ACCELERATION-SENSING LOADER ACTIVATION SYSTEM AND METHOD

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Appl. No.: 11/957,829
Filed: Dec. 17, 2007

Related U.S. Application Data
Provisional application No. 60/886,605, filed on Jan. 25, 2007.

Publication Classification
Int. Cl.
F41B 15/00 (2006.01)

U.S. Cl. ............................................. 124/82; 124/54

ABSTRACT

An acceleration-sensing loader activation system can include an acceleration sensor configured to generate an electrical signal corresponding to the magnitude and periodicity of movement of a marker or loader body or a marker or loader component. A signal filter circuit can be arranged in communication with the acceleration sensor to receive and filter the electrical signal. A signal amplifier circuit can be arranged in communication with the signal filter circuit to amplify a signal from the signal filter circuit and transmit the amplified signal to a signal processing circuit. The signal processing circuit can be programmed to evaluate the incoming signal and determine whether it corresponds to a desired actuation event (such as a firing event). If the signal processing circuit determines that a desired actuation event has occurred, it can then send a control signal to a control circuit to activate a feed device of the loader. A method of activating a loader assembly preferably includes using an acceleration sensor to detect movement of a paintball marker or loader's operating mechanisms and/or body and to output an electrical signal proportional to the magnitude and periodicity of the movement. The resulting signal is then preferably processed using filtering, amplification, and digital signal processing circuitry to determine whether the movement corresponds to a desired actuation event and, if so, to provide an activation signal to activate a loading operation of the paintball loader's internal feed mechanism.
Logic Flow Diagram for Accelerometer Based Shot Detection in Paintball Hopper Mechanism

FIG. 1

FIG. 2
FIG. 5

S1

SENSE ACCELERATION AND GENERATE SIGNAL

S2

FILTER AND AMPLIFY SIGNAL

S3

PROCESS SIGNAL

S4

ACTIVATION EVENT?

S5

ACTIVATE FEED DEVICE
ACCELERATION-SENSING LOADER ACTIVATION SYSTEM AND METHOD

PRIORITY CLAIM

[0001] This application is a non-provisional application of and claims priority from copending U.S. Provisional Patent Application No. 60/886,605, filed Jan. 25, 2007, the contents of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present invention relates to mechanisms and methods for activating a motor or other agitator or feed system in a paintball marker loader. In particular, this invention relates to a method and mechanism for sensing a firing or other operation of the paintball marker and activating the loader in response thereto.

BACKGROUND OF THE INVENTION

[0003] Present day paintball markers are capable of high rates of fire. Higher firing rates also, however, require faster loading rates in order to provide a sufficient supply of paintballs to the paintball marker. Conventional loaders have utilized various methods and mechanisms to assist in feeding paintballs from the loader into the paintball marker at higher speeds. Typically, these may rely on an electronic “eye” (optical sensor) or sound sensor to detect a firing operation of a paintball marker and to activate a supply of paintballs in the loader to ensure that paintballs are arranged in the neck of the loader in proximity to a feed neck of the paintball marker. Unfortunately, electronic “eyes” may have difficulty sensing the presence or absence of a paintball under various situations. In particular, the ambient lighting and the color of the paintballs can affect the ability of the “eyes” to detect paintballs. The optical sensors may also become dirty and have difficulty sensing paintballs. Sound activation mechanisms are also subject to error as they may respond to the sound of other paintball markers firing or other ambient noises. A more reliable loader activation system and method is therefore desirable.

SUMMARY OF THE INVENTION

[0004] When a paintball marker is activated or fired, a sequence of internal mechanical events occurs to propel the paintball out of the marker. The internal mechanical movements of the firing mechanism and the resulting release of the paintball create forces which cause movement (acceleration) of the marker body and attached paintball loader assembly during a shot sequence. By sensing these accelerations (such as by means of an acceleration sensor with appropriate signal filtering, signal amplification and signal processing), it can be determined when a paintball marker firing (or other desired activation event) occurs. This processed activation event signal can then be used to activate the feed mechanism of a paintball loader to initiate the paintball loading process. The acceleration sensor may, for instance, be used as part of the marker control system or it may be integrated directly into a paintball loader control system.

