VERTICAL TAKE-OFF AND LANDING AIRCRAFT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of U.S. Application No. 16/878,380, filed May 19, 2020, which is incorporated herein by reference in its entirety.

FIELD

[0002] This disclosure generally relates to vertical take-off and landing aircraft, and more specifically to fixed wing vertical take-off and landing aircraft.

BACKGROUND

[0003] Vertical take-off and landing (VTOL) aircraft are aircraft that can take-off and land vertically and hover, providing the ability to carry travelers directly to their destination. Helicopters are VTOL aircraft that generate lift entirely through their rotors. Some VTOL aircraft have wings and propulsion systems that enable the wings to provide the lift required during forward flight. Some winged VTOL aircraft use separate propulsion systems for vertical thrust for use during take-off and landing and forward thrust for use during cruising. Other winged VTOL aircraft use tiltable propulsion systems that tilt between vertical thrust and forward thrust positions.

SUMMARY

[0003a] According to an aspect, the present disclosure refers to a vertical take-off and landing aircraft comprising: a fuselage; at least one wing connected to the fuselage; a plurality of rotors connected to the at least one wing for providing lift for vertical take-off and landing of the aircraft; and a plurality of proprotors connected to the at least one wing and tiltable between lift configurations for providing lift for vertical take-off and landing of the aircraft and propulsion configurations for providing forward thrust to the aircraft.

[0004] According to various ~~embodiments~~examples, a vertical take-off and landing aircraft includes a fixed wing, a plurality of rotors for providing lift during vertical take-off and landing, and a plurality of proprotors that can tilt from lift configurations for providing lift during vertical take-off and landing to propulsion configurations for providing the forward air speed required for the aircraft to be supported by the fixed wing. By configuring the VTOL aircraft so that a portion of the propulsion system is dedicated to lift and a portion of the propulsion system is used during both lift and forward flight, the

aircraft can be lighter and have lower drag than VTOL aircraft that have separate lift and propulsion systems and VTOL aircraft that use all propulsion for both lift and forward flight.

[0005] A vertical take-off and landing aircraft includes a fuselage; at least one wing connected to the fuselage; a plurality of rotors connected to the at least one wing for providing lift for vertical take-off and landing of the aircraft; and a plurality of proprotors connected to the at least one wing and tiltable between lift configurations for providing lift for vertical take-off and landing of the aircraft and propulsion configurations for providing forward thrust to the aircraft.

[0006] In any of these examples~~embodiments~~, the plurality of rotors can be rearward of the at least one wing and the plurality of proprotors can be forward of the at least one wing. In any of these examples~~embodiments~~, a plurality of booms can be mounted to the at least one wing, each boom mounting one rotor and one proprotor to the at least one wing.

[0007] In any of these examples~~embodiments~~, a first proprotor can be forward of a second proprotor that is adjacent to the first proprotor.

[0008] In any of these examples~~embodiments~~, a first proprotor can be mounted at a higher position on the aircraft than a second proprotor that is adjacent to the first proprotor.

[0009] In any of these examples~~embodiments~~, each rotor can have only two blades. In any of these examples~~embodiments~~, each rotor can be configured to fix the two blades in position during forward flight. In any of these examples~~embodiments~~, each proprotor can have greater than two blades.

[0010] In any of these examples~~embodiments~~, a first rotor of the plurality of rotors can be canted relative to a second rotor of the plurality of rotors such that a rotational axis of the first rotor is non-parallel with a rotational axis of the second rotor. In any of these examples~~embodiments~~, a cant angle of any rotor or proprotor is such that a respective burst disc cannot intersect with passengers or a pilot. In any of these examples~~embodiments~~, a cant angle of any rotor or proprotor is such that a respective burst disc cannot intersect with any flight-critical component.

[0011] In any of these examples~~embodiments~~, a first proprotor of the plurality of proprotors can be canted relative to a second proprotor of the plurality of proprotors such that a rotational axis of the first proprotor is non-parallel with a rotational axis of the second proprotor.

[0012] In any of these examples~~embodiments~~, the aircraft further includes a control system configured to actively alter a tilt of at least one proprotor to generate yawing moments during hover.

[0013] In any of these examples~~embodiments~~, attack angles of blades of the proprotors can be collectively adjustable during flight.

[0014] In any of these examples~~embodiments~~, propulsion can be provided entirely by the proprotors.

[0015] In any of these examples~~embodiments~~, a range of tilt of the proprotors can be greater than ninety degrees.

[0016] In any of these examples~~embodiments~~, the at least one wing can provide the lift required during cruising.

[0017] In any of these examples~~embodiments~~, the at least one wing can be a high wing mounted to an upper side of the fuselage.

[0018] In any of these examples~~embodiments~~, the at least one wing has control surfaces.

[0019] In any of these examples~~embodiments~~, all of the rotors and proprotors are mounted to the at least one wing.

[0020] In any of these examples~~embodiments~~, the aircraft is electrically powered.

[0021] In any of these examples~~embodiments~~, the aircraft is manned.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[0023] FIG. 1 shows a VTOL aircraft in a forward flight configuration, according to various embodiments;

[0024] FIG. 2 shows a VTOL aircraft in a takeoff and landing configuration, according to various embodiments;

[0025] FIG. 3 is a perspective view of a VTOL aircraft illustrating the rotor and proprotor positions in the lift and forward flight configurations, according to various embodiments;

[0026] FIG. 4 is a top view of the VTOL aircraft of FIG. 3;

[0027] FIG. 5 is a front view of the VTOL aircraft of FIG. 3;

[0028] FIG. 6 is a side view of the VTOL aircraft of FIG. 3; and

[0029] FIGS. 7 and 8 are front and side views, respectively, of a VTOL aircraft illustrating the size of the aircraft relative to a standing person, according to various embodiments.

DETAILED DESCRIPTION

[0030] According to various embodiments, VTOL aircraft described herein include at least one fixed wing, a plurality of rotors that are fixed for providing lift during take-off, landing, and hover, and a plurality of proprotors that are tiltable from lift configurations for providing lift to propulsion configurations for providing the forward thrust needed for the at least one fixed wing to provide the lift to the aircraft. By configuring the VTOL aircraft so that a portion of the propulsion system is dedicated to lift and a portion of the propulsion system is used during both lift and forward flight, the aircraft can be lighter and have lower drag than VTOL aircraft that have separate lift and propulsion systems and VTOL aircraft that use all propulsion for both lift and forward flight. Winged VTOL aircraft that have separate propulsion systems for vertical propulsion and forward propulsion essentially waste the forward propulsion system during vertical take-off and landing and hover. In contrast, aircraft according to the principles described herein utilize the forward propulsion