CLAIMS

1. A control system (1200) configured to control a deceleration process of an air vehicle (100) which comprises at least one tiltable propulsion unit (420), each of the at least one tiltable propulsion units is tiltable to provide a thrust whose direction is variable at least between a general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle; the air vehicle further comprises a wing (320) configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle the control system comprising:

at least one input for receiving information indicative of monitored airspeed of the air vehicle and of monitored altitude of the air vehicle; and

a control unit (1220), configured to issue controlling commands to controllers (1410, 1420, 1420, 1440, 1450) of aerodynamic systems (420, 345) of the air vehicle, the aerodynamic systems comprising the at least one tiltable propulsion unit; wherein the control unit is configured issue the controlling commands for:

a. controlling, during a descent of the air vehicle, a descending course of the air vehicle based on at least monitored airspeed and monitored altitude of the air vehicle, at least by controlling in a first part of the descent, an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle; and following a tilting of the at least one tiltable propulsion unit, controlling in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle; and

b. controlling a reducing of a groundspeed of the air vehicle substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by controlling thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle and set groundspeed, while restricting reduction of the thrust power based on a lower threshold (1720) that is determined in response to a measured airspeed of the air vehicle;

wherein the control unit is configured to control the reducing of the groundspeed of the air vehicle during a substantially horizontal flight of the air vehicle; and to control, during at least the second part of the descent, reduction of the groundspeed below a maximum permitted threshold speed before an end of the descent and before a beginning of the substantially horizontal flight of the air vehicle.

2. The system according to claim 1, wherein the control unit is configured to control the descending course and the reducing of the groundspeed automatically.

3. The system according to claim 1, wherein the air vehicle includes a wing (320), wherein the control unit is configured to balance between contradictory aerodynamic effects resulting from the wing and from the at least one tiltable propulsion unit.

4. The system according to claim 1, wherein the control unit comprises an altitude control module (1221) configured to minimize a vertical deviation of the air vehicle from a set altitude when the control unit controls the reducing of the groundspeed, and to restrict the minimizing at least based on the restricting of the reduction of the thrust power based on the lower threshold.

5. The system according to claim 4, wherein the altitude control module is configured to further restrict the minimizing by restricting a rate of thrust power reduction based on a maximal permitted thrust power reduction rate.

6. The system according to claim 1, wherein the control unit comprises a speed control module that is configured to determine the set groundspeed in response to a distance of the air vehicle from a predetermined hover destination position.

7. The system according to claim 1, wherein the control unit further includes a monitor, configured to repeatedly check, starting at the first part of the descent and at least until a first occurrence of an event selected from (a) receiving a negative result and (b) reduction of the groundspeed to substantially hovering, whether flight parameters are within an envelope permitting deceleration to hover at a predetermined hover destination position; wherein the control unit is configured to selectively instruct tilting of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction if a result of the checking was negative, and to further control a directing of the air vehicle to a position and a state in which the flight parameters are within the envelope.

8. The system according to claim 1, wherein the control unit further comprises a tilting control module that is configured to determine timing for tilting of the at least one tiltable propulsion

unit between the first and the second parts of the descent, for minimizing a duration between the tilting and the substantial hover.

9. The system according to claim 1, wherein the control unit is configured to restrict the reduction of the groundspeed for preventing a reduction of the airspeed below a predetermined threshold until reaching a vicinity of a predetermined hover destination position.

10. The system according to claim 1, wherein the control unit comprises a pitch control module (1224), configured to keep a pitch of the air vehicle within a permitted pitch range when the control unit controls the reducing of the groundspeed, wherein the permitted pitch range is dynamically determined in response to the measured airspeed of the air vehicle.

11. The system according to claim 10, wherein the pitch control module is configured to prevent stalling of the air vehicle at least by keeping the pitch within the permitted pitch range.

12. The system according to claim 1, wherein the control unit is configured to: determine, before the second part of the descent, a permitted air vehicle descending angle for at least a part of the descending course based on atmospheric conditions, and control the descending course during at least a part of the first part of the descent based on the permitted air vehicle descending angle.

13. The system according to claim 1, wherein the control unit is configured to control a substantially vertical descent of the air vehicle, after the reducing of the groundspeed of the air vehicle substantially to hover, until a fulfillment of at least one ground detection condition.

14. The system according to claim 13, wherein the control unit comprises a landing altitude control module (1221) that is configured to control a reduction of an altitude of the air vehicle during at least a part of the vertical descent, and to control modification of thrust power of the at least one tiltable propulsion unit, when controlling the reduction of the altitude, for minimizing a deviation of the monitored altitude of the air vehicle from a monotonously decreasing set altitude that decreases below a local ground level more than five times a height of the air vehicle.

15. The system according to claim 14, wherein the control unit is configured to initiate the controlling of the substantially vertical descent of the air vehicle if predetermined time elapsed from the tilting of the at least one tiltable propulsion unit, regardless of sensors data.

