rod extender 150 (**Fig. 13**) is housed, and rod 40 that is controlled to selectively extend from and retract into body 38. Although actuators 36 may be linear screw-type actuators, which are preferred, other types of actuators may be acceptable. Active controller 152 (**Fig. 13**) is typically operatively in communication with controllable rod extender 150 and configured to selectively effect the extension of rod 40 out from and retraction of rod 40 into body 38.

[0024] In embodiments, actuators 36 are relatively stiff, as opposed to being compliant. As opposed to compliant actuators, e.g. air actuators, actuators 36 are capable of active actuation in both directions and substantially predictable.

[0025] Each body 38 is typically movably coupled to upper plate 34 with a gimbaling, pivoting, swiveling, or articulated joint 42 or the like. An example of an appropriate joint 42 is a universal-joint (U-joint). In a preferred embodiment, joint 42 anchors body 38 to upper plate 34 and may provide for some angular freedom of motion of body 38 with respect to upper plate 34. This coupling may permit changes in pitch and roll for actuator 36 and may further provide for a secure upper anchoring point for changes in the overall length of actuator 36. Although actuators 36 may be disposed other than substantially above upper plate 34, those couplings would be similar.

[0026] Rods 40 may be terminated at their distal ends with joints 70 such as spherical bearing and/or ball and socket joints 70 (**Fig. 5**). Joints 70 may be coupled to lower plate 32 via devises 62. As illustrated in the exemplary embodiment, distal end 41 of rod 40 protrudes from body 38 and is coupled to ball and socket joint 70. Rod 40 may pass through the ball of ball and socket joint 70 and be secured to clevis 62. In this embodiment distal end 41 of rod 40 is anchored to lower plate 32 and may provide for some angular freedom of motion of distal end 41 of rod 40 of linear actuator 36 with respect to lower plate 32. This structure may permit changes

CLAIMS

What is claimed is:

1. A motion base, comprising:

a. a lower plate (32);

b. an upper plate (34), the lower plate (32) and the upper plate (34) separated by a distance defining a space between the lower plate (32) and the upper plate (34);

c. a plurality of lateral stabilizers (50) disposed in-between and connected to the lower and upper plates (32,34), the plurality of lateral stabilizers (50) configured to provide lateral and torsional stability between the lower and upper plates (32,34);

d. a plurality of actuators (36), each actuator (36) operatively connected to the upper plate (34) and the lower plate (32), each actuator (36) comprising:

i. a body (38) operatively connected to the upper plate (34) such that the body does not project into the space between the lower plate (32) and the upper late (34), the body adapted to attach to a load carrier;

ii. a rod (40) movably disposed at least partially within the body (38), the rod (40) comprising a proximal end disposed within the body (38) and a distal end extending out from the body (38) into the space between the lower plate (32) and the upper plate (34), the distal end operatively connected to the lower plate (32), the rod (40) and body (38) defining an actuator effective length; and

iii. a controllable rod extender (150) operatively coupled to the proximal end of the rod (40) and configured to selectively extend the rod (40) out from and retract the rod (40) into the body (38), effectively causing the actuator (36) to dynamically change its effective length from a first predetermined length to a second predetermined length; and

e. an active controller (152) operatively in communication with the controllable rod extender and configured to selectively effect the extension of the rod out from and retraction of the rod into the body.

2. The motion base of Claim 1, wherein the controllable rod extender comprises a controllable rod extender driver (37).

3. The motion base of Claim 1, wherein the controllable rod extender driver (37) comprises an electric motor, an electrically controlled linear motor, a hydraulic piston, or a pneumatic piston.

4. The motion base of Claim 1, further comprising a movable joint (42) disposed between one of the bodies (38) and the distal end of the rod (40) of that body (38).

5. The motion base of Claim 1, wherein:

a. the active controller (152) further comprises an active feedback control loop (156); and

b. the controllable rod extender (150) comprises a controllable rod extender driver (37), operatively in communication with the active feedback control loop (156).

6. The motion base of Claim 5, wherein:

a. the active controller (152) further comprises a sensor (158) operatively in communication with the active feedback control loop (156); and

b. the active feedback control loop (156) comprises at least one of a positional feedback control loop, a velocity feedback control loop, an acceleration feedback control loop, an impulse feedback control loop, or a force compliance feedback control loop.

7. The motion base of Claim 1, wherein the controllable rod extender (150) comprises a linear Acme screw type actuator, a linear ball screw type actuator, or a linear roller screw type actuator.

8. The motion base of Claim 1, wherein the distal end of the rod (40) is disposed adjacent to a vertex of an imaginary triangle (39) projected onto one of the upper and lower plates (32,34).

9. The motion base of Claim 1, wherein the rod extension out from and retraction into the body (38) is configured to be continuously variable.

10. The motion base of Claim 1, wherein the rod extension out from and retraction into the body (38) is configured to be stepwise variable.

11. The motion base of Claim 1, wherein the body (38) and the distal end of the rod (40) are coupled to respective ones of the upper and lower plates (32,34) via joints (42) configured to allow two rotational degrees of freedom.

12. The motion base of Claim 11, wherein the allowed two rotational degrees of freedom do not include heave.

13. The motion base of Claim 1, wherein when the rod (40) is configured to prevent the distance between the upper plate (34) and lower plate (32) from oscillating when the rod (40) is moved to stop at a predetermined length.

14. The motion base of Claim 1, wherein the actuator (36) is coupled to the upper plate (34) and the lower plate (32) via a U-joint.

