[0017] A haptic interface of another example comprises a plurality of linear motion vibration actuators that are vibrated with similar frequency and phase. The amplitude of vibration of the actuators is preferably controlled to achieve a desired direction of overall vibration force. In one instance, the actuators each comprise of a moving magnet and a stationary electromagnet which applies forces onto the moving magnet.

[0018] A computer system may be provided according to the present invention which includes a graphical display and a haptic interface. The haptic interface may comprise a plurality of linear motion vibration actuators which are vibrated with similar frequency and phase. The amplitude of vibration of these actuators is controlled to achieve a direction of overall vibration force which corresponds to the direction of an event which is displayed on the computer system's graphical display. The haptic interface may comprise a pair of linear motion vibration actuators that are located in the handles of a hand held controller. The actuators can be vibrated with similar frequency and phase. The amplitude of vibration of these actuators is controlled to achieve a direction of overall vibration force which corresponds to the direction of an event which is displayed on the computer system's graphical display.

[0019] In another example, a vibration device comprises a plurality of rotary vibration actuators that are synchronously vibrated. A pair of rotary vibration actuators with eccentric weights may be employed. Here, one of the pair of actuators can be rotated clockwise and the other can be rotated counterclockwise in the same plane. The shaft angles at which the centrifugal force generated by the eccentric weights is preferably aligned for both actuators, and is desirably repeated for multiple revolutions. One or both of the actuators may be stepper motors. In one case, the centrifugal force generated by the eccentric weights is aligned to corresponds to a direction of an event within a computer simulation.

[0020] In accordance with an embodiment of the present invention, a vibration device is provided, which comprises a base member and a plurality of actuators coupled to the base member. The plurality of actuators includes a first actuator and a second actuator. The first actuator has a first member and a second member. The first member is operatively coupled to a first portion of the base member. The second member is moveable relative to the first member of the first actuator. The second actuator also has a first member and a second member. The first member is operatively coupled to a second portion of the base member. The second member is moveable relative to the first member of the second actuator. The vibration device also comprises means for synchronously vibrating at least the first and second ones of the plurality of actuators.

[0021] In one alternative, at least one of the first and second actuators preferably comprises a linear motion vibration actuator. In an example, the first member of the linear motion vibration actuator desirably includes a permanent magnet, the second member of the linear motion vibration actuator desirably includes an electromagnet, and the synchronously vibrating means is operable to modulate a magnetic force between the electromagnet and the permanent magnet. In another alternative, the first member of the linear motion vibration actuator desirably includes an electromagnet, the second member of the linear motion vibration actuator desirably includes a permanent magnet, and the synchronously vibrating means is operable to modulate a magnetic force between the electromagnet and the permanent magnet.

[0022] In another alternative, the vibration device further comprises a spring device coupled to the second member of the linear motion vibration actuator for providing a restoring force thereto. In a further alternative, the synchronously vibrating means operates the first and second actuators at a substantially identical phase and a substantially identical frequency. In yet another alternative, the synchronously vibrating means controls operation of the first and second actuators to vary at least one of an amplitude of a combined vibration force of the first and second actuators and a direction of the combined vibration force. In a further alternative, the second actuator may be oriented non-orthogonally relative to the first actuator.

[0023] In another alternative, the plurality of actuators further includes a third actuator having a first member and a second member. Here, the first member of the third actuator is coupled to a third portion of the base member, and the second member thereof is moveable relative to the first member of the third actuator. The first, second and third actuators are oriented such that the vibration device is operable to generate a three dimensional combined vibration force.

[0024] In a further alternative, at least one of the first and second actuators comprises a rotary actuator. In one example, the rotary actuator includes a pivoting mass. In this case the vibration device preferably further comprising a spring device coupled to the pivoting mass and to the base member. Here, the synchronously vibrating means is operable to control the vibration device at a resonant frequency of the pivoting mass and the spring device. The spring device may be coupled to the pivoting mass such that a nonlinear spring force is generated.

[0025] In another alternative, the vibration device further comprises a pair of spring devices. Here, at least one of the first and second actuators comprises a rocking actuator having a rocking mass pivotally coupled at one end thereof to the base member by the pair of spring devices.

[0026] In a further alternative, at least the first and second actuators of the plurality of actuators are synchronously vibrated for a first duration of time and are vibrated asynchronously for a second duration of time.

[0027] In accordance with another embodiment of the present invention, a vibratory control system is provided. The vibratory control system comprises a plurality of actuators coupled to a base, a plurality of drivers and a controller. The plurality of actuators includes first and second actuators. The first actuator has a first member and a second member moveable relative to the first member thereof. The first member of the first actuator is operatively coupled to a first portion of the base. The second actuator has a first member and a second member moveable relative to the first member thereof. The first member of the second actuator is operatively coupled to a second portion of the base. Each of the plurality of drivers is operatively coupled to one of the plurality of actuators. The controller is coupled to the plurality of drivers and operable to provide amplitude, phase