[0005] According to principles of the present invention, an acceleration sensing mechanism may include an acceleration sensor located on or within the paintball marker body or on or within a paintball loader body. A signal filter circuit can be arranged in communication with the acceleration sensor to receive and filter signals responsive to movement of the acceleration sensor. A signal amplifier circuit can be arranged in communication with the signal filter circuit to amplify a signal from the signal filter circuit and transmit the amplified signal to a signal processing circuit. The signal processing circuit can be programmed to evaluate the incoming signal and determine whether it corresponds to a desired actuation event (e.g., a firing event) or some other type of marker movement. If the signal processing circuit determines that a desired activation event has occurred, it can then send an activation or control signal to a motion control circuit to activate an agitation or other feed device of the loader to help move paintballs into a neck of the loader in communication with a feed neck of the paintball marker.

[0006] A method of activating a loader assembly therefore preferably includes using an acceleration sensor to detect movement of a paintball marker or loader’s operating mechanisms and/or body and to output an electrical signal proportional to the magnitude and periodicity of the movement. The resulting signal is then preferably processed using filtering, amplification, and digital signal processing circuitry to determine whether the movement corresponds to a desired activation event and, if so, to provide an activation signal to activate a loading operation of the paintball loader’s internal mechanisms.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The foregoing and additional objects, features, and advantages of the present invention will become more readily apparent from the following detailed description, made with reference to the accompanying figures, in which:

[0008] FIG. 1 is a schematic block diagram of a loader activation circuit implementing an acceleration sensor according to principles of the present invention;

[0009] FIG. 2 is a somewhat schematic cutaway side view of a loader configured to be activated in response to the loader activation circuit of FIG. 1, with the acceleration sensor arranged in the loader body;

[0010] FIG. 3 is a somewhat schematic cross-sectional side view of a paintball marker and loader implementing the loader activation circuit of FIG. 1, wherein the acceleration sensor is arranged in communication with an operating mechanism in the paintball marker;

[0011] FIG. 4 is a somewhat schematic cross-sectional side view of a paintball marker and loader implementing the loader activation circuit of FIG. 1, wherein the acceleration sensor is arranged in the paintball marker body;

[0012] FIG. 5 is a flow chart illustrating a method of using an acceleration sensor to activate a loading mechanism in a loader according to another aspect of the present invention.

DETAILED DESCRIPTION

[0013] In the following detailed description, reference is made to the accompanying drawings, which form part thereof, and in which are shown, by way of illustration, exemplary, non-limiting embodiments illustrating various principles of the present invention and how it may be practiced.

[0014] FIG. 1 is a schematic block diagram of a loader activation circuit 100 implementing an acceleration sensor 110 according to principles of the present invention. Referring to FIG. 1, a loader activation circuit 100 preferably includes an acceleration sensor 110 (e.g., a MEMS accelerometer), a filter circuit 120 (e.g., a RC low pass filter), an amplifier circuit 130 (e.g., an op-amp based amplifier), a
signal processing circuit 140 (e.g., a microcontroller-based processor), and a motor control circuit 150 (e.g., a bidirectional DC motor control system).

[0015] The acceleration sensor 110 is preferably configured to detect movement of the loader, a paintball marker, and/or an operating component of the loader. The signal filter circuit 120 can be arranged in communication with the acceleration sensor 110 to receive and filter signals from the acceleration sensor 110 that are generated responsive to movement of the acceleration sensor 110. The amplifier circuit 130 can be arranged in communication with the signal filter circuit 120 to amplify signals received from the signal filter circuit 120 and in further communication with the signal processing circuit 140 to transmit the amplified signal to a signal processing circuit 140. The signal processing circuit 140 preferably communicates with the control circuit 150. Throughout this description, where the specified communication is an electrical communication, that communication can, for instance, be a wired or wireless communication. The communication can either be direct or through one or more intermediary circuits, components, or devices.

