(19) **United States**

(12) **Patent Application Publication** (10) Pub. No.: **US 2017/0065881 A1**
Grant et al. (43) **Pub. Date:** **Mar. 9, 2017**

(54) **PROGRAMMABLE GAME-BASED HAPTIC ENABLED GUN CONTROLLER**

(71) Applicant: **Immersion Corporation**, San Jose, CA (US)

(72) Inventors: **Danny Grant**, Laval (CA); **Erin Ramsay**, Dollard-des-Ormeaux (CA); **Ali Modarres**, Mont-Royal (CA); **David Birnbaum**, Oakland, CA (US); **Juan Manuel Cruz-Hernandez**, Montreal (CA); **Robert W. Heubel**, San Leandro, CA (US); **Hendrick Bartel**, San Francisco, CA (US)

Publication Classification

(51) **Int. Cl.**
A63F 13/285	(2006.01)
A63F 13/837	(2006.01)
A63F 13/92	(2006.01)

(52) **U.S. Cl.**
CPC *A63F 13/285* (2014.09); *A63F 13/92* (2014.09); *A63F 13/837* (2014.09)

(57) **ABSTRACT**

Various systems, game controllers, and methods for simulating various objects such as weapons are provided. For example, a game controller may include a trigger, a processor within the body that receives a trigger signal when the trigger is activated by the user. The processor may communicate with a computer running a software program such as a gaming application, and an actuator coupled to the trigger, the actuator configured to output a haptic effect to the trigger in response to receiving a control signal from the processor. The game controller may simulate a gun and generate a recoil effect. In some embodiments, the recoil effect may be generated by impacting a moving mass from a discharge end of the gun to a handle end of the gun. In some embodiments, the recoil effect may be generated by using a body part of a user as a tether.

FIG. 1

FIG. 2
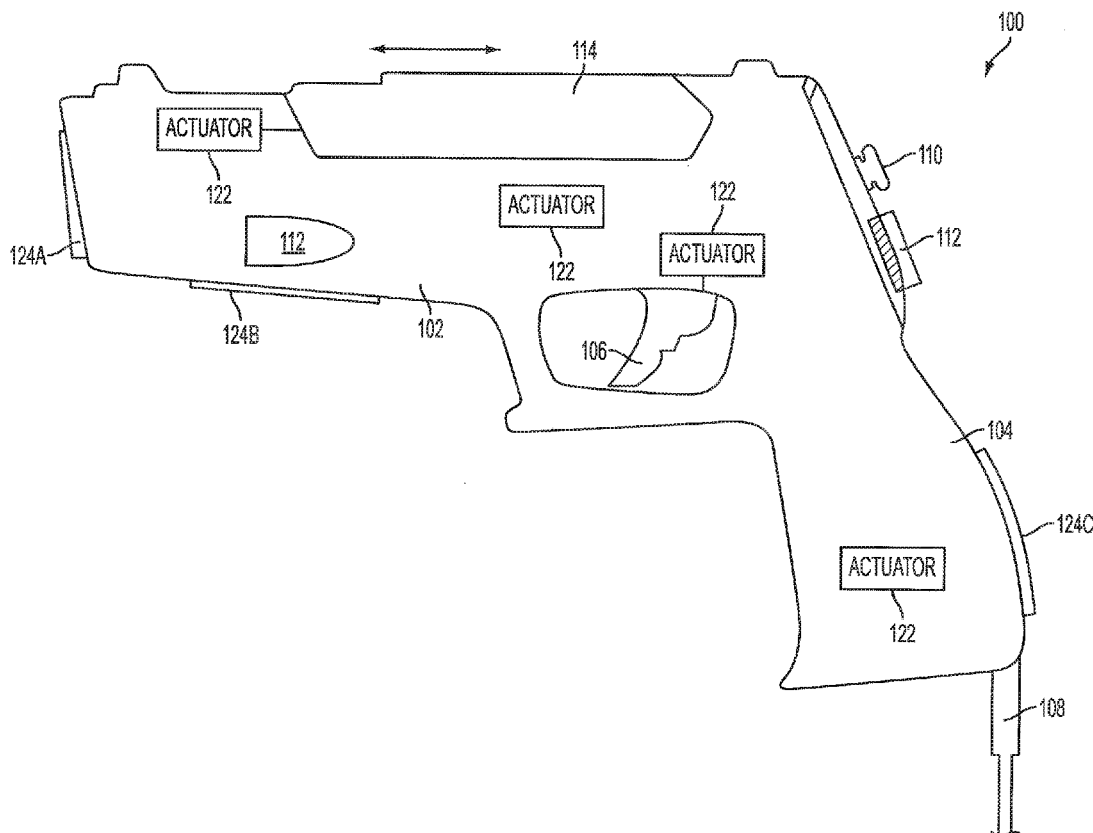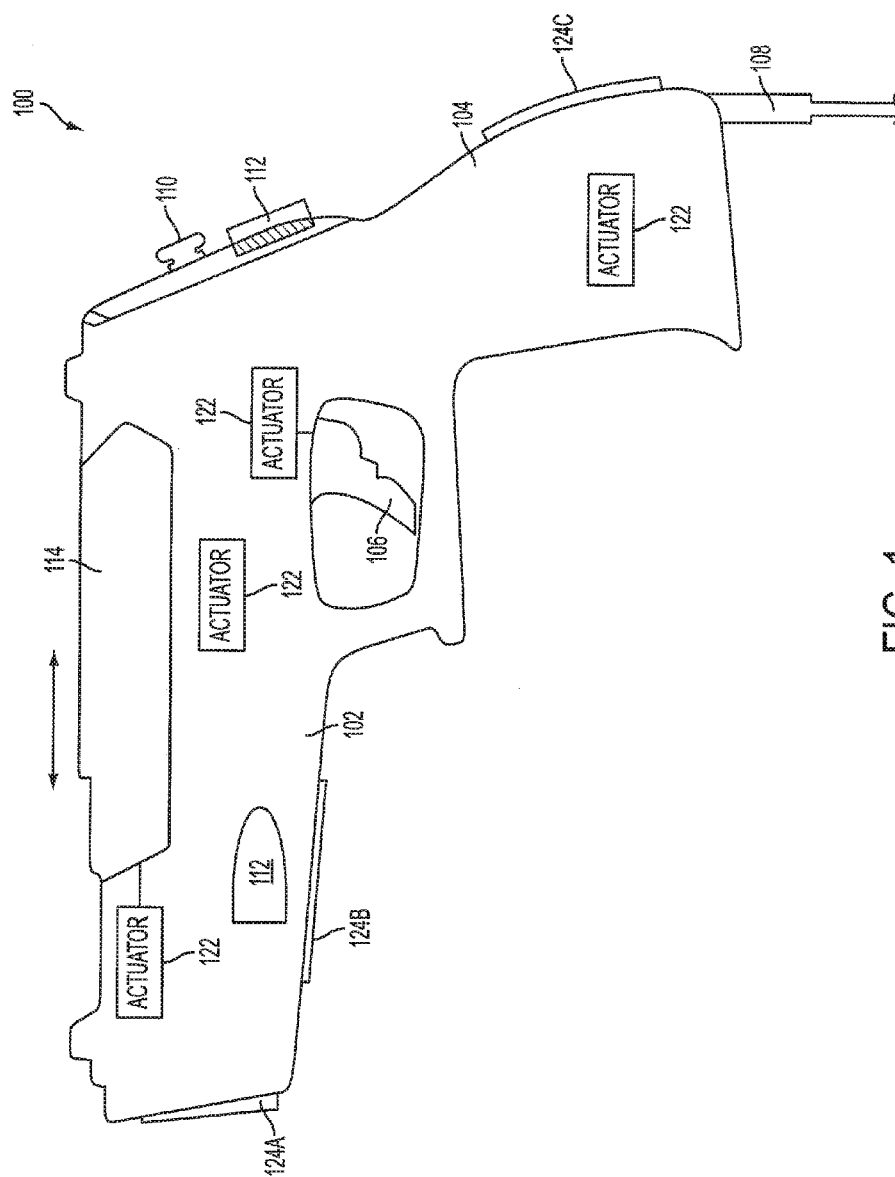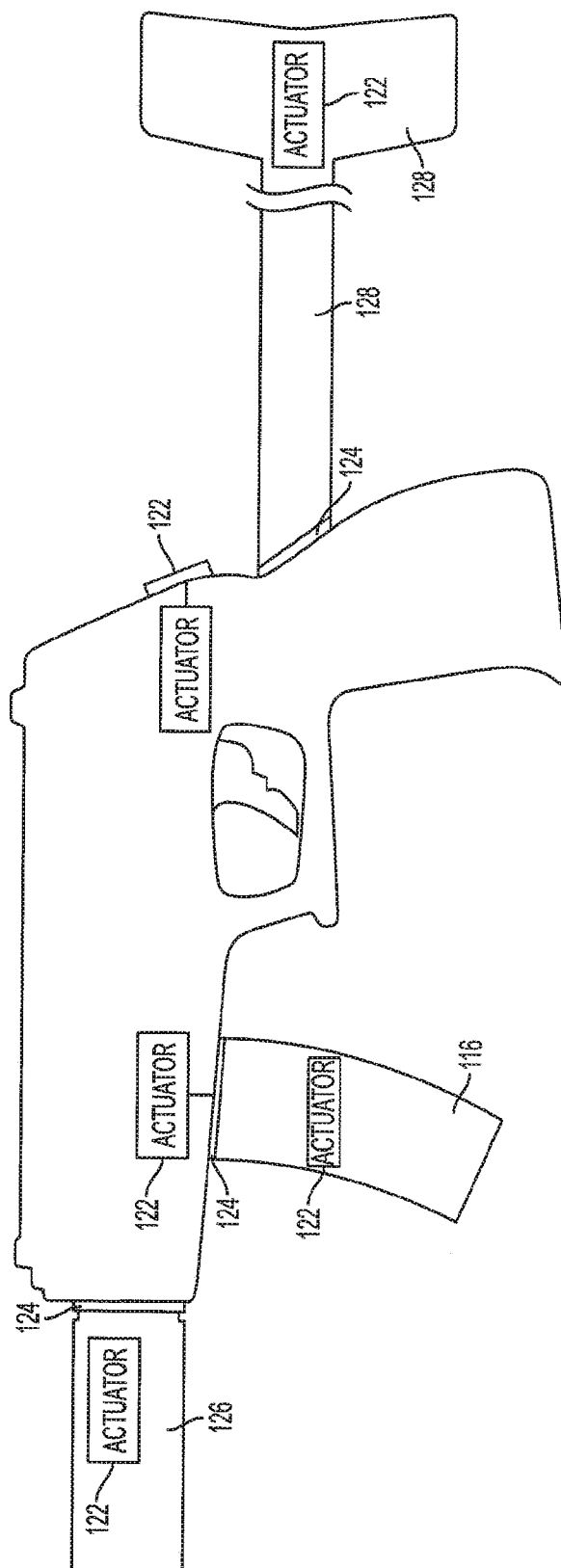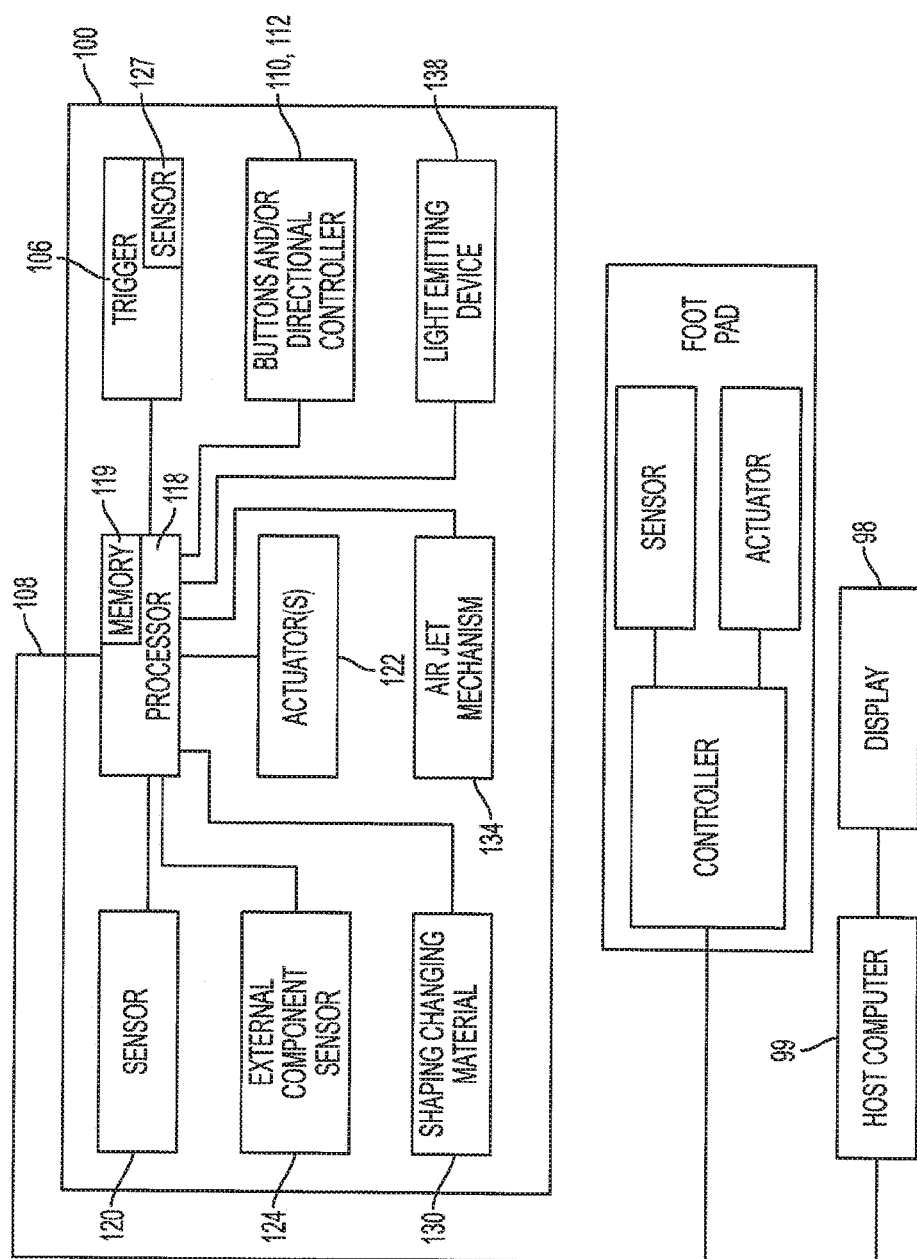
FIG. 3