16. The system according to claim 1, wherein the control unit is configured to issue the controlling commands to the controllers of the aerodynamic systems for controlling an operation of at least one aerodynamic system of the air vehicle selected from a group consisting of an aileron, an elevator, a rudder, a ruddervator, a flaperon, elevons, and a wing flap.

17. The system according to claim 1, wherein the control unit is further configured to reduce rotation speed of at least one rotating component of one or more of the at least one tiltable propulsion units between the first and the second parts of the descent, for reducing angular momentum on the at least one tiltable propulsion unit.

18. The system according to claim 1, wherein the air vehicle comprises at least one non-tiltable propulsion unit and the control unit is configured, during at least part of the second part of the descent, to control operating of at least one non-tiltable propulsion unit to provide thrust in the general vertical thrust vector direction.

19. A method (1500) for controlling a deceleration process of an air vehicle (100) which comprises at least one tiltable propulsion unit (420), each of the at least one tiltable propulsion unit is tiltable to provide a thrust whose direction is variable at least between a general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle (100); the air vehicle further comprises a wing (320) configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle, the method comprising:
during a descent of the air vehicle (100), controlling (1510) a descending course of the air vehicle (100) based on at least monitored airspeed and monitored altitude of the air vehicle (100), said controlling comprising carrying out:
in a first part of the descent, controlling (1520) an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle (100); and

following a tilting of the at least one tiltable propulsion unit, controlling (1540) in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle (100); and
controlling (1550) a reducing of a groundspeed of the air vehicle (100) substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by:
controlling (1560) thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle (100) and set groundspeed, while restricting reduction of the thrust power based on a lower threshold (1720) that is determined in response to a measured airspeed of the air vehicle; controlling the reducing of the groundspeed of the air vehicle during a substantially horizontal flight of the air vehicle, and controlling, during at least the second part of the descent, reduction of the groundspeed below a maximum permitted threshold speed before an end of the descent and before a beginning of the substantially horizontal flight of the air vehicle.

20. The method according to claim 19, wherein the controlling (1510) of the descending course and the controlling (1550) of the reducing of the groundspeed comprises automated controlling by at least one processor of a control unit mounted on the air vehicle (100).

21. The method according to claim 19, wherein the controlling of the deceleration process comprises controlling the deceleration process of the air vehicle that includes a wing, and balancing between contradictory aerodynamic effects resulting from the wing and from the at least one tiltable propulsion unit.

22. The method according to claim 19, wherein at least part of the controlling (1550) of the reducing of the groundspeed is carried out after the controlling (1510) of the descending course of the air vehicle, during a substantially horizontal flight of the air vehicle.

23. The method according to claim 22, further comprising controlling, during at least the second part of the descent, reduction of the groundspeed below a maximum permitted threshold speed before an end of the descent and before a beginning of the substantially horizontal flight of the air vehicle.

24. The method according to claim 19, further comprising minimizing a vertical deviation of the air vehicle (100) from a set altitude concurrently with at least a part of the controlling (1550) of the reducing of the groundspeed, wherein the minimizing is restricted at least by the restricting of the reduction of the thrust power based on the lower threshold.

25. The method according to claim 24, wherein the minimizing is further restricted by restricting a rate of thrust power reduction based on a maximal permitted thrust power reduction rate.

26. The method according to claim 19, further comprising determining the set groundspeed in response to a distance of the air vehicle (100) from a predetermined hover destination position.

27. The method according to claim 19, further comprising:
repeatedly checking (1580), starting at the first part of the descent and at least until a first occurrence of an event selected from (a) receiving a negative result and (b) reduction of the groundspeed to substantially hovering, whether flight parameters are within an envelope permitting deceleration to hover at a predetermined hover destination position; and
selectively instructing tilting of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction if a result of the checking was negative, and controlling a directing of the air vehicle (100) to a position and a state in which the flight parameters are within the envelope, and reinitiating the method (1500) starting again with the controlling (1510) during the first part of the descent.

28. The method according to claim 19, further comprising determining (1534) timing for tilting of the at least one tiltable propulsion unit between the first and the second parts of the descent for minimizing a duration between the tilting and the substantial hover.

29. The method according to claim 19, wherein the controlling (1550) of the reducing of the groundspeed comprises restricting the reduction of the groundspeed for preventing a reduction of the airspeed below a predetermined threshold until reaching a vicinity of a predetermined hover destination position.

30. The method according to claim 19, further comprising keeping a pitch of the air vehicle (100) within a permitted pitch range concurrently with at least a part of the controlling (1550)

of the reducing of the groundspeed, wherein the permitted pitch range is dynamically determined in response to the measured airspeed of the air vehicle (100).

31. The method according to claim 30, wherein the keeping of the pitch within the permitted pitch range prevents stalling of the air vehicle.