[0016] The signal processing circuit 140 can be a microcontroller-based signal processor programmed to evaluate the incoming signal and determine whether it corresponds to a desired activation event (e.g., a firing event) or to some other type of movement. In operation, if the signal processing circuit 140 determines that a desired activation event has occurred, it can then send an activation (or control) signal to the control circuit 150 (or directly to the feed mechanism) to activate a feeding mechanism of the loader. Any type of agitation or other feed mechanism (such as a vibrator, or a motor-driven paddle, drive cone, or other impeller, for example) could be used in the loader to help move paintballs into a neck of the loader in communication with a feed neck of the paintball marker. In one embodiment, for instance, the control circuit 150 can be a motor control circuit which sends a control signal to a drive motor in the loader to rotate a paddle, drive cone, or other impeller and move paintballs into the loader neck.

[0017] FIG. 2 is a somewhat schematic perspective view of a loader 200 configured to be activated in response to the loader activation circuit 100 of FIG. 1 according to an embodiment incorporating principles of the present invention. In this embodiment, the acceleration sensor 110 is arranged in the loader body 202.

[0018] Referring to FIGS. 1 and 2, a paintball loader 200 preferably includes a body 202 that houses a supply of paintballs 250 and a loader control mechanism 240. The size and shape of the loader body 202 can take any desired configuration. A loader feed neck 210 is preferably arranged at the bottom of the loader 200 to connect to a feed tube 310 of a paintball marker 300 (see FIG. 3). The loader control mechanism 240 preferably includes an agitator or other feed device 220 arranged in the hopper 200 near the feed neck 210 to help urge paintballs into the neck 210 during operation of the loader. The feed device 220 can, for instance, be a vibrator, or a motor-driven paddle, drive cone or other impeller, or any other electronically actuated feed device. In this embodiment, the feed device 220 is preferably a bi-directional DC motor 222 coupled to an impeller 224. The loader control mechanism 240 also preferably includes a circuit board 230 arranged in the loader housing 202, preferably in an area proximal to the feed device 220.

[0019] In this embodiment, the acceleration sensor 110 is also preferably arranged in the loader housing 202. The acceleration sensor 110 can be arranged directly on the circuit board 230, mounted to the housing 202, or arranged in any other desired location in the loader 200. The acceleration sensor 110 can, for instance, communicate with the circuit board 230 through either a wired or wireless communication. The circuit board 230 preferably includes a signal filter 120, an amplifier 130, a signal processing circuit 140, and a motor control circuit 150, such as was described previously with reference to FIG. 1.

[0020] In this embodiment, the acceleration sensor 110 preferably detects movement of the paintball loader 200 and sends a signal corresponding to the magnitude and periodicity of that movement to the signal filter 120 for filtering. The filtered signal from the signal filter 120 is then passed on to the amplifier 130 which amplifies the signal and sends it to the signal processor 140 for evaluation. The signal processor 140 determines whether or not the signal corresponds to a desired activation event (e.g., a firing event). If the signal processor 140 determines that a desired activation event has occurred, it sends a control signal to the motor control unit 150 to activate the motor and drive paintballs into the feed neck 210.

[0021] FIG. 3 is a somewhat schematic cross-sectional side view of a paintball marker 300 and loader 200 implementing the loader activation circuit 100 of FIG. 1 according to another embodiment incorporating principles of the present invention. In the embodiment shown in FIG. 3, the acceleration sensor 110 is preferably arranged on or in communication with a feed mechanism with an operating mechanism (e.g., a bolt 315) in the paintball marker 300. Throughout the description, where the specified communication is non-electrical, the term “communication” refers to an operable relationship between the components and may, for example, be direct or indirect physical connection or some other operable relationship.