FIG. 4
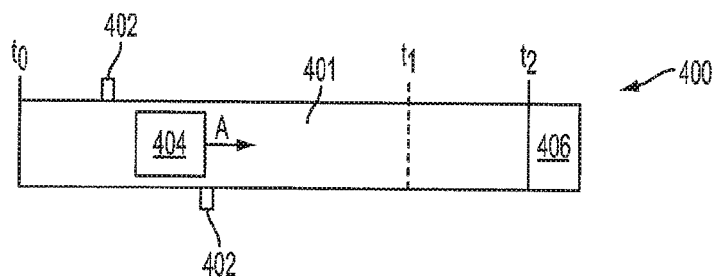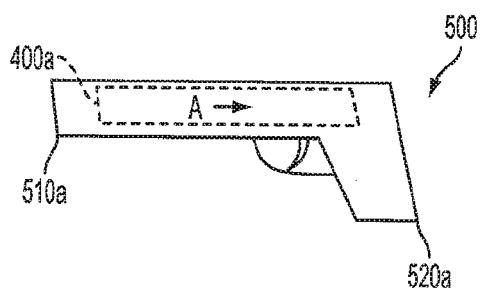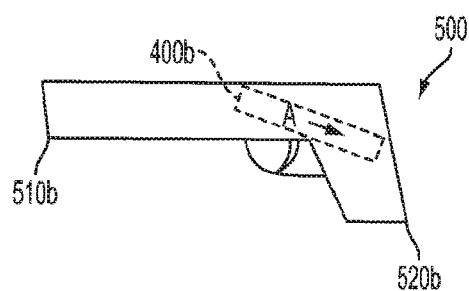
FIG. 5a