32. The method according to claim 19, wherein the controlling (1540) in the second part of the descent is preceded by determining a permitted air vehicle descending angle for at least a part of the descending course based on atmospheric conditions, wherein the controlling (1510) of the descending course during at least a part of the first part of the descent is based on the permitted air vehicle descending angle.

33. The method according to claim 19, further comprising controlling a substantially vertical descent of the air vehicle, after the reducing of the groundspeed of the air vehicle (100) substantially to hover, until a fulfillment of at least one ground detection condition.

34. The method according to claim 33, comprising controlling (1620) a reduction of an altitude of the air vehicle (100) during at least a part of the vertical descent, wherein the controlling (1620) of the reduction of the altitude comprises controlling modification of thrust power of the at least one tiltable propulsion unit for minimizing a deviation of the monitored altitude of the air vehicle (100) from a monotonously decreasing set altitude that decreases below a local ground level more than five times a height of the air vehicle.

35. The method according to claim 34, comprising initiating the controlling of the substantially vertical descent of the air vehicle (100) if predetermined time elapsed from the tilting of the at least one tiltable propulsion unit, regardless of sensors data.

36. The method according to claim 19, wherein at least the controlling (1510) of the descending course comprises controlling an operation of at least one aerodynamic part of the air vehicle (100) selected from a group consisting of an aileron, an elevator, a rudder, a ruddervator, a flaperon, elevons, and a wing flap.

37. The method according to claim 19, further comprises reducing rotation speed of at least one rotating component of one or more of the at least one tiltable propulsion units between the

first and the second parts of the descent, for reducing angular momentum on the at least one tiltable propulsion unit.

38. The method according to claim 19, wherein the air vehicle comprises at least one non-tiltable propulsion unit, the method comprising: during at least part of the second part of the descent, controlling operating of at least one non-tiltable propulsion unit to provide thrust in the general vertical thrust vector direction.

39. A program storage device readable by machine, tangibly embodying a computer readable code portion executable by the machine for controlling a deceleration process of an air vehicle which comprises at least one tiltable propulsion unit, each of the at least one tiltable propulsion units is tiltable to provide a thrust whose direction is variable at least between a general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle; the air vehicle further comprises a wing configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle, the computer readable code portion comprising instructions for:
during a descent of the air vehicle, controlling a descending course of the air vehicle based on at least monitored airspeed and monitored altitude of the air vehicle, said controlling comprising carrying out in the following order:
in a first part of the descent, controlling an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle; and
following a tilting of the at least one tiltable propulsion unit, controlling in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle; and
controlling a reducing of a groundspeed of the air vehicle substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by:
controlling thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle and set groundspeed, while restricting reduction of the thrust power based on a lower threshold that is determined in response to a measured airspeed of the air vehicle; and
controlling the reducing of the groundspeed of the air vehicle during a substantially horizontal flight of the air vehicle, and controlling, during at least the second part of the descent, reduction

of the groundspeed below a maximum permitted threshold speed before an end of the descent and before a beginning of the substantially horizontal flight of the air vehicle.

40. A control system (1200) configured to control a deceleration process of an air vehicle (100) which comprises at least one tiltable propulsion unit (420), each of the at least one tiltable propulsion units is tiltable to provide a thrust whose direction is variable at least between a general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle; the air vehicle further comprises a wing (320) configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle the control system comprising:

at least one input for receiving information indicative of monitored airspeed of the air vehicle and of monitored altitude of the air vehicle; and

a control unit (1220), configured to issue controlling commands to controllers (1410, 1420, 1420, 1440, 1450) of aerodynamic systems (420, 345) of the air vehicle, the aerodynamic systems comprising the at least one tiltable propulsion unit; wherein the control unit is configured issue the controlling commands for:

c. controlling, during a descent of the air vehicle, a descending course of the air vehicle based on at least monitored airspeed and monitored altitude of the air vehicle, at least by controlling in a first part of the descent, an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle; and following a tilting of the at least one tiltable propulsion unit, controlling in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle; and

d. controlling a reducing of a groundspeed of the air vehicle substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by controlling thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle and set groundspeed, while restricting reduction of the thrust power based on a lower threshold (1720) that is determined in response to a measured airspeed of the air vehicle;

wherein the control unit comprises a pitch control module (1224), configured to keep a pitch of the air vehicle within a permitted pitch range when the control unit controls the reducing of the groundspeed, wherein the permitted pitch range is dynamically determined in response to the measured airspeed of the air vehicle.

41. The system according to claim 40, wherein the air vehicle includes a wing (320), wherein the control unit is configured to balance between contradictory aerodynamic effects resulting from the wing and from the at least one tiltable propulsion unit.