[0022] Referring to FIGS. 1 and 3, the loader 200 can be constructed similar to that described previously with respect to FIG. 2, except that rather than having the acceleration sensor 110 arranged in the loader 200, the acceleration sensor 110 can be arranged on or near a bolt 315 (or other operating component) of the paintball gun 300 to sense movement of that component. A circuit board 330 arranged in the paintball marker 300 preferably communicates with (either through a wired or wireless connection) and receives a signal from the acceleration sensor 110 that, corresponds to movement of the bolt 315. The paintball marker circuit board 330 may further include the signal filter 120, amplifier 130, and signal processor 140. Alternatively, one or more of those circuit elements may be included in the circuit board 230 of the loader 200. The circuit board 330 in the paintball marker 300 can also communicate with the circuit board 230 arranged in the loader 200 either through a wired or a wireless connection. The motor control unit 150 is preferably arranged in the loader 200.

[0023] In operation, the acceleration sensor 110 detects movement of the bolt 315 and preferably sends a signal corresponding to the magnitude and periodicity of the bolt movement to the signal filter 120. As in the previously described embodiment, the signal filter 120, amplifier 130, and signal processor 140 work together to determine whether the bolt movement corresponds to a desired loader activation event, such as a firing event of the paintball marker 300. If it is determined that a desired loader activation event has
occurred, the signal processor 140 can instruct the control unit 150 to activate the loader motor 222 (or other feed device).

In FIG. 4 is a somewhat schematic cross-sectional side view of a paintball marker 300 and loader 200 implementing the loader activation circuit 100 of FIG. 1 according to a still further embodiment incorporating principles of the present invention. In the embodiment shown in FIG. 4, the acceleration sensor 110 is arranged in the paintball marker body 300 to detect movement of the paintball marker body 302.

Referring to FIGS. 1 and 4, the loader 200 and paintball marker 300 can be constructed and arranged similar to that of the previous embodiments, except that the acceleration sensor is arranged on or in the body 302 of the paintball marker body 300. The acceleration sensor 110 can communicate (such as through wired or wireless communication) with a circuit board 330 in the paintball marker 300 or with a circuit board 230 in the loader 200. In this specific embodiment, the acceleration sensor 110 is arranged on the circuit board 330 of the paintball marker body 300.

In operation, the acceleration sensor 110 in this embodiment detects movement of the paintball marker 300. A signal corresponding to the paintball marker movement is sent to the signal filter 120, which can be arranged, for example, either in the loader 200 or the paintball marker 300. As in the other embodiments, the signal filter 120, amplifier 130, and signal processor 140 preferably process the acceleration-based signal to determine whether the detected movement corresponds to a desired loader activation event (e.g., a firing event). If the detected movement corresponds to an activation event, the signal processor 140 instructs the control unit 150 to send an activation signal to the feed device 220 to drive paintballs into the feed neck 210.

FIG. 5 is a flow chart illustrating a method of using an acceleration sensor to activate a loading mechanism in a loader according to another aspect of the present invention. Referring to FIG. 5, a method of activating a loader feed device according to principles of the present invention begins in step S1 by sensing movement (e.g., acceleration) of a paintball marker, a paintball marker component, a loader component, or the loader itself. When movement is detected, an electrical signal proportional to the magnitude and periodicity of the movement is preferably generated. The signal is then filtered and amplified in step S2. The filtered and amplified signal is further processed in step S3 (such as through a digital signal processor) and is then determined, in step S4, whether or not the detected movement corresponds to a desired activation event. If the detected movement is determined to correspond to a desired activation event (such as a firing event, for example), then the loader feed mechanism is activated in step S5. If, however, the detected movement is determined not to correspond to a desired activation event, the feed device is not activated and the process returns to step S1.

Having described and illustrated principles of the present invention in various preferred embodiments thereof, it should be apparent that the invention can be modified in arrangement and detail without departing from such principles. For instance, it should be recognized that the principles of this invention can be implemented with any electronic or mechanical paintball marker and that the loader size, shape, and design can take any desired configuration. In addition, one or more of the circuit elements could be combined with other circuit elements or be omitted altogether. Furthermore, in the described method, one or more of the steps can be combined with other steps, separated into additional steps, rearranged with other steps, or omitted altogether. We therefore claim all modifications and variations coming within the spirit and scope of the following claims.