FIG. 5b
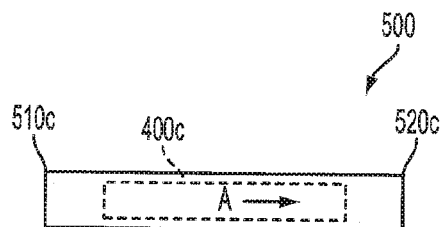
FIG. 5c

FIG. 6a

FIG. 6b

700

734

714

712

742

732

720

724

722

710

744

FIG. 7a

700

710

750

720

744

FIG. 7b

800

850

FIG. 8a

800

850

FIG. 8b

900

901

CONTROLLER
902

COMPUTER
904

903

RECOIL DEVICE
906

905

FIG. 9

1000a

1010

902

906a

904

FIG. 10a

1000b

1010

906b

902

904

FIG. 10b

1000c

1010

906c

1030

902

1020

1040
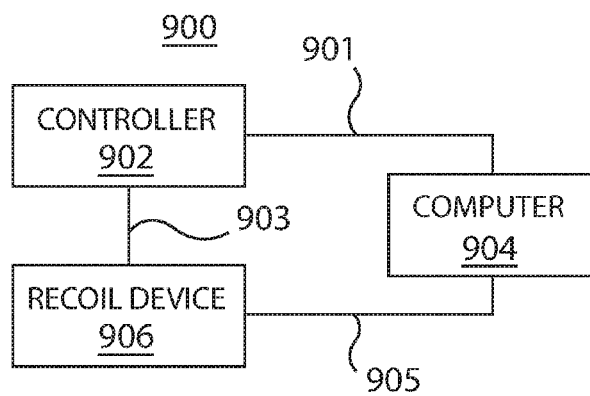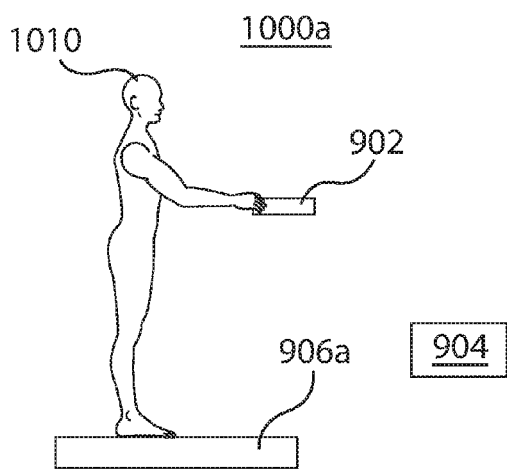
904
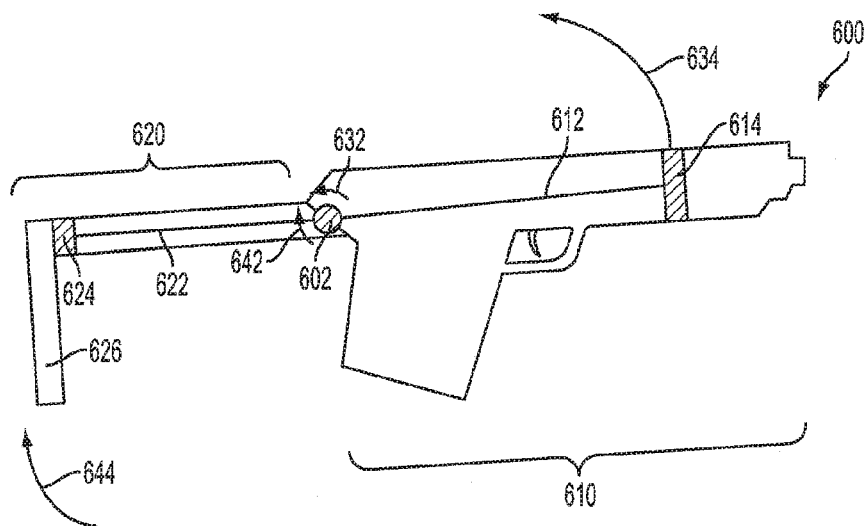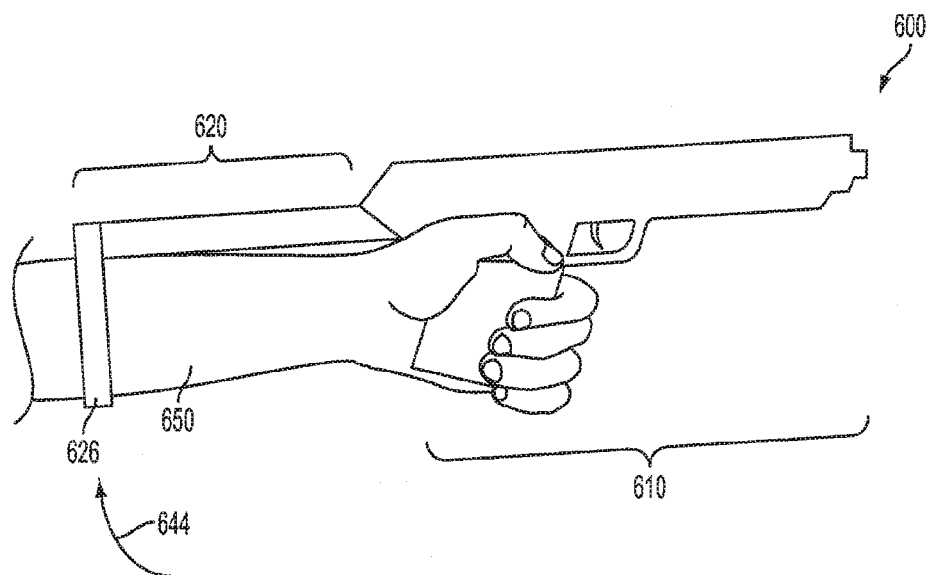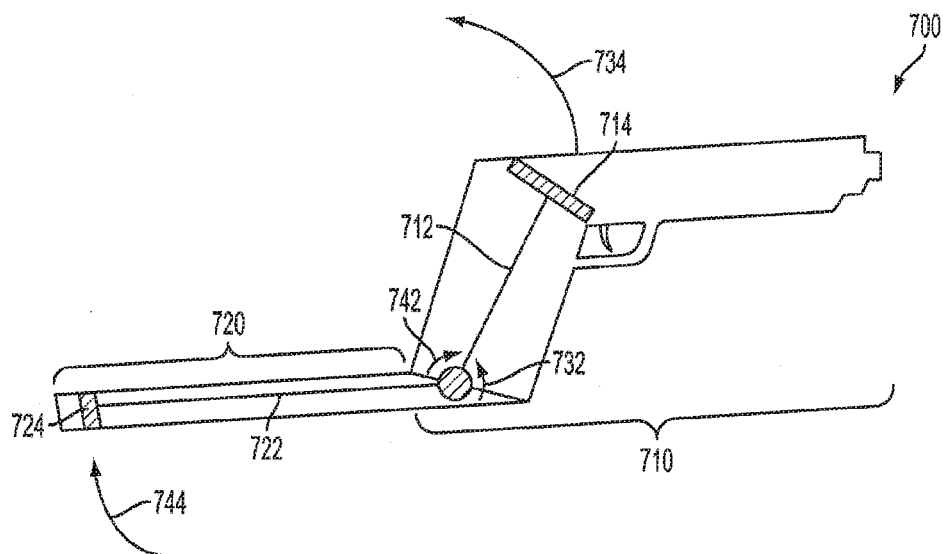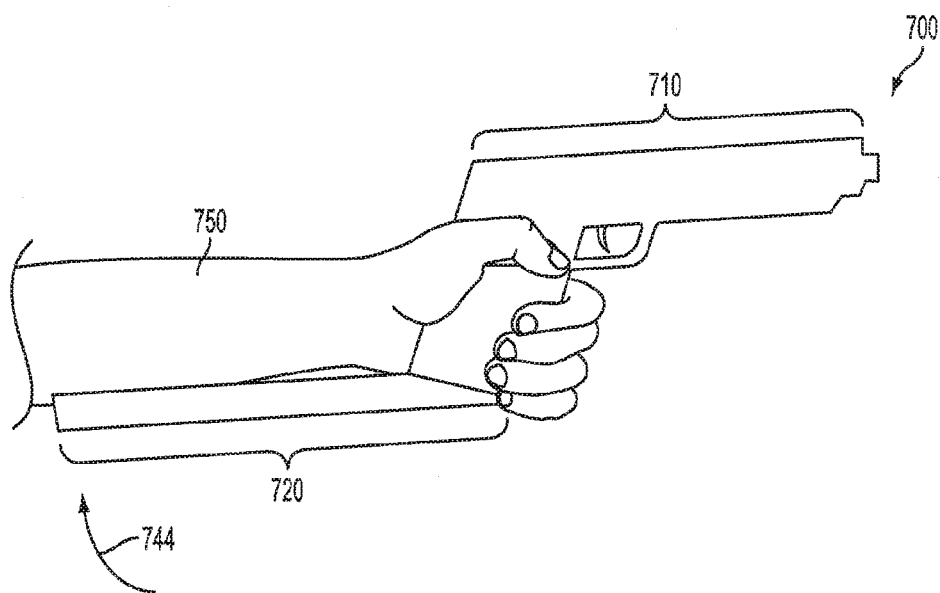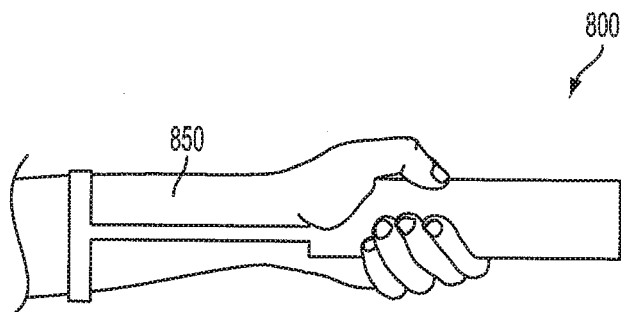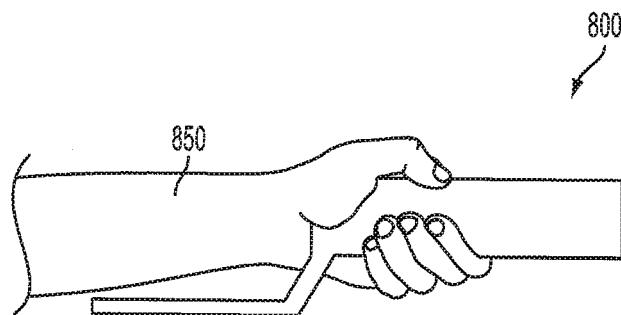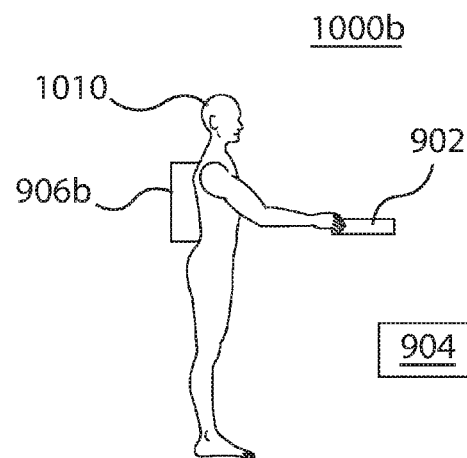
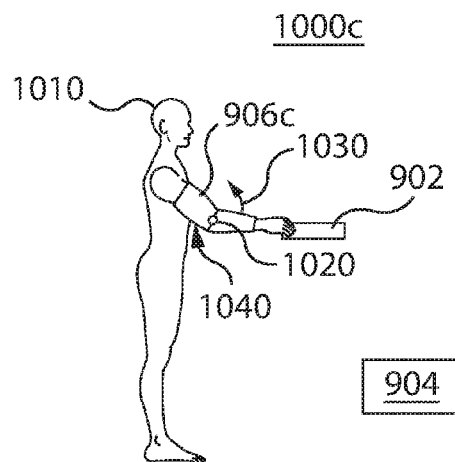FIG. 10c

PROGRAMMABLE GAME-BASED HAPTIC ENABLED GUN CONTROLLER

CROSS-REFERENCE TO RELATION APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 13/964,628 filed Aug. 12, 2013, now allowed, which is a divisional of U.S. patent application Ser. No. 12/652,599 filed Jan. 5, 2010, now U.S. Pat. No. 8,506,369 issued Aug. 13, 2013, which claims priority to U.S. Provisional Patent Application Ser. No. 61/142,864, filed Jan. 6, 2009, each of which are hereby incorporated by reference herein in their entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to a programmable game-based haptic enabled gun controller.

BACKGROUND

[0003] Video games and video game systems have become even more popular due to the marketing toward, and resulting participation from, casual gainers. Popular video game systems like the PLAYSTATION 3 and XBOX have shooting games in which regular palm-type controllers are used to move and operate a weapon. These systems may utilize controllers that output haptic effects which are presented to the user. The WII system utilizes a WIIMOTE controller which can fit into a plastic shell-shaped gun, whereby the WIIMOTE can provide limited haptic effects which are felt by the user during playing a gun game.

[0004] However, none of the existing systems or games are configured to provide the user with a gun controller that provides extreme realism which allows the user to be immersed in the gaming experience.

SUMMARY

[0005] The invention addressing these and other drawbacks in the art relates to systems, game controllers, and methods for simulating various objects such as weapons. For example, a game controller may include a body having a handle adapted to be grasped by a user, a trigger coupled to the body adapted to be operated by the user's finger, a processor within the body and configured to receive a trigger signal from the trigger when the trigger is activated by the user, the processor configured to communicate with a computer running a software program, and an actuator coupled to the trigger, the actuator configured to output a haptic effect to the trigger in response to receiving a control signal from the processor.

[0006] In some embodiments, a method of generating a recoil effect on a controller may include detecting a trigger signal, moving a mass, by an actuator in response to the trigger signal, from a first position at a discharge end of the controller in a first direction toward a second position, releasing the mass, by the actuator, at the second position such that the mass travels from the second position in the first direction to an end stop at a handle end of the controller and impacts the end stop using momentum from the actuator, where the impact generates the recoil effect.

