Claims

1. A device for assisting an upper arm of a user, comprising:

a support mechanism configured for supporting the device on a torso of the user, the support mechanism comprising:

a base bracket coupled to a waist position of the user; and

a support link member coupled to the base bracket through a respective universal joint;

an arm link member connectable to the upper arm;

a joint member coupled with the arm link member and the support mechanism, wherein the device, in use, transfers a load from the upper arm, through the joint member to the torso; and

a force generating member arranged on the support mechanism and configured for providing a resisting torque between the arm link member and support mechanism, and wherein the force generating member is mechanically configured to apply a relatively larger resisting torque at a predetermined range of motion of the upper arm and to apply a relatively lesser resisting torque outside the predetermined range,

wherein the support mechanism is configured to support the device through the base bracket, and the base bracket is attached to a back of the user by a back strap during operation,

wherein each force generating member is a torque generator comprising an eccentric pulley, the eccentric pulley moves, in use, with the upper arm, and an eccentricity of the eccentric pulley defines the predetermined range, wherein the eccentric pulley is aligned with a shoulder joint of the user, and

wherein elastic ropes are provided connecting the back strap and the support mechanism.

2. The device according to claim **1**, wherein the predetermined range of the motion of the upper arm comprises a case where the upper arm is perpendicular to the torso.

3. The device according to claim **2**, wherein the force generating member is configured to provide largest resisting torque when the upper arm is raised perpendicular to the torso.

4. The device according to claim **1**, wherein the force generating member is configured to apply substantially no force when the upper arm is in a natural drooping position.

5. The device according to any one of claims **1**-**4**, wherein the joint member is rotatably coupled to the arm link member and the support mechanism, and is arranged parallel to a shoulder joint of the user when the device is in a mounted state.

6. The device according to any one of claims **1**-**4**, wherein the force generating member comprises one or more springs for controlling a magnitude of the resisting torque.

7. The device according to any one of claims **1**-**4**, wherein the force generating member is a force generator, the force generator comprises a hydraulic cylinder, an electric motor or a pneumatic system for generating the resisting torque.

8. The device according to any one of claims **1**-**4**, wherein the force generating member is configured to apply the resisting torque at the joint member using one or more Bowden cables.

9. The device according to claim **7**, further comprising:

a sensor system configured to detect information of the user; and

a control module configured to generate and provide a control signal to the force generator based on the information of the user detected by the sensor system.

10. The device according to claim **9**, wherein the sensor system is in communication with the control module to control at least one aspect of toggling the force generator between a working mode in which the force generator generates a resisting torque and a non-working mode in which the force generator does not generate a resisting torque.

11. The device according to claim **9**, wherein the sensor system comprises one or more of an angle sensor, a velocity sensor, a force sensor and an accelerometer.

12. The device according to any one of claims **1**-**4**, wherein a length of the arm link member is adjustable.

13. A device for assisting upper arms of a user, comprising:

a support mechanism configured for supporting the device on a torso of the user, the support mechanism comprising:

a base bracket coupled to a waist position of the user; and

two support link members coupled to the base bracket through a respective universal joint;

two arm link members connectable to a respective said upper arm;

two joint members coupled with the two arm link members and the two support link members, respectively, wherein the device, in use, transfers a load from the upper arm, through the two joint members to the torso; and

at least one force generating member arranged on the base bracket and configured for providing a resisting torque between each arm link member and the support mechanism, wherein the at least one force generating member is mechanically configured to apply a relatively larger resisting torque at a predetermined range of motion of the upper arm and to apply a relatively lesser resisting torque outside the predetermined range,

wherein the support mechanism is configured to support the device through the base bracket, and the base bracket is attached to a back of the user by a back strap during operation,

wherein each force generating member is a torque generator comprising an eccentric pulley, the eccentric pulley moves, in use, with the upper arm, and an eccentricity of the eccentric pulley defines the predetermined range, wherein the eccentric pulley is aligned with a shoulder joint of the user, and

wherein the device further comprises elastic ropes connected between the back strap and the two support link members.

14. The device according to claim **13**, wherein the predetermined range of the motion of the upper arm comprises a case where the upper arm is perpendicular to the torso.

15. The device according to claim **14**, wherein the at least one force generating member is configured to provide largest resisting torque when the upper arm is raised perpendicular to the torso.

16. The device according to claim **13**, wherein the at least one force generating member is configured to apply substantially no force when the upper arm is in a natural drooping position.

17. The device according to any one of claims **13**-**16**, wherein the joint member is rotatably coupled to the arm link member and the support mechanism, and is arranged parallel to a shoulder joint of the user when the device is in a mounted state.

18. The device according to any one of claims **13**-**16**, wherein each of the at least one force generating member comprises one or more springs for controlling a magnitude of the resisting torque.

19. The device according to any one of claims **13**-**16**, wherein each of the at least one force generating member is a force generator, and wherein the force generator comprises a hydraulic cylinder, an electric motor or a pneumatic system for generating the resisting torque.

20. The device according to any one of claims **13**-**16**, wherein the at least one force generating member is configured to apply the resisting torque at the joint member using one or more Bowden cables.

21. The device according to claim **19**, further comprising:

a sensor system configured to detect information of the user; and

a control module configured to generate and provide a control signal to the at least one force generator based on the information of the user detected by the sensor system.

22. The device according to claim **21**, wherein the sensor system is in communication with the control module to control at least one aspect of toggling the at least one force generator between a working mode in which the force generator generates a resisting torque and a non-working mode in which the force generator does not generate a resisting torque.

23. The device according to claim **21**, wherein the sensor system comprises one or more of an angle sensor, a velocity sensor, a force sensor and an accelerometer.

24. The device according to any one of claims **13**-**16**, wherein a length of each support link member is adjustable and/or a length of each arm link member is adjustable.

25. A device for assisting at least one upper arm of a user, comprising:

at least one arm link member connectable to the upper arm of the user;

a base bracket attachable to a torso of the user;

at least one support link member coupled to the base bracket;

at least one joint member rotatably coupled with the at least one arm link member and the at least one support link member, respectively, wherein the device, in use, transfers load from the upper arm, through the at least one joint member to the torso of the user; and

at least one force generating member arranged on the base bracket and configured to provide a resisting torque between the at least one arm link member and the at least one support link member, respectively, wherein the at least one force generating member is mechanically configured to apply a relatively larger resisting torque at a predetermined range of motion of the upper arm and to apply a relatively lesser resisting torque outside the predetermined range, and wherein the at least one force generating member is configured to provide largest resisting torque when the upper arm is raised perpendicular to the torso, and provide substantially no torque when the upper arm is in a natural drooping position.