies in view of the flight instruction to ensure that:

the plurality of tilting fan assemblies are in the forward flight position during a forward flight of the aircraft, and

the plurality of tilting fan assemblies that are in the vertical lift position during liftoff, hover or landing of the aircraft.

12. The aircraft of claim 11, wherein the control system is configurable to:

control the position of the tilting fan assemblies based on flight data received by sensors coupled to the aircraft.

13. The aircraft of claim 11, wherein the control system is configurable to:

control the position of the tilting fan assemblies automatically.

14. The aircraft of claim 11, wherein the control system is configurable to:

control the position of the tilting fan assemblies based on a signal received from a remote entity.

15. The aircraft of claim 11, wherein the control system is configurable to:

control a first tilting fan assembly and a second tilting fan assembly among the plurality of tilting fan assemblies independently from each other.

16. The aircraft of claim 11, wherein the control system is configurable to control:

at least a subset of the plurality of tilting fan assemblies simultaneously.

17. An aircraft comprising:

a fuselage;

a pair of wings coupled to opposite sides of the fuselage;

a plurality of tilting fan assemblies coupled to the pair of wings, wherein the plurality of tilting fan assemblies are configured to move between a vertical lift position and a forward flight position, wherein the plurality of tilting fan assemblies are configured to create a vertical lift when in the vertical lift position;

at least three support structures coupled to each one of the pair of wings,

wherein a lift fan assembly is non-tiltably mounted to a top surface of a first end of each support structure, and each tilting fan assembly among the plurality of tilting fan assemblies is mounted to a second end of each support structure via a tilting mechanism, wherein the lift fan assemblies are provided at a trailing edge of the pair of wings and the plurality of tilting fan assemblies are provided at a leading edge of the pair of wings; and

a control system configured to control the plurality of tilting fan assemblies between the vertical lift position and the forward flight position.

18. The aircraft of claim 17, wherein the plurality of support structures coupled to an underside of the pair of wings.

19. The aircraft of claim 17, wherein the control system is configurable to control a first tilting fan assembly and a second tilting fan assembly among the plurality of tilting fan assemblies independently from each other.

20. The aircraft of claim 17, wherein the control system is configurable to control at least a subset of the plurality of tilting fan assemblies simultaneously.

21. The aircraft of claim 17, wherein the control system is configurable to control a position of the tilting fan assemblies based on flight data received by sensors coupled to the aircraft.

22. The aircraft of claim 17, wherein the control system is configurable to control a position of the tilting fan assemblies automatically.

23. The aircraft of claim 17, wherein the control system is configurable to control a position of the tilting fan assemblies to implement a flight instruction received from a remote entity, wherein the flight instruction includes at least one of a takeoff instruction, a hover instruction, a cruise instruction, or a landing instruction.

24. The aircraft of claim 17, further comprising:

a tailplane in form of a V-tail coupled to a rear end of the fuselage.

25. A method for controlling one or more tilting fan assemblies of an aircraft, the method comprising:

receiving, by a control system coupled to an aircraft, a flight instruction, wherein the aircraft comprises a fuselage, a pair of wings and at least three support structures coupled to each of the pair of wings, wherein each lift fan assembly among a plurality of lift fan assemblies is non-tiltably mounted to a first end of each support structure, and each tilting fan assembly among a plurality of tilting fan assemblies is mounted to a second end of each support structure via a tilting mechanism;

determining, by the control system, a position of a plurality of tilting fan assemblies coupled to the aircraft, wherein the aircraft is configured for vertical takeoff and landing;

controlling, by the control system, one or more of the plurality of tilting fan assemblies between a vertical lift position and a forward flight position based on the flight instruction, wherein the plurality of lift fan assemblies are provided at a trailing edge of the pair

of wings and the plurality of tilting fan assemblies are provided at a leading edge of the pair of wings; and

continuously monitoring, by the control system, the position of the plurality of tilting fan assemblies in view of the flight instruction to ensure that:

the plurality of tilting fan assemblies are in the forward flight position during the forward flight of the aircraft, and

the plurality of tilting fan assemblies that are in the vertical lift position during liftoff, hover or landing of the aircraft.

26. The method of claim 25, further comprising:

controlling, by the control system, a first tilting fan assembly and a second tilting fan assembly among the plurality of tilting fan assemblies independently from each other.

27. The method of claim 25, further comprising:

controlling, by the control system, at least a subset of the plurality of tilting fan assemblies simultaneously.

28. The method of claim 25, further comprising:

controlling, by the control system, the position of the plurality of tilting fan assemblies automatically.

29. The method of claim 25, further comprising:

controlling, by the control system, a position of the plurality of tilting fan assemblies to implement a flight instruction received from a remote entity, wherein the flight instruction includes at least one of a takeoff instruction, a hover instruction, a cruise instruction, or a landing instruction.

30. The method of claim 25, wherein the flight instruction is a takeoff instruction, and wherein controlling the one or more of the plurality of tilting fan assemblies comprises:

determining whether each of the plurality of tilting fan assemblies is in a vertical lift position; and

controlling the one or more of the plurality of tilting fan assemblies to the vertical lift position.

31. The method of claim 25, wherein the flight instruction is a hover instruction or a landing instruction, and wherein controlling the one or more of the plurality of tilting fan assemblies comprises:

controlling the one or more of the plurality of tilting fan assemblies to the vertical lift position.

32. The method of claim 25, wherein the flight instruction is an instruction to switch to forward flight, and wherein controlling the one or more of the plurality of tilting fan assemblies comprises:

controlling the one or more of the plurality of tilting fan assemblies to the forward flight position.

33. The method of claim 32, further comprising:

controlling one or more of a plurality of lift fan assemblies to stop operating during a forward flight of the aircraft.

34. The method of claim 25, further comprising:

receiving, by the control system, flight data from one or more sensors coupled to the aircraft; and

controlling the position of the plurality of tilting fan assemblies based on the flight data received from the one or more sensors coupled to the aircraft.