[0007] In some embodiments, a method of generating a recoil effect remote from a controller may include detecting, by a recoil device remote from the controller, a trigger signal originating from the controller such that the recoil device

contacts a first location of a body of the user and the controller contacts a second location of the body of the user. The controller may be operated by the user to control a gaming application. The method may further include causing, by the recoil device in response to the trigger signal, a recoil effect to be output to a user at the first location remote from the second location.

[0008] Various other objects, features, and advantages of the invention will be apparent through the detailed description of the preferred embodiments and the drawings attached hereto. It is also to be understood that both the foregoing general description and the following detailed description are exemplary and not restrictive of the scope of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0009] The accompanying drawings, which are incorporated into and constitute a part of this specification, illustrate one or more examples of embodiments and, together with the description of example embodiments, serve to explain the principles and implementations of the embodiments.

[0010] FIG. 1 illustrates a side view of an example game controller in accordance with an embodiment.

[0011] FIG. 2 illustrates a side view of an example game controller in accordance with an embodiment.

[0012] FIG. 3 illustrates a block diagram of a game controller in accordance with an embodiment.

[0013] FIG. 4 is a block diagram of a recoil actuator that generates a recoil effect, according to various embodiments of the invention.

[0014] FIG. 5a is a block diagram of a controller, which includes a recoil component that generates a recoil effect, according to various embodiments of the invention.

[0015] FIG. 5b is a block diagram of a controller, which includes a recoil component that generates a recoil effect, according to various embodiments of the invention.

[0016] FIG. 5c is a block diagram of a controller, which includes recoil component that generates a recoil effect, according to various embodiments of the invention.

[0017] FIG. 6a is a cross-sectional illustration of a controller that generates a user-grounded recoil effect, according to various embodiments of the invention.

[0018] FIG. 6b is a block diagram of a controller that generates a user-grounded recoil effect, according to various embodiments of the invention.

[0019] FIG. 7a is a block diagram of a controller that generates a user-grounded recoil effect as held by a user, according to various embodiments of the invention.

[0020] FIG. 7b is a block diagram of a controller that generates a user-grounded recoil effect as held by a user, according to various embodiments of the invention.

[0021] FIG. 8a illustrates a controller that generates a user-grounded recoil effect as grasped by a user, according to various embodiments of the invention.

[0022] FIG. 8b illustrates a controller that generates a user-grounded recoil effect as grasped by a user, according to various embodiments of the invention.

[0023] FIG. 9 is a block diagram of a system for providing recoil effects, according to various embodiments of the invention.

[0024] FIG. 10a illustrates a system for providing recoil effects using a recoil device configured as a foot pad, according to various embodiments of the invention.

2

[0025] FIG. 10*b* illustrates a system for providing recoil effects using a recoil device configured as a wearable body device, according to various embodiments of the invention.

[0026] FIG. 10*c* illustrates a system for providing recoil effects using a recoil device configured as a wearable arm device, according to various embodiments of the invention.

DETAILED DESCRIPTION

[0027] Example embodiments are described herein in the context of a programmable game-based haptic enabled gun controller. Those of ordinary skill in the art will realize that the following description is illustrative only and is not intended to be in any way limiting. Other embodiments will readily suggest themselves to such skilled persons having the benefit of this disclosure. Reference will now be made in detail to implementations of the example embodiments as illustrated in the accompanying drawings. The same reference indicators will be used throughout the drawings and the following description to refer to the same or like items.

[0028] In the interest of clarity, not all of the routine features of the implementations described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application- and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skill in the art having the benefit of this disclosure.

[0029] In accordance with this disclosure, the components, process steps, and/or data structures described herein may be implemented using various types of operating systems, computing platforms, computer programs, and/or general purpose machines. In addition, those of ordinary skill in the art will recognize that devices of a less general purpose nature, such as hardwired devices, field programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), or the like, may also be used without departing from the scope and spirit of the inventive concepts disclosed herein. It is understood that the phrase "an embodiment" encompasses more than one embodiment and is thus not limited to only one embodiment. Where a method comprising a series of process steps is implemented by a computer or a machine and those process steps can be stored as a series of instructions readable by the machine, they may be stored on a tangible medium such as a computer memory device (e.g., ROM (Read Only Memory), PROM (Programmable Read Only Memory), EEPROM (Electrically Eraseable Programmable Read Only Memory), FLASH Memory, Jump Drive, and the like), magnetic storage medium (e.g., tape, magnetic disk drive, and the like), optical storage medium (e.g., CD-ROM, DVD-ROM, paper card, paper tape and the like) and other types of program memory.

[0030] FIG. 1 illustrates a schematic of a haptically enabled gun controller for use with a video game in accordance with an embodiment. As shown in FIG. 1, the controller 100 includes a body 102, a handle 104, a trigger 106, an input/output port 108 which may be wired, as shown, or wireless using any appropriate known technology. It should be noted that the gun controller shown in FIG. 1 is only an example and any other design of gun is contemplated. For instance, the controller may be designed to look like a semi-automatic or automatic rifle, shotgun, grenade launcher, and the like.

[0031] The particular controller 100 shown in FIG. 1 includes one or more directional-pad controllers 110 as well as one or more buttons 112 to operate various features during game play. In an embodiment, the controller 100 may include a slidable barrel 114 which the user may slide back and forth (as shown by the arrow) to load a virtual bullet into the chamber after the weapon is loaded. In addition, the controller 100 includes one or more actuators 122 located within various locations of the controller. More details regarding the different actuators are discussed below, although the same reference numeral is referred to for all actuators for clarity purposes.

[0032] In an embodiment, the gun controller 100 is reconfigurable to allow the user to expand the same base controller 100 into a rifle, shotgun or semi-automatic/automatic gun, as shown in FIG. 2. In particular, the controller 100 shown in FIGS. 1 and 2 includes an external component port 124 at the end of the barrel 124A, under the barrel 124B, and at the rear side of the handle 124C, although component ports 124 may be located elsewhere. It is also contemplated that any number of component ports (if any) are configured on the controller 100.

[0033] In the embodiment shown in FIG. 2, the controller 100 may be configured to engage removable stock and barrel components which would allow the user to use the controller like a rifle. In particular, the controller in FIG. 2 is shown to have an extended barrel 126 coupled to the controller 100 at port 124A, an additional handle (or cartridge) 116 coupled to the controller 100 at port 124B, and a stock butt 128 coupled to the controller at port 124C. It is preferred, however, that the center of mass of the controller 100 changes as external components are attached or removed from the base 102, whereby the change in the center of mass may adjust the weight and/or control of the controller (e.g. heaver when in a rifle configuration, lighter when in a regular pistol configuration). The detachable components may be hollow or made of a material which allows haptic effects from the base to be sufficiently felt at the attached component, which will be discussed in more detail below.

[0034] In an embodiment, as shown in FIG. 2, any or all of the detachable components 116, 126, 128 include one or more actuators 122 therein, whereby the component is electrically connected to the base 102 when attached thereto to allow the actuators 122 to operate in conjunction with the controller 100. The actuators 122 within the detachable components would thus preferably be connected to the base 102 and would receive respective control signals to activate those actuators 122 to output various haptic effects to the user. For example, the butt 128 of the stock may be designed to include one or more actuators 122 which activate in response to receiving a control signal from the processor (see FIG. 3). Upon receiving the control signal, the actuator 122 in the butt 128 would be configured to output a haptic effect which is directly felt in the user's arm (i.e. simulate recoil). It is contemplated that the handle (or cartridge) 116 also includes an actuator 122 therein electrically coupled to the controller 100, whereby the actuator 122 may output a vibration or pulse upon the controller 100 being "fired" by the user. Similarly, the extended barrel 126 may include an actuator 122 therein that is electrically coupled to the controller 100, whereby the actuator 122 may output a

vibration or pulse upon the controller **100** being fired by the user. Although not shown, the controller **100** may be configured to engage a tri-pod and/or scope to use the controller **100** as a sniper rifle.

[0035] The controller **100** is preferably configured to provide the user with the physically satisfying experience of simulating the act of reloading the weapon. As mentioned, the port **124** of the controller **100** may be a cartridge bay which allows the user to insert and remove a cartridge. The controller **100** may be configured to allow the use of double sided clips, whereby the user may pull the cartridge out and then re-set it. One or more actuators **122** of the controller **100** be programmed to output a haptic effect, such as a pulse, to indicate that the cartridge has been engaged. In an example, the controller **100** may utilize button **112** which the user presses, whereby a spring-like haptic effect may be output by the actuator **122** onto the button **112** to simulate the weapon being cocked. Additionally or alternatively, the controller **100** may be configured to allow the simulation of loading shotgun shells.

[0036] FIG. **3** illustrates a block diagram of the gun controller in accordance with an embodiment. As shown in FIG. **3**, the controller **100** preferably includes a local processor **118** which communicates with a video game console **99** (hereinafter referred to as well as the "host computer"). In an embodiment, transceiver port **108** connects the controller **100** to the host computer **99** via a wire. In another embodiment, the transceiver port **108** wirelessly connects the controller **100** to the host computer **99**. The host computer **99** is preferably coupled to a display **98** which displays the graphical environment of the video game. The controller **100** may be alternatively configured to not include the local processor **118**, whereby all input/output signals from the controller **100** are handled and processed directly by the host computer **99**.

[0037] The local processor **118** is preferably coupled to the controller trigger **106**, the directional-pad controller(s) **110** (if any), the button(s) **112** (if any), one or more sensors **120**, one or more actuators **122** as well as one or more optional external component ports **124**. The processor **118** may also be coupled to other components, such as a shape changing material **130** of the body, one or more light emitting devices **132** on the exterior of the body and an air jet mechanism **134**. It should be noted that the schematic shown in FIG. **3** is an example and not all of the components need to be incorporated into the controller **100**.

