sensor values. It also logs parameters for later analysis and generates alarms for parameters out of range. This module uses the front panel or vibration of the actuator to warn of low voltage from the battery.

[0074] A number of variations in the above described system and method include, for example, variations in the power sources, microcontroller functionality and the like. Specifically, power sources such as supercapacitors, organic batteries, disposable batteries and different types of rechargeable batteries can be used in place of a regular rechargeable battery. Moreover, microcontroller functionality can be split among several processors or a different mix of internal and external functions. Also, different types of braces, with or without hinges and support frames, may be used for attachment to the body, and they may be of different lengths. Finally, various ways of communicating the 'weight-on-foot' may be used, either through wired or wireless connections to the control circuitry, or by making the brace long enough to reach the foot.

[0075] In summary, the present invention provides a light weight active muscle assistance device. And, although the present invention has been described in considerable detail with reference to certain preferred versions thereof, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained herein.

What is claimed is:

1. An apparatus for controlling joint movement and reducing muscle stress, comprising

a first fastening means;

a second fastening means;

a stationary portion coupled to the first fastening means;

a moving portion coupled to the second fastening means, the stationary and moving portions being attachable proximate to a joint of the human body with the first and second fastening means, respectively, and participating in movements of the joint;

detection means operative to detect joint movements and muscle stress;

an actuator operative, when energized, to exert force between the stationary and moving portions; and

control means responsive to the detection means for controlling the energizing and de-energizing of the actuator, wherein the energizing is controllable for directing the force so that, when assisting, the force reduces the muscle stress and, when resisting, the force opposes joint movement.

2. An apparatus as in claim 1 having user selectable modes of operation, including assist and resist modes.

3. An apparatus as in claim 2 wherein the user selectable modes further include an idle mode.

4. An apparatus as in claim 2, wherein the user selectable modes further include a rehabilitate mode.

5. An apparatus as in claim 2, wherein the user selectable modes further include a monitor mode.

6. An apparatus as in claim 2 wherein the force is exerted for opposing the joint movement in the resist mode.

7. An apparatus as in claim 4 wherein the force is exerted for assisting to reduce the muscle stress in the assist and rehabilitation modes.

8. An apparatus as in claim 1 operative to allow free joint movement before energizing the actuator and when the actuator is de-energized so as to cancel the force between the stationary and moving portions.

9. An apparatus as in claim 1 wherein the detection means is operative to determine if there is joint movement that requires the force for opposing the joint movement.

10. An apparatus as in claim 1 wherein the detection means is operative to determine if a muscle associated with the joint movement is under stress and requiring the force for assisting to reduce the muscle stress.

11. An apparatus as in claim 1, wherein the actuator is an electrostatic actuator.

12. An apparatus as in claim 11, wherein the electrostatic actuator has a stationary component and a moving component movably mounted proximate to the stationary component and capable, when the actuator is not energized, of moving freely in a plane substantially parallel to the surface of the stationary component.

13. An apparatus as in claim 11 wherein the electrostatic actuator is configured as a rotary actuator in which the moving and stationary components share an axis running through their midpoints around which the moving component rotates clockwise or counter clockwise depending on the joint movement.

14. An apparatus as in claim 1 in which the actuator is coupled to both the stationary and moving portions to facilitate the assistance or resistance with extension and flexion associated with the joint movement.

15. An apparatus as in claim 1 being configured with an exoskeletal frame for attachment to a limb above and below the joint such that the actuator is located on a lateral side of the limb.

16. An apparatus as in claim 1 wherein the actuator is coupled to the stationary portion, moving portion, or both, at a location proximate to a pivot point of the joint.

17. An apparatus as in claim 11 wherein the electrostatic actuator is configured with two portions one of which being capable of moving in a plane substantially proximate and parallel to the other, each portion having a plurality of electrodes which in the portion capable of moving are connected to ground and in the other portion are electrically connected in a predetermined order to a multi-phase driving signal for inducing an electrostatic field therebetween.

18. An apparatus as in claim 17 wherein the multi-phase driving signal is one of sinusoidal and pulsed.

19. An apparatus as in claim 17 wherein the portion capable of moving is supported rotatbaly over the other part.

20. An apparatus as in claim 11, wherein the electrostatic actuator has a stator made of a first plurality of two-dimensional structures stacked over each other and a moving part, made of a second plurality of two-dimensional structures stacked over each other and interleaved with the first plurality of two-dimensional structures of the stator such that adjacent two-dimensional structures are electrically isolated from each other.

21. An apparatus as in claim 20, wherein the moving part has at least one set of electrodes connected to a fixed voltage, and the stator has multiple sets of electrodes with each set independently switchable between high and lower voltages.