15. A method of effecting a change in a relationship between an upper plate (34) of a motion base and a lower plate (32) of a motion base, comprising:

a. providing a motion base, the motion base comprising:

i. a lower plate (32);

ii. an upper plate (34) the lower plate (32) and the upper plate (34) separated by a distance defining a space between the lower plate (32) and the upper plate (34);

iii. a plurality of lateral stabilizers (50) disposed in-between and connected to the lower and upper plates (32,34), the plurality of lateral stabilizers (50) configured to provide lateral and torsional stability between the lower and upper plates (32,34);

iv. a plurality of actuators (36), each actuator (36) operatively connected to the upper plate (34) and the lower plate (32), each actuator (36) comprising:

1. a body (38) operatively connected to the upper plate (34) such that the body does not project into the space between the lower plate (32) and the upper late (34), the body adapted to attach to a load carrier;
2. a rod (40) movably disposed at least partially within the body (38), the rod (40) comprising a proximal end disposed within the body (38) and a distal end extending out from the body (38) into the space between the lower plate (32) and the upper plate (34), the distal end operatively connected to the lower plate (32), the rod (40) and body (38) defining an actuator effective length; and
3. a controllable rod extender (150) operatively coupled to the proximal end of the rod (40) and configured to selectively extend the rod (40) out from and retract the rod (40) into the body, effectively causing the actuator (36) to dynamically change its effective length from a first predetermined length to a second predetermined length; and

v. an active controller (152) operatively in communication with the controllable rod extender (150) and configured to selectively effect the extension of the rod (40) out from and retraction of the rod (40) into the body;

b. determining a desired effective state of a parameter for each of the plurality of actuators (36);

c. determining a current effective state of the parameter for each of the plurality of actuators (36); and

d. sending a control signal to each controllable rod extender (150) of each actuator (36) to change the current effective state of the parameter of each actuator (36) if needed to match the current effective state of the parameter to the desired effective length by moving each such actuator's (36) extendable rod (40) into each such actuator's body (38) or moving each such actuator's (36) extendable rod (40) out from each such actuator's body (38) such that the current effective length for each of the plurality of actuators (36) matches the desired parameter for that actuator (36).

16. The method of effecting a change in a relationship between an upper plate (34) of a motion base and a lower plate (32) of a motion base of Claim 15, further comprising:

a. outputting a signal indicative of present effective parameter of an actuator (36) from a sensor (158) operatively coupled to the actuator (36), the sensor (158) configured to determine a current state of the parameter;

b. receiving the output indicative signal as a first input signal at a comparator circuit (156);

c. using the comparator circuit (156) to compare the first input signal to a second input signal received from the active controller (152) operatively in communication with the comparator circuit (156) and a processor (168) to create a compared signal;

d. providing the compared signal to a servo amplifier (161) operatively in communication with the comparator circuit (156) and the controllable rod extender (150); and

e. using the compared signal to create the control signal that effects a change in the current effective state of the parameter of each actuator (36) as needed, the control signal operative to move an actuator's extendable rod (40) into the actuator's body (38) or move the actuator's extendable rod (40) out from the actuator's body (38) such that the current effective state parameter for the actuator (36) matches the desired effective state parameter for that actuator (36).

17. The method of effecting a change in a relationship between an upper plate (34) of a motion base and a lower plate (32) of a motion base of Claim 15, wherein the controllable rod extender (150) comprises an electric controllable rod extender, the electric controllable rod extender comprising an electric linear motor, the method further comprising using the electric linear motor to effectively lock the electric controllable rod extender in place.

18. The method of effecting a change in a relationship between an upper plate (34) of a motion base and a lower plate (32) of a motion base of Claim 15, the controllable rod extender (150) comprising a linear screw-type controllable rod extender comprising a rotatable screw whose length defines an axis, the controllable rod extender further comprising a drive nut configured to rotatably accept the screw within the drive nut, the drive nut restrained from rotating, the rod (40) operatively coupled to the drive nut, the method further comprising:

a. rotating the screw within the drive nut; and

b. as the screw rotates, forcing the drive nut along the axis in a first direction towards the distal end of the rod (40) or in a second direction away from the distal end of the rod (40), depending on a rotation direction of the screw and extending the rod (40) out from or retracting the rod (40) into its respective body, depending on the direction of rotation of the screw.

19. The method of effecting a change in a relationship between an upper plate (34) of a motion base and a lower plate (32) of a motion base of Claim 18, further comprising using a brake (164) operatively coupled to the screw to keep the screw from rotating when power is removed from the controllable rod extender.

20. The method of effecting a change in a relationship between an upper plate (34) of a motion base and a lower plate (32) of a motion base of Claim 15, wherein the controllable rod extender (150) further comprises a controllable rod extender controller (152) operatively coupled to the controllable rod extender (150) and the motion base further comprises a feedback control loop (156) operatively coupled to the controllable rod extender (150), the method further comprising:

a. obtaining a first signal indicative of a present effective parameter of the actuator (36);

b. inputting the first signal indicative of the present effective parameter of the actuator (36) to the feedback control loop (156);

c. obtaining a second signal indicative of a desired effective parameter of the actuator (36);

d. inputting the second signal indicative of the desired effective parameter of the rod (40) to the feedback control loop (156);

e. generating a compared signal;

f. providing compared signal to a servo amplifier (161) operatively in communication with the controllable rod extender (150); and

g. using the compared signal to send the control signal to each controllable rod extender of each actuator (36) to change the current effective state of the parameter of each actuator (36) as needed by moving each such actuator (36)'s extendable rod into each such actuator's body (38) or moving each such actuator (36)'s extendable rod out from each such actuator's body (38) such that the current effective state of the parameter for each of the plurality of actuators (36) matches the desired effective state of the parameter for that actuator (36).