METHODS AND APPARATUSES FOR HAPTIC SYSTEMS

This application is a continuation-in-part of U.S. Patent Application Serial No. 14/808,247, filed July 24, 2015, which application is a continuation of U.S. Patent Application Serial No. 13/804,429, filed March 14, 2013, now U.S. Patent No. 9,146,069, which claims the benefit of U.S. Provisional Application No. 61/650,006, filed May 22, 2012, the entire contents of which are incorporated herein by reference. This application also claims benefit of U.S. Provisional Application No. 62/085,443, filed November 28, 2014, and U.S. Provisional Application No. 62/170,572, filed June 3, 2015, which are incorporated herein by reference.

U.S. Patent Application No. 14/551,526 is also incorporated by reference herein.

SUMMARY OF INVENTION

An aspect of the present invention provides a simulation system, comprising:

a body;

a linear motor attached to the body, the linear motor having at least two independent magnetic coils and a sliding mass having at least one magnet that magnetically interacts with at least one of the at least two independent magnetic coils when an electrical current is passed through at least one of the at least two independent magnetic coils;

a controller that controls movement of the sliding mass by controlling the electrical current going to at least one of the at least two independent magnetic coils, using pulse-width modulation, such that the sliding mass produces a force on the body that simulates a haptic effect.

An another aspect of the present invention provides a simulation system, comprising:

a body;

a linear motor attached to the body, the linear motor controlling a sliding mass;

a controller that controls movement of the sliding mass, by controlling a current of the linear motor using pulse-width modulation, such that the sliding mass produces a force on the body that simulates a haptic effect.

A further aspect of the present invention provides a simulation system, comprising:

a visual display in communication with a user;

a peripheral device including a body and a linear motor having a sliding mass;

a tracking system monitoring at least one of the user's movement and a movement of the peripheral device;

a computer system running a simulation and providing an output image from the simulation to the visual display and updating the image using a set of location data from the tracking system, the location data corresponding to at least one of the user's movement and the movement of the peripheral device,

wherein the computer system is in communication with a control system that controls the sliding mass, by controlling a current of the linear motor using pulse-width modulation, which produces a force on the body simulating a haptic effect that correlates with the simulation.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of a firearm training system, according to an exemplary embodiment of the present disclosure.

Figure 2 is a side view of a simulated firearm body of the system shown in Figure 1.

Figure 3 is a perspective view of an upper assembly of the simulated firearm body shown in Figure 2.

Figure 4 is an exploded view of the simulated firearm body shown in Figure 2.

Figure 5 is a perspective view of a linear motor and sliding mass, according to an exemplary embodiment of the present disclosure.

Figure 6 is an exploded side view of the linear motor and sliding mass shown in Figure 5.

Figure 7 is an assembled side view of the linear motor and sliding mass shown in Figure 6.

Figure 8 is a perspective view of a support bracket for a linear motor and sliding mass, according to an exemplary embodiment of the present disclosure.

Figure 9 is a side view of a simulated firearm body, according to an exemplary embodiment of the present disclosure.

Figure 10 is a schematic flow diagram of the simulated firearm system shown in Figure 1.

WHAT IS CLAIMED IS:

1. A simulation system, comprising:

a body;

a linear motor attached to the body, the linear motor having at least two independent magnetic coils and a sliding mass having at least one magnet that magnetically interacts with at least one of the at least two independent magnetic coils when an electrical current is passed through at least one of the at least two independent magnetic coils;

a controller that controls movement of the sliding mass by controlling the electrical current going to at least one of the at least two independent magnetic coils, using pulse-width modulation, such that the sliding mass produces a force on the body that simulates a haptic effect.

2. The simulation system of claim 1, wherein the controller has a programmed impulse value that directs the movement of the sliding mass.

3. The simulation system of claim 1, wherein the haptic effect is at least one of a simulated firearm recoil force, a gaming firearm effect, and a gaming peripheral device effect.

4. The simulation system of claim 1, wherein the haptic effect is a firearm recoil force for at least one of a rifle, pistol, heavy weapon, semi-automatic weapon, and automatic weapon.

5. The simulation system of claim 1, further comprising a mechanical stop, wherein the sliding mass is driven against the mechanical stop to simulate the haptic effect.

6. The simulation system of claim 5, wherein the mechanical stop includes an angled surface that transfers a portion of the force in a direction different than the direction of the sliding mass.

7. The simulation system of claim 1, wherein the body is a handgun and when the linear motor and the sliding mass are at rest in a starting position their center of gravity is substantially aligned with the center of gravity of the handgun.