[0038] With regard to the one or more actuators **122** of the controller, the local processor **118** provides haptic effect signals to the actuators **122** based on high level supervisory or streaming commands from the host computer **99**. In the streaming embodiment, the voltage magnitudes and durations are streamed to the controller **100** where information is provided by the host computer **99** to the actuators **122**. In operation, the host computer **99** may provide high level commands to the local processor **118** such as the type of haptic effect to be output (e.g. vibration, jolt, detent, pop, etc.) by one or more selected actuators, whereby the local processor **118** instructs the actuator as to particular characteristics of the haptic effect which is to be output (e.g. magnitude, frequency, duration, etc.) The haptic effects thereby provide the user with the feeling that the controller **100** has come alive during game play, as would a real gun when used.

[0039] In an embodiment, the controller **100** is weapon-shaped, whereby the local processor **118** is preferably housed within the controller **100** and is not easily removable from the body of the controller **100** (e.g. XBOX, PLAY-STATION 3, etc.). In an embodiment, the local processor **118** is within a dedicated video game controller (e.g. WII remote control), whereby the weapon controller **100** is a shell which is configured to receive the dedicated video game controller therein. It is also contemplated that the controller **100** shell may include a dedicated local processor in addition to the processor **118** in the video game controller, whereby processing duties, communications and instructions are efficiently routed between the multiple processors to achieve greater speed, bandwidth, and flexibility.

[0040] The sensor **120** preferably monitors position and/or movement of the controller **100** (e.g. accelerometer) to track the position of the gun and provides sensor signals to the processor **118**. The processor **118** preferably transmits these sensor signals to the host computer **99** to dynamically operate the user's character and/or gun shown on the display **98** during game play. Additionally or alternatively, the sensor **120** may be configured to provide sensor signals directly to the host computer (shown by line **120**A). More details of the sensor **120** are discussed below.

[0041] The trigger **106** is coupled to the processor **118** whereby the trigger, when depressed, preferably outputs a trigger signal to the processor **118** to indicate that the user intends to shoot the weapon. The processor **118** and/or host computer **99** preferably determines whether the user is pointing to a designated target on the screen when the trigger **106** is pressed, and if the determination is affirmative, the target will be shown on the display **98** as being hit. In contrast, if the determination is negative, the target will be shown on the display as not being hit.

[0042] As shown in FIGS. **1** and **3**, the controller **100** includes one or more actuators **122** coupled to the trigger **106** (hereinafter referred to as a "trigger actuator"). In an embodiment, the trigger actuator **122** is configured to output a haptic effect upon receiving a control signal from the processor **118**, whereby the haptic effect provides the user with a realistic sensation of what the trigger of a real gun would feel like when operated. In an embodiment, a sensor **127** is coupled to the trigger to measure the distance that the trigger is moved by the user's finger. Such measured data is preferably used to utilize haptic effects having position-based and/or time-based components.

[0043] The actuator may output a haptic effect which incorporates any waveform having a position-based component and a predetermined time-based component. In other words, the position-based component is utilized to track the position of the trigger, whereby the predetermined time-based component is played when the position of the trigger has been reached. The predetermined time-based component can be based on a predefined waveform that is output as a function of time (i.e., defined before it is output). A predetermined time-based component, for example, can be stored in a processor-readable medium for retrieval by the processor **118** or other controller. For example purposes only, a predetermined time-based component can be a pulse waveform that has a maximum force and a duration of 75 ms. This waveform may be stored in, for example, a memory **119** and retrieved by a processor **118** when the processor **118** receives an indication that the trigger is at a desired position.

[0044] The position-based component can include, for example, a base-line waveform. In an embodiment, the position-based component can be a physical or a virtual spring force. In an embodiment, the position-based component of the haptic effect can be a sinusoidal detent profile, such as a series of pulses imparted onto the trigger **106**. Any base-line waveform in which the output force is a function of the position of the trigger may be used as the position-based component.

[0045] It is contemplated that the predetermined time-based waveform of the haptic effect can include a waveform having characteristics that are alterable based on detectable conditions. In one embodiment, the magnitude of the pre-determined time-based waveform may be changed based on a detected instantaneous velocity of the trigger **106** as it is being moved. In an alternative embodiment, the duration of the predetermined time-based waveform can be changed based on a detected instantaneous velocity of the trigger **106**. In an embodiment, the duration and the magnitude of the predetermined time-based waveform can be changed based on a detected instantaneous velocity of the trigger. The controller can acquire a predetermined time-based wave-form having different magnitudes depending on the detected velocity of the trigger. More details regarding time-based and position-based haptic effects are discussed in U.S. Pat. No. 7,283,120, assigned to Immersion Corporation.

[0046] As such, the trigger actuator **122** is programmable, whereby the actuator **122** can be set to output the haptic effect based on the sensed distance that the trigger is pressed by the user. For example, if the user is operating a revolver in the game, the trigger actuator **106** may be programmed to output a click or other haptic effect when the user presses the trigger past a desired position along the entire permitted distance of movement. In another example, if the user is operating an automatic rifle in the game, the trigger actuator **122** may be programmed to output a series of clicks or other haptic effects when the user presses the trigger only a slight distance from the neutral position. In yet another example, the trigger actuator **122** may be configured to output a resistive force toward the neutral position based on the type of gun the user is supposed to be handling. For lighter guns, such as pistols, the resistive force would be relatively less than with a heavier gun (e.g. Magnum) which would have a higher resistive force applied to the user's finger. In an embodiment, the user may choose through the controller **100** or the software to customize and set the threshold distance upon which the trigger actuator **122** will activate and/or the type of haptic effect which the trigger actuator **122** will output. In some embodiments, a simulated weapon may include modifications that may be taken into account when generating the resistive force. For example, a user may operate a handgun having a silencer in the game. The effects of the silencer, such as weight, shape, or other effect of the silencer may be taken into account when generating the resistive force. Thus, when the handgun, for example, includes a silencer, the resistive force may be different as compared to when the handgun does not include the silencer.

[0047] In an embodiment, the controller **100** includes one or more actuators **122** in the body, whereby the actuator **122** outputs a haptic effect to the body **102** to provide the user with a feeling that the weapon is actually discharging. It should be noted that the actuators **122** are shown in FIG. **2** in the body, although multiple actuators **122** are contemplated at different locations on the body. In an embodiment,

the body actuator **122** is programmable, whereby the actuator **122** is set to output varying haptic effects to the body **102** and/or handle **104** based on the type of the gun being simulated (e.g. semi-automatic, automatic, laser, etc.) Additionally or alternatively, the actuator **122** may be program-mable to output varying haptic effects based on the weight and/or caliber of the gun being simulated. For example, if the user is operating a revolver in the game, the body actuator **122** may be programmed by the software to output a single pulse when the user presses the trigger. In another example, if the user is operating an automatic or semi-automatic rifle in the game, the body actuator **122** may be programmed by the software to output a series of pulses to the body **102** when the user presses the trigger, thereby mimicking an automatic or semi-automatic rifle. The mag-nitude of the haptic effect output by the actuator may be varied depending on what type of the gun is being simulated (e.g., revolver vs. shotgun) as instructed by the software. In an embodiment, the user may choose through the controller **100** or the software to customize and set the type of haptic effect which the body actuator **122** will output.

[0048] The actuator **122** may be programmed by the software to output distinctive haptic effects for different kinds of weapons. For instance, the acceleration and/or frequency of the haptic effect may vary depending on mass, caliber, use (one hand vs. two) of the weapon. The trigger actuator and/or body actuator **122** may also output a dis-tinctive haptic effect click when the user is firing an empty weapon. This empty click could also differ based on the type of weapon being operated by the user.

[0049] In an embodiment, the controller **100** includes an actuator **122** within the handle **104** or stock butt, whereby the actuator **106** is configured to output a haptic effect which represents a recoil effect (hereinafter referred to as a "recoil actuator"). It is preferred that the recoil actuator **122** is programmable by the software to output a recoil force which differs based on the type of weapon that the user is operating. For example, if the controller **100** is configured to have a stock butt which sits against the user's arm or shoulder, a recoil actuator **122** in the body and/or the butt output a force, vibration, or other haptic effect which is felt as a shaking or moving of the user's arm or shoulder to give the recoil effect. It is possible to adjust the recoil to cause the butt or handle to move upward relative to the user's body, whereby the user's body is used as leverage to cause the handle or butt to move upward. The system may be configured such that the sensor **120** provides a sensor signal of the location where the barrel is pointed immediately after the recoil is output. This would provide the user with a more realistic experience of the difficulty of successfully hitting a target when the weapon has a substantial recoil effect.

[0050] As mentioned above, the controller **100** may include a slider **114** in an embodiment, whereby the user may slide the slider **114**, as with a real weapon, to ready the weapon for firing. The controller **100** may include an actuator **122** coupled to slider **114**, whereby the actuator outputs a haptic effect to be felt by the user as the slider **114** is slid along the body **102**. In an embodiment, the actuator **122** is programmed by the software to output different haptic effects based on the direction which the slider **114** is moved. For example, as the slider **114** is moved toward the handle **102** of the weapon, the actuator **122** may be programmed by the software to output a resistive force much like a real slider mechanism. The actuator **122** may also be programmed to

output a haptic effect (e.g., a click or pulse) when the slider **114** is moved a predetermined (or maximum) distance, such as to represent that the weapon is cocked. In the same example, as the slider **114** is moved back toward its default position, the actuator **122** may be programmed to output a same or different haptic effect (such as an assistive force) which is felt by the user. Additionally or alternatively, a spring or other urging member may be coupled to the slider **114**, whereby the spring applies the resistive and/or assistive forces to the slider **114** as it is moved.

[0051] In an embodiment, all or a portion of the controller **100** may be made of materials which react based on the amount of controller **100** use during game play. In particular, the materials of the controller **100** may be configured to change color and/or its exterior dimension based upon receiving a signal from the processor **118**. For example, excessive rate of fire could cause result in the barrel heating up as a precursor to a weapon jam. In this example, the processor **118** receives the amount of times the trigger is activated (or held down) in a set amount of time. Upon the processor **118** determining that the number of trigger activations exceed a predetermined threshold, the processor **118** sends a signal to the controller coupled to the material, whereby the material expands/contracts and/or changes color. The material is preferably configured to gradually expand/contract and/or change color as the trigger activations continue after exceeding the threshold. In an embodiment in which the body changes color, the body **102** may include a series of light emitting diodes (LED) or other light emitting devices **132** which gradually illuminate as the weapon "heats up". In some embodiments, actuator **122** is a temperature actuator that regulates the temperature of controller **100**. For example, the temperature actuator may provide heat to the weapon to mirror the temperature of the virtual weapon in gameplay. In an embodiment, the trigger actuator may receive a signal from the processor to output a hard stop haptic effect onto the trigger after a maximum number of trigger activations are tracked in the set amount of time. This hard stop haptic effect would simulate the weapon seizing due to overheating.