What is claimed is:

1. A paintball loader activation system, comprising: an acceleration sensor configured to detect an acceleration and to generate an acceleration-based signal corresponding to the acceleration; and a processing circuit communicating with the acceleration sensor to receive the acceleration-based signal, wherein the processing circuit is configured to evaluate the acceleration-based signal and to generate an activation signal to activate a loading mechanism of a paintball loader when the detected acceleration corresponds to a desired activation event.

2. A system according to claim 1, wherein the acceleration sensor is arranged on or in the paintball loader to detect acceleration of the paintball loader.

3. A system according to claim 1, wherein the acceleration sensor is arranged on or in a paintball marker to detect acceleration of the paintball marker.

4. A system according to claim 1, wherein the acceleration sensor is arranged in communication with an operating component of a paintball marker to detect acceleration of the operating component.

5. A system according to claim 1, wherein the paintball loader is mounted to a paintball marker wherein the desired activation event is a firing event of the paintball marker.

6. A system according to claim 1, wherein the acceleration-based signal corresponds to a magnitude and periodicity of the acceleration and wherein the system further comprises a filter arranged in electrical communication between the acceleration sensor and the processing circuit to filter the acceleration-based signal before supplying it to the processing circuit.

7. A system according to claim 6, further comprising an amplifier arranged in electrical communication between the filter and the processing circuit to amplify the filtered acceleration-based signal before supplying it to the processing circuit.

8. A system according to claim 1, further comprising a control circuit communicating with the processing circuit to receive the activation signal from the control circuit wherein the control circuit is configured to generate a control signal to control the loading mechanism of the paintball loader in response to the activation signal from the control circuit.

9. A system according to claim 8, wherein the loading mechanism is a DC motor and wherein the control circuit is a motor control circuit configured to control the DC motor.

10. A system according to claim 1, wherein the processing circuit comprises a micro-controller based processor programmed to evaluate the acceleration-based signal to determine whether it corresponds to the desired activation event.

11. A paintball loader activation system, comprising: a loader having a loader body comprising a paintball storage area and a feed neck; a loader feeding system arranged in the loader body and configured to urge a supply of paintballs from the paintball storage area toward the feed neck; a loader control circuit for controlling the loader feeding system;
an acceleration sensor configured to detect acceleration and generate an acceleration-based signal corresponding to the detected acceleration; and a processing circuit configured to receive the acceleration-based signal and to instruct the control circuit to activate the loader feeding system when the acceleration-based signal corresponds to a desired activation event.

12. A system according to claim 11, wherein the acceleration sensor is arranged on or in the loader body to detect an acceleration of the loader.

13. A system according to claim 11, wherein the loader is attached to a paintball marker and wherein the acceleration sensor is arranged on or in the paintball marker to detect an acceleration of the paintball marker.

14. A system according to claim 11, further comprising a paintball marker, wherein the acceleration sensor is arranged in communication with an operating component of the paintball marker to detect an acceleration of the paintball marker operating component.

15. A system according to claim 11, wherein the desired activation event is a firing event of a paintball marker attached to the loader.

16. A method of actuating a loading mechanism of a paintball loader mounted to a paintball marker, said method comprising:

- detecting an acceleration of the paintball marker or loader or of an operating component of either the paintball marker or the loader;
- generating an acceleration-based signal in response to the detected acceleration;
- processing the acceleration-based signal to determine whether it corresponds to a desired loader actuation event; and
- actuating the loading mechanism of the paintball loader when the acceleration-based signal corresponds to the desired loader actuation event.

17. A method according to claim 16, further comprising filtering the acceleration-based signal before processing the acceleration-based signal.

18. A method according to claim 17, further comprising amplifying the filtered acceleration-based signal before processing the acceleration-based signal.

19. A method according to claim 16, wherein detecting an acceleration comprises detecting an acceleration of a loader body using an acceleration sensor arranged on or in the loader body.

20. A method according to claim 16, wherein the desired loader actuation event is a firing event of the paintball marker.