Claims

1. A mobility aid comprising:

a mobile base movable along a mobile-base-movement plane, the mobile base having a plurality of wheels;

a seat pivotably coupled to the mobile base in a manner so as to be pivotable between a sitting disposition, in which the seat is oriented parallel to the mobile-base-movement plane, and a standing disposition, in which the seat is oriented perpendicular to the mobile-base-movement plane and a main sitting surface of the seat is facing forward with respect to a forward-movement direction of the mobile base; and

a balance-assist unit having

a balance-assist-linkage mechanism coupled to the seat, and

a body-support-module coupled to the balance-assist-linkage mechanism,

wherein components of the balance-assist-linkage mechanism are jointed in a manner movable to allow movements of the body-support-module relative to the seat along a module-movement-plane parallel to the mobile-base-movement plane when the seat is in the standing disposition,

wherein the body-support-module comprises

a connection structure which couples the body-support-module to the balance-assist-linkage mechanism;

a body-support-member; and

a support-member-movement mechanism which couples the body-support-member to the connection structure,

wherein the support-member-movement mechanism is configured to provide the body-support-member with three degree-of-freedom relative to the connection structure, the three degree-of-movement including upward and downward movements perpendicular to the module-movement-plane, roll movements about a roll axis extending perpendicularly from a body contact surface of the body-support-member, and pitch movements about a pitch axis

perpendicular to both the roll axis and upward and downward movements.

2. The mobility aid as claimed in claim 1, further comprising

a parallelogram linkage mechanism connecting the mobile base, the seat and the balance-assist unit, the parallelogram linkage mechanism having a pair of equal parallel links being parallel to the seat,

wherein the seat is attached to one of the pair of equal parallel links,

wherein first and second pin joints of the parallelogram linkage mechanism, which are respectively at first longitudinal ends of the pair of equal parallel links, couple the seat to the mobile base and third and fourth pin joints of the parallelogram linkage mechanism, which are respectively at second longitudinal ends of the pair of equal parallel links, couple the seat to the balance-assist-unit in a manner such that an orientation of the balance-assist-linkage mechanism of the balance-assist-unit with respect to the mobile base is unchanged when the seat is pivoted about the first and second pin joints simultaneously to move the seat between the sitting disposition and the standing disposition with respect to the mobile base.

3. The mobility aid as claimed in claim 1 or 2, further comprising a seat-actuator disposed between the seat and the mobile base so as to actuate the seat between the sitting disposition and the standing disposition.

4. The mobility aid as claimed in any one of claims 1 to 3, wherein the balance-assist-linkage mechanism is configured to provide the body-support-module with a three degree-of-freedom relative to the seat along the module-movement-plane, the three degree-of-freedom includes forward and backward movements which are parallel to the forward-movement direction of the mobile base, lateral movements which are perpendicular to the forward and backward movements, and yaw movements about a support-module-rotational axis which is perpendicular to the module-movement-plane.

5. The mobility aid as claimed in any one of claims 1 to 4, wherein the balance-assist-linkage mechanism comprises a pair of arm assemblies, each arm assembly comprising

a first link member and a second link member,

wherein the first link member is rotatable about a first revolute joint having a first rotational axis perpendicular to the module-movement-plane, the first revolute joint connecting the first link member to the seat,

wherein the second link member is in sliding engagement with the first link member via a prismatic joint having a sliding axis along or parallel to the module-movement-plane,

wherein the body-support-module is connected to the second link member via a second revolute joint having a second rotational axis perpendicular to the module-movement-plane.

6. The mobility aid as claimed in any one of claims 1 to 4, wherein the balance-assist-linkage mechanism comprises a pair of arm assemblies, each arm assembly comprising

a first link member and a second link member,

wherein the first link member is rotatable about a first revolute joint having a first rotational axis perpendicular to the module-movement-plane, the first revolute joint connecting the first link member to the seat,

wherein the second link member is connected and rotatable relative to the first link member via a second revolute joint having a second rotational axis perpendicular to the module-movement-plane, and

wherein the body-support-module is connected to the second link member via a third revolute joint having a third rotational axis perpendicular to the module-movement-plane.

