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(54) **TILT SENSING IN AN AMUSEMENT GAME
DEVICE**

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(57) **ABSTRACT**

Operation of an amusement game device is controlled in part by using an accelerometer positioned with a game cabinet of the amusement game device. The accelerometer is first used to establish a reference idle position for the amusement game device. During game play of the amusement game device, it is then determined if a force applied to the amusement game device as sensed by the accelerometer exceeds a threshold that is set relative to the reference idle position for the amusement game device. When it is determined that a force applied to the amusement game device as sensed by the accelerometer during play of the amusement game device exceeds the threshold that is set relative to the reference idle position for the amusement game device, play of the amusement game device is caused to be inhibited in whole or in part.

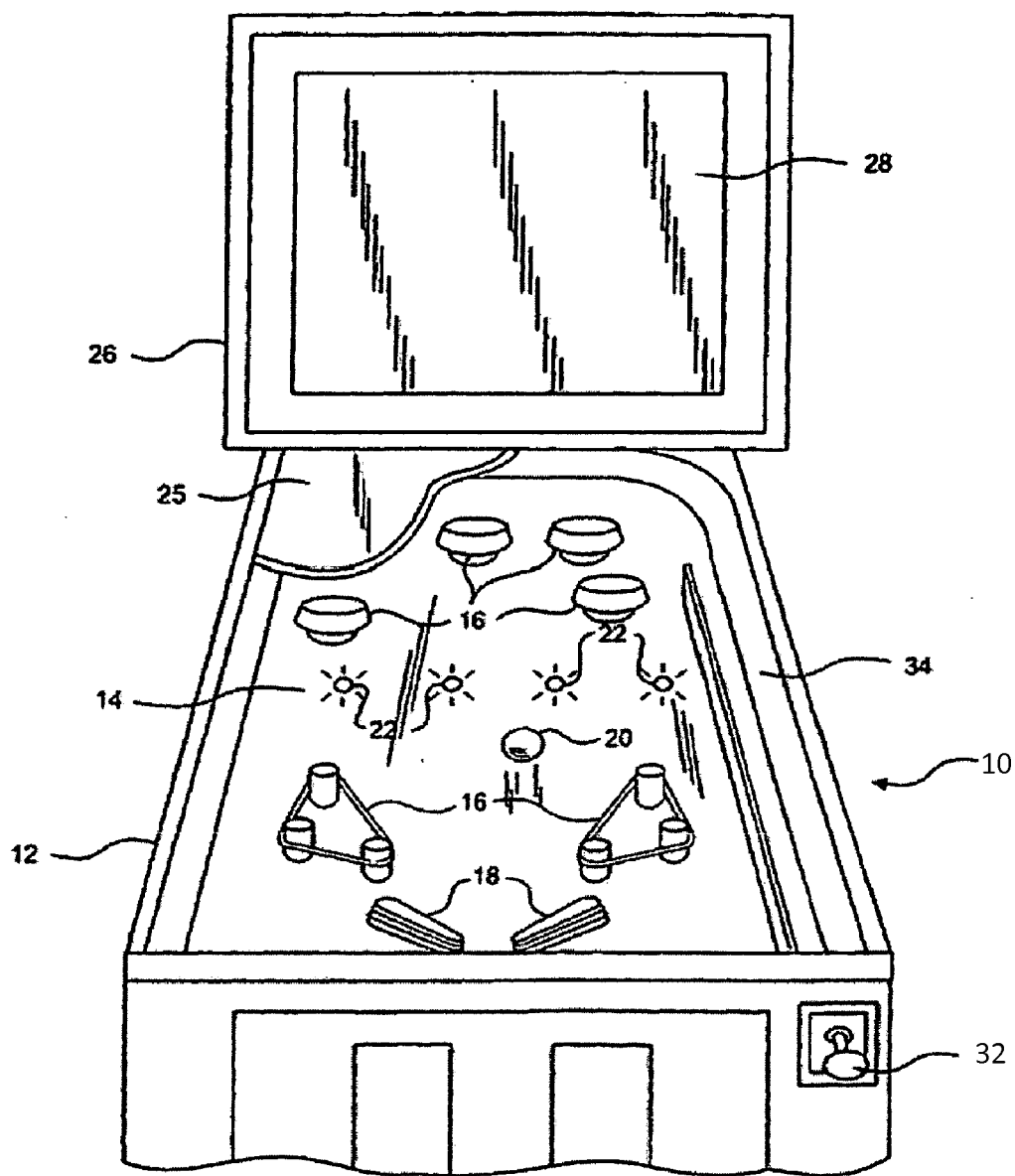


FIG. 1
PRIOR ART

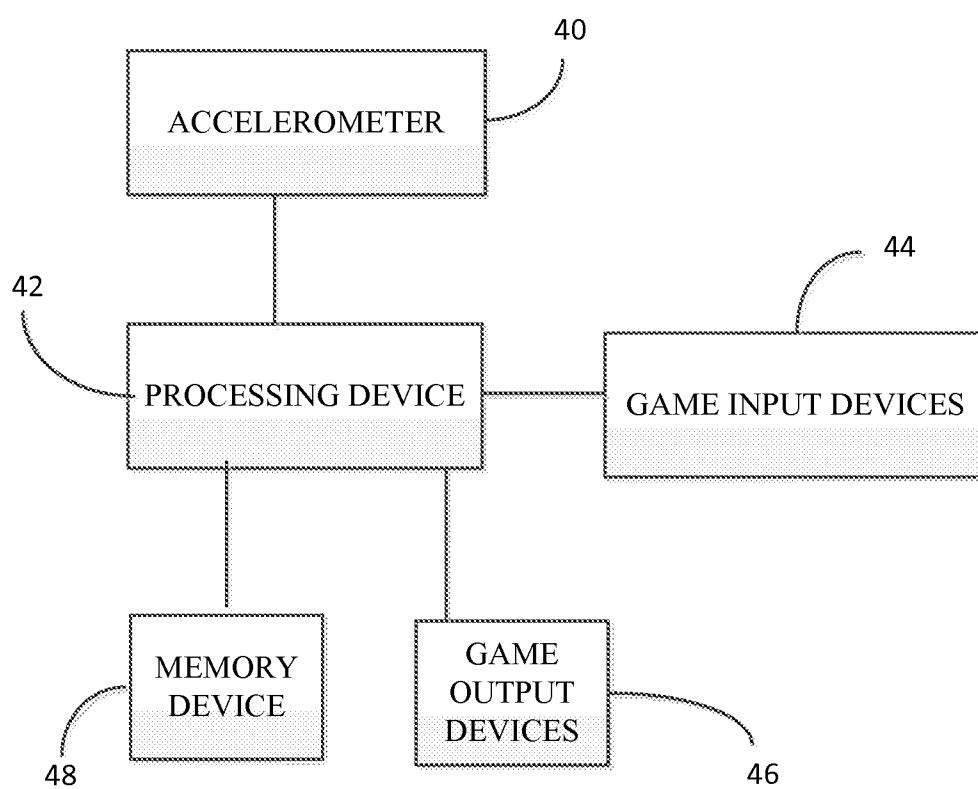


FIGURE 2

TILT SENSING IN AN AMUSEMENT GAME DEVICE

BACKGROUND

[0001] Amusement game devices, such as pinball machines, video games, redemption games, etc. of the commercial, e.g., revenue generating, and non-commercial, e.g., home entertainment, type are well known in the art. By way of example, U.S. Pat. No. 5,338,031, U.S. Pat. No. 6,158,737, and U.S. Published Application No. 2007/0026918 (which publications are incorporated herein by reference in their entirety) illustrate and describe amusement game devices of the type having a cabinet which houses a playfield assembly including a playing field or playfield which may be inclined. As further described in the '031 patent, it is known that players often attempt to lift, shake, shove, tilt, etc. such amusement game devices (individually and collectively referred to herein as “tilting” an amusement game device) for the purpose of influencing operation of the devices to their advantage. Thus, in order to prevent such abuse, amusement game device manufacturers have developed tilt prevention mechanisms that terminate play of the game, in whole or in part, if the amusement game device is tilted beyond predetermined limits. Conventionally utilized tilt prevention mechanisms include an electrically conductive member suspended from the game cabinet in pendulum fashion and an electrical contact surrounding the conductive member. When the game is tilted during game play the free end of the conductive member swings into the contact ring and completes a circuit directing the game's microprocessor to stop play as described above.

SUMMARY