[0052] In an embodiment, the controller **100** includes one or more air jets **134** in the body and/or in a detachable component to provide the user with a different type of haptic effect when an event occurs during game play. The air jet is preferably positioned near the rear of the controller and faces back at the user, although the air jet may be placed anywhere else and/or positioned at any desired direction on the controller. The air jet can be used to expel air at the user when the weapon jams or a virtual bullet gets stuck in the chamber. In an embodiment, the air jet may expel air when the user's character on the display screen **98** takes a hit or is damaged. It is contemplated that other media besides air may be expelled, such as water, electrical charge (for electrotactile stimulation), etc. In an embodiment, an air compressor or cartridge is positioned within the body **102** whereby the compressor or cartridge discharges air when operated into a nozzle which expels the air out of the body (and towards the user). The compressor or cartridge may decrease in air pressure as the air is discharged, thereby giving a feeling of the weapon becoming effectively lighter. This effect could represent the weapon becoming lighter as the bullets are discharged.

[0053] In an embodiment, the controller **100** may include an accelerometer, gyroscope or other position-sensing tech-

nology which provides additional sensing capability of the controller **100** as it is moved during game play. In an embodiment, the user's character or gun displayed on the display screen **98** may adjust the position and/or orientation of the displayed weapon based on the sensed position of the controller **100** in the user's hands. For example, the displayed weapon would be shown in the proscribed vertical fashion when the accelerometer senses the controller **100** held vertically. In contrast, the displayed weapon would be shown to be held horizontally (e.g., an orientation used by gangsters and other villains in popular culture) when the accelerometer senses the user orienting the controller **100** horizontally. The haptic effects output by any or all of the controller's **100** actuator(s) may also change depending on sensed orientation of the controller **100**. In another example, the software may be enabled to operate with the accelerometer to show the user's character twirling the gun on the display in response to the user twirling the controller **100**. It is contemplated that the accelerometer may be used to shake loose a weapon jam (by shaking the controller), unlock the weapon for a secondary mode (e.g. using the grenade launcher), or to reload the weapon. In an embodiment in which the controller **100** simulates a shotgun, the accelerometer may track the user's quick upward movement of the controller to close the displayed shotgun after it is loaded. In an embodiment, the controller **100** is used with the software to play a quick draw game in which the user is duels with another player or the computer, whereby whoever draws from their holster and hits the opponent first wins the match. In this embodiment, the accelerometer tracks the speed at which the user's controller is moved from a downward position (such as in being in the user's holster) to pointing at the displayed opponent.

[0054] In an embodiment, the accelerometer in the controller **100** may be used to further influence game play. For example, the user may move the controller **100** after shooting a bullet to cause the bullet to alter its trajectory, such as curving around corners or imparting lateral acceleration of the bullet. In particular, the software run on the host computer changes the path of the bullet upon receiving sensor signals from the controller's accelerometer. For example, after the user pulls the trigger (and the bullet is along its trajectory), the user may move the controller upward, whereby the accelerometer, tracking such motion of the controller, sends sensor signals to the processor and ultimately to the host computer. The software program, upon receiving such sensor signals, causes the displayed bullet to move upward.

[0055] In an embodiment, the signals transmitted by the accelerometer may be used to measure and incorporate a user's 'steady-handedness' with the weapon when playing a game. For example, if the accelerometer may be configured to be extremely sensitive to the movements of the controller **100** when the user is operating the controller **100** as a sniper rifle in the game.

[0056] In an embodiment, the controller **100** may be used with a foot pad in which the foot pad includes one or more actuators which output haptic effects in response to receiving corresponding control signals from the host computer **99**. For example, the user standing on the foot pad may feel vibrations or individual pulses through the user's feet to simulate the feel of shells dropping around the user depending on the rate of fire and the caliber of the weapon. In particular, the processor **118** provides control signals to the

actuator in the foot pad in response to the controller **100** providing signals to the host computer indicating that the user is operating the trigger **106**. It is preferred that the actuators in the foot pad output the haptic effects in delayed response to the trigger **106** being operated to simulate the time that the bullet falls from the weapon to the ground. It should be noted that the foot pad may output haptic effects in response to other events occurring during game play (grenade explosion near the user, etc.). The foot pad can further comprise a force actuator that shifts the balance of the user, to further simulate the recoil forces of the firearm. In some embodiments, controller **100** and/or the foot pad may provide gaming effects to communicate information such as game events that are unrelated to the weapon. The gaming effects may be haptic effects, audio effects, and/or visual effects. In an embodiment, controller **100** may simulate an advanced weapon that communicates alerts to the user such as when entering a hostile area during a combat game. When entering the hostile area, for example, controller **100** may provide a haptic effect or other gaming effect to alert the user.

[0057] In an embodiment, the controller **100** may include one or more pressure sensors, touch screens, capacitive buttons or like technology to track how the user is holding the controller. For clarity, pressure sensors will be referred to, although any other appropriate technology is contemplated. The pressure sensor may be used with the software program to gauge the consistency of the user's action and whether the user would likely hit the target. For instance, the pressure handle may indicate that the user is holding a shotgun or larger caliber gun with one hand. The host computer and software program, upon receiving this information, may be less likely to reward the user with a confirmed hit. The host computer may also show the user's character holding the displayed weapon with one or two hands (along with accurate representations of where the hands are on the displayed weapon) depending on whether the pressure sensors indicate the user holding the controller with one or two hands.

[0058] FIG. 4 is a block diagram of a recoil actuator **400** that generates a recoil effect, according to various embodiments of the invention. According to various embodiments of the invention, recoil actuator **400** includes, among other things, a cavity **401**, a coil **402** coupled to cavity **401**, a moving mass **404**, and an end stop **406**. Cavity **401** may include be any shaped cavity through which moving mass **404** may travel such as, for example, cylindrical, oval, square, curvilinear, and/or other shaped cavity. As illustrated in FIG. **4**, coil **402** may be wrapped around cavity **401** or otherwise coupled to a surface of cavity **401**. Recoil actuator **400** may include, for example, a linear voice coil actuator or other actuator configured to move moving mass **404** toward end stop **406**.

[0059] In some embodiments, recoil actuator **400** may cause moving mass **404** to move in a first direction illustrated in FIG. **4** as arrow A through cavity **401** toward end stop **406**. In some embodiments, moving mass **404** may be composed of metal or otherwise have magnetic properties. Recoil actuator **400** may apply a current through coil **402**, thereby generating a magnetic field, which causes movement of moving mass **404** in the first direction. End stop **406** may be directly coupled to a housing or other component of a controller. Thus, impact of moving mass **404** with end stop **406** may generate the recoil effect to the controller.

[0060] In some embodiments, moving mass **404** may include different materials that provide different recoil effects depending on the material used. In some implementations, for example, moving mass **404** may be made from different materials that provide different impact sensations, thereby generating different recoil effects. In some implementations, at least a portion of moving mass **404** may include rubber (or other material), which changes the recoil effect as compared to when rubber is not used. For example, at least a portion of moving mass **404** may include a rubber portion that impacts end stop **406** and changes the recoil effect as compared to without the rubber portion. In some embodiments, end stop **406** may likewise include different materials that provide different recoil effects depending on the material used. Thus, in some embodiments, moving mass **404** and/or end stop **406** may include different materials that varies the haptic perception of the recoil effect.

[0061] In some embodiments, moving mass **404** is positioned at an origin position to and is moved toward a position t_1. At position t_1, moving mass **404** is released and travels to position t_2, where moving mass **404** impacts end stop **406**, thereby causing the recoil effect. In some embodiments, moving mass **404** is released by reducing the current applied to coil **402**. In some embodiments, the current is reduced to zero. In some embodiments, moving mass **404** is released when moving mass **404** moves beyond a range of coil **402**. For example, coil **402** may terminate at a position at or before position t_1. Thus, moving mass **404** is released when moved beyond position t_1.

[0062] In some embodiments, after impact with end stop **406**, moving mass **404** may move from position t to position t or other position, where moving mass **404** is recaptured. Upon recapture, moving mass **494** may be moved in a second direction opposite the first direction toward position for other position. Thus, once the recoil effect is delivered via impact between moving mass **404** and end stop **406**, recoil actuator **400** may recapture moving mass **404** in order to suppress unintended subsequent recoil effects. For example, recoil actuator **400** may provide a countering force that gradually increases over time to moving mass **404** after impact with end stop **306** in order to prevent undesirable or otherwise unintended recoil effects. In some embodiments, recoil actuator **400** may recapture moving mass **404** after a predefined period of time and/or number of impacts between moving mass **404** and end stop **306**. Thus, moving mass **404** may impact end stop **406** a number of times before being recaptured by recoil actuator **400**.

[0063] In some embodiments, the speed at which moving mass **404** is moved in the first direction may be varied to output different magnitudes of recoil. For example, moving mass **404** may be moved in the first direction at a higher speed to simulate a larger recoil for a larger simulated gun compared to a smaller simulated gun and vice versa. In some embodiments, different speeds are achieved by varying the current applied to coil **402**.

[0064] In an example operation, a trigger signal indicating that a trigger (or other user interface input) has been actuated may be received. In response to the trigger signal, recoil actuator **400** may move moving mass **404** from position t_0 to position t_1, at which point recoil actuator **400** may release moving mass **404**. Once released, moving mass **404** moves from position t_1 to position t_2 using momentum from recoil actuator **400**. At position t_2, moving mass **404** impacts end stop **406**, thereby causing the recoil effect. In some embodi-

ments, recoil actuator **400** may recapture moving mass **404** at position t₁ (or other position). In some embodiments, upon recapture, recoil actuator **400** may return moving mass **404** to position t₀ or other position.