~~7. The mobility aid as claimed in any one of claims 1 to 6, wherein the body-support-module comprises~~

~~a connection structure which couples the body-support-module to the balance-assist-linkage mechanism;~~

~~a body-support-member; and~~

~~a support-member-movement mechanism which couples the body-support-member to the connection structure,~~

~~wherein the support-member-movement mechanism is configured to provide the body-support-member with three degree-of-freedom relative to the connection structure, the three degree-of-movement including upward and downward movements perpendicular to the module-movement-plane, roll movements about a roll axis extending perpendicularly from a body contact surface of the body-support-member, and pitch movements about a pitch axis perpendicular to both the roll axis and upward and downward movements.~~

7. The mobility aid as claimed in any one of claims 1 to 6, wherein the support-member-movement mechanism comprises a prismatic joint or a linear joint connecting the connection structure to the body-support member, wherein the prismatic joint or the linear joint is configured to provide the upward and downward movements and the roll movements.

8. The mobility aid as claimed in claim 7, wherein the prismatic joint is arranged perpendicular to the module-movement-place of the balance-assist-linkage mechanism.

9. The mobility aid as claimed in any one of claims 1 to 8, wherein the body-support-member and the support-member-movement mechanism are connected by a slot connection configured to provide the pitch movements.

810. The mobility aid as claimed in any one of claims 1 to 79, further comprising a variable braking system coupled to the balance-assist-linkage mechanism of the balance-assist unit to vary a stiffness of the balance-assist-linkage mechanism.

911. The mobility aid as claimed in claim 810, wherein the variable braking system comprises a brake mechanism located at the mobile base and a cable connecting the brake mechanism to a joint of the balance-assist-linkage mechanism to provide a resistive force from the brake mechanism to said joint for stiffness control of said joint.

1012. The mobility aid as claimed in claim 911, wherein the variable braking system comprises a cable routing assembly having a set of pulleys to guide the cable from the joint of the balance-assist-linkage mechanism to the brake mechanism.

1113. The mobility aid as claimed in claim 1012, wherein the cable routing assembly comprises a brake-pulley which is directly connected to the brake mechanism and to which an end of the cable is attached.

1214. The mobility aid as claimed in any one of claims 911 to 1113, wherein the variable braking system comprises four brake mechanisms located at the mobile base and four cables connecting the four brake mechanism respectively to four joints of the balance-assist-linkage mechanism.

1315. The mobility aid as claimed in any one of claims 911 to 1113, wherein the brake mechanism comprises a magnetic powder brake.

~~14~~16. The mobility aid as claimed in any one of claims 1 to ~~13~~15, further comprising a shank support mechanism at a front portion of the mobile base with respect to the forward-movement direction of the mobile base, the shank support mechanism comprises

a pair of shank support plates, and

a movement mechanism configured to move the pair of shank support plates between an open position and a close position,

wherein, in the open position, the pair of shank support plates is moved apart from each other such that a space in front of the front portion of the mobile base is unobstructed by the pair of shank support plates, and wherein, in the closed position, the pair of shank support plates is moved towards each other such that the pair of shank support plates is positioned in front of the front portion of the mobile base.

~~15~~17. The mobility aid as claimed in any one of claims 1 to ~~14~~16, wherein the body-support-module comprises a securing component for connecting a user to the balance-assist unit.

~~16~~18. The mobility aid as claimed in claim ~~15~~17, wherein the securing component comprises a quick attachment and release buckle.

~~17~~19. The mobility aid as claimed in any one of claims 1 to ~~16~~18, wherein the balance-assist unit further comprises a sensor arrangement configured to detect movements of the balance-assist unit.

~~18~~20. The mobility aid as claimed in claim ~~17~~19, wherein the sensor arrangement comprises at least one position sensor attached to the balance-assist-linkage mechanism.

~~19~~21. The mobility aid as claimed in claim ~~17~~19 or ~~18~~20, wherein the sensor arrangement comprises at least one inertial measurement unit or accelerometer attached to the body-support-module.

~~20~~22. The mobility aid as claimed in claim ~~17~~19 to ~~19~~21, further comprising a processor configured to control the mobile base for automatic following based on detection signals from the sensor arrangement when the seat is in the standing disposition, and further configured to control a degree of stiffness of the balance-assist-linkage mechanism of the balance-assist unit based on detection signals from the sensor arrangement when the seat is in the standing disposition.