8. The simulation system of claim 1, wherein the body is a rifle and when the linear motor and the sliding mass are at rest in a starting position their center of gravity is substantially aligned with the center of gravity of the rifle.

9. The simulation system of claim 1, further comprising a power unit that supplies power to at least one of the linear motor and the controller.

10. The simulation system of claim 9, wherein the power unit includes a battery that is fed into a circuit to step-up the voltage before being fed to the controller that is attached to the linear motor.

11. A simulation system, comprising:

a body;

a linear motor attached to the body, the linear motor controlling a sliding mass;

a controller that controls movement of the sliding mass, by controlling a current of the linear motor using pulse-width modulation, such that the sliding mass produces a force on the body that simulates a haptic effect.

12. The simulation system of claim 11, wherein the controller has a programmed impulse value that directs the movement of the sliding mass.

13. The simulation system of claim 11, wherein the haptic effect is at least one of a simulated firearm recoil force, a gaming firearm effect, and a gaming peripheral device effect.

14. The simulation system of claim 11, wherein the haptic effect is a firearm recoil force for at least one of a rifle, pistol, heavy weapon, semi-automatic weapon, and automatic weapon.

15. The simulation system of claim 11, wherein the body is at least one of a handgun, rifle, automatic weapon, semi-automatic weapon, wand, shock stick, tennis racket, golf club, bat, glove, chair, cricket bat, pool stick, boxing glove, gamepad, gaming controller, two handed controller, fishing rod and reel, light saber, sword, nun chucks, chainsaw, ax, knife, police baton, halo plasma gun, hockey stick, laser gun, badminton racket and bow and arrow.

16. The simulation system of claim 11, further comprising a mechanical stop, wherein the sliding mass is driven against the mechanical stop to simulate the haptic effect.

17. The simulation system of claim 16, wherein the mechanical stop includes an angled surface that transfers a portion of the force in a direction different than the direction of the sliding mass.

18. The simulation system of claim 17, wherein the force is transferred toward a person holding the body and substantially vertically relative to the person holding the body.

19. The simulation system of claim 16, wherein the mechanical stop is releasably secured to the body such that it is interchangeable with another mechanical stop.

20. The simulation system of claim 19, wherein the another mechanical stop includes a material different than the mechanical stop such that a different simulation effect is felt by a user.

21. The simulation system of claim 16, wherein the mechanical stop is adjustable such that the angle of impact of the sliding mass is changed such that a different simulation effect is felt by a user.

22. The simulation system of claim 21, wherein the mechanical stop is at least one of manually adjustable and automatically adjustable.

23. The simulation system of claim 11, wherein the body is a handgun and when the linear motor and the sliding mass are at rest in a starting position their center of gravity is substantially aligned with the center of gravity of the handgun.

24. The simulation system of claim 11, wherein the body is a rifle and when the linear motor and the sliding mass are at rest in a starting position their center of gravity is substantially aligned with the center of gravity of the rifle.

25. The simulation system of claim 11, wherein the body is a M4 rifle body.

26. The simulation system of claim 11, wherein the body is a heavy weapon and when the linear motor and the sliding mass are at rest in a starting position their center of gravity is substantially aligned with the center of gravity of the heavy weapon.

27. The simulation system of claim 26, wherein the body is a M2 heavy weapon body.

28. The simulation system of claim 11, further comprising a power unit that supplies power to at least one of the linear motor and the controller.

29. The simulation system of claim 28, wherein the power unit includes a battery.

30. The simulation system of claim 28, wherein at least one of the power unit and the controller are external to the body and tethered to the body by a power cord.

31. The simulation system of claim 28, wherein at least one of the power unit and the controller are directly connected to the body without a cord.

32. The simulation system of claim 28, wherein the power unit includes a battery that is fed into a circuit to step-up the voltage before being fed to the controller that is attached to the linear motor.

a computer system running a simulation and providing an output image from the simulation to the visual display and updating the image using a set of location data from the tracking system, the location data corresponding to at least one of the user's movement and the movement of the peripheral device,

wherein the computer system is in communication with a control system that controls the sliding mass, by controlling a current of the linear motor using pulse-width modulation, which produces a force on the body simulating a haptic effect that correlates with the simulation.

41. The simulation system of claim 40, wherein the visual display is a head mounted display that is attachable to the user.

42. The simulation system of claim 40, wherein the visual display is a projection based system that feeds images directly into the user's eyes.