[0065] FIG. **5***a* is a block diagram of a controller **500**, which includes recoil actuator **400***a* that generates a recoil effect, according to various embodiments of the invention. Controller **500** may include, among other things, a discharge end **510***a*, a recoil actuator **400***a*, and a handle end **520***a*. In some embodiments, controller **500** is configured to resemble a gun. Recoil actuator **400***a* may be positioned substantially parallel along a gun shaft of controller **500**.

[0066] In some embodiments, a user may point discharge end **510***a* away from the user toward a screen or other interface in order to simulate a shot. Handle end **520***a* may be positioned toward the user. Thus, when controller **500** is grasped by the user to simulate a shot at a screen or other interface, discharge end **510***a* may be positioned away from the user while handle end **520***a* may be positioned toward the user. In these embodiments, the first direction described above in FIG. **4** may be from discharge end **510***a* to handle end **520***a*.

[0067] FIG. **5***b* is a block diagram of a controller **500**, which includes recoil actuator **400***b* that generates a recoil effect, according to various embodiments of the invention. Controller **500** may include, among other things, a discharge end **510***b*, a recoil actuator **400***a*, and a handle end **520***b*. In some embodiments, controller **500** is configured to resemble a gun. Recoil actuator **400***a* may be positioned at a recoil angle offset from a gun shaft of controller **500**. In some embodiments, the positioning of recoil component causes a recoil effect force vector having a direction substantially perpendicular with a direction illustrated by the arrow A of motion of a moving mass, such as moving mass **404** illustrated in FIG. **4**. Thus, by varying the recoil angle, a recoil effect force vector may be varied. In some embodiments, a user may point discharge end **510***b* away from the user toward a screen or other interface in order to simulate a shot. Handle end **520***b* may be positioned toward the user. Thus, when controller **500** is grasped by the user to simulate a shot at a screen or other interface, discharge end **510***b* may be positioned away from the user while handle end **520***b* may be positioned toward the user. In these embodiments, the first direction described above in FIG. **4** may be from discharge end **510***b* to handle end **520***b*.

[0068] FIG. **5***c* is a block diagram of a controller **500**, which includes recoil actuator **400***c* that generates a recoil effect, according to various embodiments of the invention. Controller **500** may include, among other things, a discharge end **510***c*, a recoil actuator **400***a*, and a handle end **520***c*. In some embodiments, controller **500** is not shaped as a gun. In these embodiments, recoil actuator **400***c* may be positioned in a manner similar to those illustrated in FIGS. **5***a* and **5***b*. In other words, recoil actuator **400***c* may be positioned substantially parallel along a plane that spans a length of controller **500** or offset to intersect the plane. In some embodiments, the first direction may be from discharge end **510***c* toward handle end **520***c*.

[0069] In some embodiments, controller **500** may include one or more of a recoil actuator **400***a* and/or a recoil actuator **400***b*. Thus, although FIGS. **5***a*, **5***b*, and **5***c* illustrate a single recoil actuator **400**, those having skill in the art will appreciate that different numbers, combinations, and/or configurations of recoil actuator **400** may be used.

[0070] FIG. **6** is a cross-sectional illustration of a controller **600** that generates a user-grounded recoil effect, according to various embodiments of the invention. According to various embodiments of the invention, controller **600** may include, among other things, an actuator **602**, a controller base **610**, a linkage **612**, a controller anchor **614**, a grounding base **620**, a linkage **622**, a grounding anchor **624**, and a user engaging component **626**. Controller base **610** may be movably coupled to grounding base **620**. In some embodiments, controller base **610** is coupled to grounding base **620** via a hinge (not illustrated in FIG. **6***a*). In some embodiments, actuator **602** may be coupled to controller anchor **614** and grounding anchor **624** via linkage **612** and linkage **622**, respectively. Linkage **612** may be any rigid structure such as a wire through which actuator **602** imparts a force on controller anchor **614**. Similarly, linkage **622** may be a rigid structure through which actuator **602** imparts a force on grounding anchor **624**. User engaging component **626** is a structure for fastening grounding base **620** to a body part of a user such as a forearm. For example, user engaging component **626** may include a VELCRO strap, string, fabric, and/or other structure for fastening grounding base **620** to a body part of the user. In some embodiments, user engaging component **626** wraps around a body part of user **650**. For example, user **650** may slide a forearm through user engaging component **626**, then grasp controller **600**. In other embodiments, the engaging component sits naturally against the forearm in such a way that force can be applied to the forearm when the handle is gripped.

[0071] In some embodiments, actuator **602** is configured to impart a force on controller anchor **614** via linkage **612**. In some embodiments, the imparted force is a pulling force **632** that results in a force vector **634**. Force vector **634** causes controller base **610** to move in a direction of force vector **634** relative to a body part of user **650** (illustrated in FIG. **6***b*) thereby causing the recoil effect. In some implementations, controller anchor **614** may be positioned at a discharge end of controller **600**. Thus, force vector **634** may cause the recoil effect in a direction from the distal end of controller **600** toward a user grasping controller **600**.

[0072] In some embodiments, force vector **634** may cause a force vector **644** to be imparted on grounding base **620**. For example, actuator **602**, linkage **612** and linkage **622** may be coupled to a wound spool such that pulling force **632** causes force vector **634** and force vector **644**. Thus, pulling force **632** may urge together controller base **610** and grounding base **620** according to force vector **634** and force vector **644**.

[0073] When controller **600** is configured to be grasped by user **650** as illustrated in FIG. **6***b*, user engaging component **626** may fasten grounding base **620** to user **650**. Otherwise, in these embodiments, controller **600** may not be grounded and may not generate the recoil effect. Thus, instead of existing systems that may use a wall, desk, or other object apart from user **650**, controller **600** may be grounded using a body part of user **650**.

[0074] In some embodiments, actuator **602** is configured to impart a force on grounding anchor **624** via linkage **622**. In some embodiments, the imparted force is a pulling force **642** that results in a force vector **644**. Force vector **644** causes grounding base **620** to move in a direction of force vector **644** relative to a body part of user **650** (illustrated in FIG. **6***b*).

[0075] In some embodiments, actuator **602** imparts a combination of force vector **634** and force vector **644** to

8

thereby impart the recoil effect. In some embodiments, the magnitude of forces generated by actuator **602** may be varied to simulate different levels of recoil effects, such as a greater recoil effect for a larger simulated gun as compared to a smaller simulated gun.

[0076] FIG. 6*b* illustrates a controller **600** that generates a user-grounded recoil effect as grasped by user **650**, according to various embodiments of the invention. According to the embodiments illustrated by FIG. 6*b*, grounding base **620** (as illustrated in FIG. 6*a*) is positioned such that vector force **644** causes grounding base **620** to move away from a body part of user **650**. For example, grounding base **620** may be positioned above a forearm of user **650** when controller **600** is grasped in an upright position as illustrated. User engaging component **626** fastens controller **600** to user **650**, thereby holding grounding **620** substantially in place relative to user **650** as the recoil effect is delivered by controller **600**. Thus, by coupling controller **600** to a body part of user **650** via user engaging component **626**, vector force **644** is opposed by the body part of the user.

[0077] FIG. 7*a* is a cross-sectional illustration of a controller **700** that generates a user-grounded recoil effect, according to various embodiments of the invention. According to various embodiments of the invention, controller **700** may include, among other things, a recoil actuator **702**, a controller base **710**, a linkage **712**, a controller anchor **714**, a grounding base **720**, a linkage **722**, and a grounding anchor **724**. Controller base **710** may be movably coupled to grounding base **720**. In some embodiments, controller base **710** is coupled to grounding base **720** via a hinge (not illustrated in FIG. 7*a*). In some embodiments, recoil actuator **702** may be coupled to controller anchor **714** and grounding anchor **724** via linkage **712** and linkage **722**, respectively. Linkage **712** may be any rigid structure such as a wire through which recoil actuator **702** imparts a force on controller anchor **714**. Similarly, linkage **722** may be a rigid structure through which recoil actuator **702** imparts a force on grounding anchor **724**.

[0078] In some embodiments, recoil actuator **702** is configured to impart a force on controller anchor **714** via linkage **712**. In some embodiments, the imparted force is a pulling force **732** that results in a force vector **734**, thereby causing the recoil effect. Force vector **734** causes controller base **710** to move in a direction of force vector **734** relative to a body part of user **750** (illustrated in FIG. 7*b*). In some implementations, controller anchor **714** may be positioned at a discharge end of controller **700**. Thus, force vector **734** may cause the recoil effect in a direction from the distal end of controller **700** toward a user grasping controller **700**.

[0079] In some embodiments, force vector **734** may cause a force vector **744** to be imparted on grounding base **720**. For example, recoil actuator **702**, linkage **712** and linkage **722** may be coupled to a wound spool such that pulling force **732** causes force vector **734** and force vector **744**. Thus, pulling force **732** may urge together controller base **710** and grounding base **720** according to force vector **734** and force vector **744**.

[0080] When controller **700** is configured to be grasped by user **750** as illustrated in FIG. 7*b*, grounding base **720** may contact a body part of user **750** when urged upward by vector force **744**. Thus, the body part of user **750** blocks a path of grounding base **720** and therefore a user engaging portion

may not be needed. In some embodiments, controller may nonetheless include a user engaging portion (not illustrated in FIG. 7*b*).

[0081] In some embodiments, recoil actuator **702** is configured to impart a force on grounding anchor **724** via linkage **722**. In some embodiments, the imparted force is a pulling force **742** that results in a force vector **744**. Force vector **744** causes grounding base **720** to move in a direction of force vector **744** relative to a body part of user **750** (illustrated in FIG. 7*b*).

[0082] In some embodiments, recoil actuator **702** imparts a combination of force vector **734** and force vector **744** to thereby impart the recoil effect. In some embodiments, the magnitude of forces generated by recoil actuator **702** may be varied to simulate different levels of recoil effects, such as a greater recoil effect for a larger simulated gun as compared to a smaller simulated gun.