42. A method (1500) for controlling a deceleration process of an air vehicle (100) which comprises at least one tiltable propulsion unit (420), each of the at least one tiltable propulsion unit is tiltable to provide a thrust whose direction is variable at least between a general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle (100); the air vehicle further comprises a wing (320) configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle, the method comprising:

during a descent of the air vehicle (100), controlling (1510) a descending course of the air vehicle (100) based on at least monitored airspeed and monitored altitude of the air vehicle (100), said controlling comprising carrying out:

in a first part of the descent, controlling (1520) an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle (100); and

following a tilting of the at least one tiltable propulsion unit, controlling (1540) in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle (100); and

controlling (1550) a reducing of a groundspeed of the air vehicle (100) substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by:

controlling (1560) thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle (100) and set groundspeed, while restricting reduction of the thrust power based on a lower threshold (1720) that is determined in response to a measured airspeed of the air vehicle;

balancing, during the deceleration process, between aerodynamic effects resulting from the wing and from the at least one tiltable propulsion unit; and minimizing a vertical deviation of the air vehicle from a set altitude when controlling the reducing of the groundspeed, and restricting the minimizing at least based on the restricting of the reduction of the thrust power based on the lower threshold.

43. A control system (1200) configured to control a deceleration process of an air vehicle (100) which comprises at least one tiltable propulsion unit (420), each of the at least one tiltable propulsion units is tiltable to provide a thrust whose direction is variable at least between a general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle; the air vehicle further comprises a wing (320) configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle the control system comprising:

at least one input for receiving information indicative of monitored airspeed of the air vehicle and of monitored altitude of the air vehicle; and

a control unit (1220), configured to issue controlling commands to controllers (1410, 1420, 1420, 1440, 1450) of aerodynamic systems (420, 345) of the air vehicle, the aerodynamic systems comprising the at least one tiltable propulsion unit; wherein the control unit is configured issue the controlling commands for:

a. controlling, during a descent of the air vehicle, a descending course of the air vehicle based on at least monitored airspeed and monitored altitude of the air vehicle, at least by controlling in a first part of the descent, an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle; and following a tilting of the at least one tiltable propulsion unit, controlling in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle; and

b. controlling a reducing of a groundspeed of the air vehicle substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by controlling thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle and set groundspeed, while restricting reduction of the thrust power based on a lower threshold (1720) that is determined in response to a measured airspeed of the air vehicle,

wherein the control unit comprises an altitude control module (1221) configured to minimize a vertical deviation of the air vehicle from a set altitude when the control unit controls the reducing of the groundspeed, and to restrict the minimizing at least based on the restricting of the reduction of the thrust power based on the lower threshold.

44. A control system (1200) configured to control a deceleration process of an air vehicle (100) which comprises at least one tiltable propulsion unit (420), each of the at least one tiltable propulsion units is tiltable to provide a thrust whose direction is variable at least between a

general vertical thrust vector direction and a general longitudinal thrust vector direction with respect to the air vehicle; the air vehicle further comprises a wing (320) configured to provide lift to the air vehicle; the wing being in a fixed position during flight of the air vehicle the control system comprising:

at least one input for receiving information indicative of monitored airspeed of the air vehicle and of monitored altitude of the air vehicle; and

a control unit (1220), configured to issue controlling commands to controllers (1410, 1420, 1420, 1440, 1450) of aerodynamic systems (420, 345) of the air vehicle, the aerodynamic systems comprising the at least one tiltable propulsion unit; wherein the control unit is configured issue the controlling commands for:

a. controlling, during a descent of the air vehicle, a descending course of the air vehicle based on at least monitored airspeed and monitored altitude of the air vehicle, at least by controlling in a first part of the descent, an operation of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction for propelling the air vehicle; and

following a tilting of the at least one tiltable propulsion unit, controlling in a second part of the descent an operation of the at least one tiltable propulsion unit to provide thrust in the general vertical thrust vector direction for providing lift to the air vehicle; and

b. controlling a reducing of a groundspeed of the air vehicle substantially to a hover, while the at least one tiltable propulsion unit provides thrust in the general vertical thrust vector direction, at least by controlling thrust power of the at least one tiltable propulsion unit for reducing a difference between measured groundspeed of the air vehicle and set groundspeed, while restricting reduction of the thrust power based on a lower threshold (1720) that is determined in response to a measured airspeed of the air vehicle,

wherein the control unit further includes a monitor, configured to repeatedly check, starting at the first part of the descent and at least until a first occurrence of an event selected from (a) receiving a negative result and (b) reduction of the groundspeed to substantially hovering, whether flight parameters are within an envelope permitting deceleration to hover at a predetermined hover destination position,

and wherein the control unit is configured to selectively instruct tilting of the at least one tiltable propulsion unit to provide thrust in the general longitudinal thrust vector direction if a result of the checking was negative, and to further control a directing of the air vehicle to a position and a state in which the flight parameters are within the envelope.