[0083] FIG. 7*b* illustrates a controller **700** that generates a user-grounded recoil effect as grasped by user **750**, according to various embodiments of the invention. According to the embodiments illustrated by FIG. 7*b*, grounding base **720** (as illustrated in FIG. 7*a*) is positioned such that vector force **744** causes grounding base **720** to move toward a body part of user **650**. For example, grounding base **720** is positioned below a forearm of user **750** when controller is grasped in an upright position as illustrated. In these embodiments, a body part of user **750** is positioned in a path that opposes movement of grounding base **720** when vector force **744** is applied, thereby resisting motion of grounding base **720** in a direction of vector force **744**. Thus, the body part of user **750** may be used as a ground to impart the recoil effect.

[0084] FIGS. 8*a* and 8*b* illustrate a controller **800** that generates a user-grounded recoil effect as grasped by user **850**, according to various embodiments of the invention. According to various embodiments of the invention illustrated by FIGS. 8*a* and 8*b*, controller **800** may be shaped in the form of a rectangle or other shape not resembling a gun. In these embodiments, controller **800** may include components described above with respect to controller **600** and controller **700** to provide the recoil effect.

[0085] FIG. **9** is a block diagram of system **900** for providing recoil effects, according to various embodiments of the invention. According to various embodiments of the invention, system **900** may include, among other things, a controller **902**, a computer **904**, and a recoil device **906**. Controller **902** may be communicably coupled to computer **904** and to recoil device **906** via links **901** and **903**, respectively. Recoil device **906** may be communicably coupled to computer **904** via link **905**. Links **901**, **903**, and **905** may be any communication link such as known wired or wireless links. In some embodiments, controller **902** may control an application such as a game running on computer **904**, which may be a gaming console. In some embodiments, although illustrated in FIG. **9** as separate devices, controller **902** and computer **904** may include an integrated device such as a handheld gaming device (e.g., SONY PSP).

[0086] In some embodiments, recoil device **906** includes an actuator (not illustrated in FIG. **9**), such as actuator **122** described above, configured to output haptic feedback. In some embodiments, recoil device **906** is remote from controller **902**. In other words, recoil device **906** may be a standalone device that generates recoil effects to a user. In some embodiments, recoil device **906** may be coupled to the user. For example, recoil device **906** may be worn on a body

part of the user, contacted by a foot of the user such as by the user standing on recoil device **906**, or otherwise be coupled to the user.

[0087] In some embodiments, recoil device **906** responds to input from controller **902**. In these embodiments, recoil device **906** is coupled to controller **902** and receives an input signal, such as a trigger signal, from controller **902**. The trigger signal may be generated in response to a gun shot being simulated such as when a user manipulates a user interface member (not illustrated in FIG. **9**) of controller **902** to simulate pulling a trigger of a gun. In response to the input signal received from controller **902**, recoil device **906** may impart a haptic effect to the user, thereby generating a recoil effect to simulate a recoil of a gun.

[0088] In some embodiments, recoil device **906** responds to input from computer **904**. In these embodiments, recoil device **906** is coupled to and receives an input signal from computer **904**. For example, computer **904** may receive a trigger signal from controller **902** in response to which computer **904** transmits the input signal to recoil device **906**. In response to the input signal received from computer **904**, recoil device **906** may impart a haptic effect to the user, thereby generating a recoil effect to simulate the recoil.

[0089] FIG. **10a** illustrates a system **1000a** for providing recoil effects using a recoil device **906a** configured as a foot pad, according to various embodiments of the invention. According to various embodiments of the invention, a user **1010** may grasp controller **902** while interacting with computer **904** such as when playing a game. User **1010** stands on recoil device **906a**, which is configured as a foot pad or other device on which user **1010** stands. In these embodiments, recoil device **906a** may generate haptic force such that a balance of user **1010** shifts. For example, recoil device **906a** may include one or more force actuators (not illustrated in FIG. **10a**) that move in response to a trigger signal. Movement of the one or more force actuators may contact a foot of user **1010**, altering the balance of user **1010**, thereby simulating a recoil effect.

[0090] FIG. **10b** illustrates a system **1000b** for providing recoil effects using a recoil device **906b** configured as a wearable body device, according to various embodiments of the invention. According to various embodiments of the invention, user **1010** may grasp controller **902** while interacting with computer **904** such as when playing a game. User **1010** may wear recoil device **906b** on and/or around a body part of user **1010**. For example, recoil device **906b** may be configured as a vest to be worn around a torso of user **1010**, a backpack to be worn around a back of user **1010**, or other wearable device. In these embodiments, a haptic effect may be imparted to the body part of user **1010** while recoil device **906b** is worn by user **1010**. In this manner, user **1010** may feel the recoil effect at one or more parts of the body of user **1010**.

[0091] FIG. **10c** illustrates a system **1000c** for providing recoil effects using a recoil device **906c** configured as a wearable arm device, according to various embodiments of the invention. According to various embodiments of the invention, user **1010** may grasp controller **902** while interacting with computer **904** such as when playing a game. User **1010** may wear recoil device **906c** on and/or around at least a portion of an arm of user **1010**. In some embodiments, recoil device **906c** may generate haptic effects to the arm of user **1010**. In some embodiments, recoil device **906c** may include an actuator **1020** that imparts moving forces

1030 and **1040** on the arm of user **1010** similar in action to actuators **602** and **702** described above in FIGS. **6** and **7**, respectively, thereby generating the recoil effect directly on an arm of user **1010**.

[0092] Although FIGS. **10a**, **10b**, and **10c** illustrate user **1010** grasping controller **906**, user **1010** may interact with recoil device **906a**, **906b**, and **906c** in an absence of interacting with controller **906**. For example, user **1010** may stand on recoil device **906a** configured as a foot pad without grasping controller **902**. In these embodiments, simulated recoil effects may respond to a trigger signal originating from computer **904** and/or from recoil device **906a**, such as when recoil device **906a** includes a user interface member that acts as a trigger. Furthermore, recoil device **906** may be used with other devices and/or controllers disclosed herein as would be apparent to those having skill in the art.

[0093] While embodiments and applications have been shown and described, it would be apparent to those skilled in the art having the benefit of this disclosure that many more modifications than mentioned above are possible without departing from the inventive concepts disclosed herein. The invention, therefore, is not to be restricted except in the spirit of the appended claims.

1-27. (canceled)

28. A game controller comprising:

a body having a handle adapted to be grasped by a user;

a trigger coupled to the body adapted to be operated by the user's finger;

a directional-pad control coupled to the body, the directional-pad control adapted to be operated by the user;

a processor within the body and configured to receive a trigger signal from the trigger when the trigger is activated by the user and to receive a pad signal from the directional-pad control, the processor configured to communicate with a computer running a software program; and

an actuator coupled to the body, the actuator configured to output a haptic effect to the body in response to receiving a control signal from the processor.

29. The game controller of claim **28**, further comprising a position sensor coupled to the body, the position sensor configured to track the position and/or orientation of the controller and provide sensor signals to the processor and/or the computer regarding the position of the controller.

30. The game controller of claim **29**, wherein the position sensor is an accelerometer or a gyroscope.

31. The game controller of claim **29**, wherein the sensor signals from the position sensor are configured to be used by the processor and/or the computer to adjust the position and/or orientation of a character of the user in the software program.

32. The game controller of claim **29**, wherein the sensor signals from the position sensor are configured to be used by the processor and/or the computer to adjust the position and/or orientation of an object held by a character of the user in the software program.

33. The game controller of claim **28**, wherein the directional-pad control is configured to operate various features during game play.

34. The game controller of claim **28**, further comprising a touch sensor configured to track how the user is holding the controller, wherein the touch sensor is further configured to communicate touch sensing information to the computer.

35. The game controller of claim **34**, wherein the touch sensor is configured to track where and/or with how many hands the user is holding the controller.

36. A game controller comprising:

a body having a handle adapted to be grasped by a user;

a trigger coupled to the body adapted to be operated by the user's finger;

a processor within the body and configured to receive a trigger signal from the trigger when the trigger is activated by the user and to receive a pad signal from the directional-pad control, the processor configured to communicate with a computer running a software program; and

a trigger actuator coupled to the trigger, the trigger actuator configured to output a haptic effect to the trigger in response to receiving a control signal from the processor, wherein the trigger actuator is configured to output a resistive force toward a neutral position of the trigger.

37. The game controller of claim **36**, wherein the resistive force is varied depending on the control signal received from the processor.

38. The game controller of claim **37**, wherein the resistive force is varied based on selections made by the user.

39. The game controller of claim **36**, further comprising a body actuator coupled to the body, wherein the body actuator is configured to output a haptic effect to at least a portion of the body in response to receiving a control signal from the processor

40. A game system comprising:

a computer configured to operate a software program; and

a controller including;

a body having a handle adapted to be grasped by a user,

a trigger coupled to the body adapted to be operated by the user's finger,

a directional-pad control coupled to the body adapted to be operated by the user,

a processor within the body and configured to receive a trigger signal from the trigger when the trigger is activated by the user and to receive a pad signal from the directional-pad control, the processor configured to communicate with the computer, and

an actuator coupled to the body, the actuator configured to output a haptic effect to the body in response to receiving a control signal from the processor.

41. The game controller of claim **40**, further comprising a position sensor coupled to the body, the position sensor configured to track the position and/or orientation of the controller and provide sensor signals to the processor and/or the computer regarding the position of the controller.

42. The game controller of claim **41**, wherein the position sensor is an accelerometer or a gyroscope.

43. The game controller of claim **41**, wherein the sensor signals from the position sensor are configured to be used by the processor and/or the computer to adjust the position and/or orientation of a character of the user in the software program.

44. The game controller of claim **41**, wherein the sensor signals from the position sensor are configured to be used by the processor and/or the computer to adjust the position and/or orientation of an object held by a character of the user in the software program.

45. The game controller of claim **40**, wherein the directional-pad control is configured to operate various features during game play.

46. The game controller of claim **40**, further comprising a touch sensor configured to track how the user is holding the controller, wherein the touch sensor is further configured to communicate touch sensing information to the computer.

47. The game controller of claim **46**, wherein the touch sensor is configured to track where and/or with how many hands the user is holding the controller.

* * * * *