[0002] The following describes an improved tilt sensing system and method for an amusement game device, such as a pinball machine. Generally, operation of an amusement game device is controlled in part by using an accelerometer positioned with a game cabinet of the amusement game device. The accelerometer is first used to establish a reference idle position for the amusement game device. During game play of the amusement game device, it is then determined if a force applied to the amusement game device as sensed by the accelerometer exceeds a threshold that is set relative to the reference idle position for the amusement game device. When it is determined that a force applied to the amusement game device as sensed by the accelerometer during play of the amusement game device exceeds the threshold that is set relative to the reference idle position for the amusement game device, play of the amusement game device is caused to be inhibited in whole or in part.

[0003] A better understanding of the objects, advantages, features, properties and relationships of the tilt sensing mechanism for an amusement game device described hereinafter will be obtained from the following detailed description and accompanying drawings which set forth illustrative embodiments which are indicative of the various ways in which the principles of the invention may be employed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] For a better understanding of the amusement game device described hereinafter reference may be had to the following drawings in which:

[0005] FIG. 1 illustrates an exemplary amusement game device in the form of a prior art pinball machine; and

[0006] FIG. 2 is an exemplary block diagram of an amusement game device including accelerometer based tilt sensing functionality.

DETAILED DESCRIPTION

[0007] With reference to the Figures, an amusement game device, in the exemplary form of a pinball machine **10** is now described. It is to be appreciated, however, that this exemplary form for the amusement game device **10** is not intended to be limiting. Rather, those of ordinary skill in the art will appreciate that the tilt sensing mechanism described hereinafter can be utilized in any type of amusement game device, such as video games, redemption games, etc. of the commercial and non-commercial type, in which it is desired to inhibit a user's tilting of the amusement game device during play thereof.

[0008] In keeping with the example of an amusement game device **10** of the pinball machine type, the amusement game device **10** illustrated in FIG. 1 includes a cabinet **12** which houses various apparatus used to define play of a game. Game play may be commenced in response to insertion of money—paper or coins referred to collectively as “coins”—into a coin accepting device, upon exercising of credits earned, by accepting payment from an account, e.g., via use of a swipe card reading device, a bar code reading device, a near field communications device, etc., and/or by otherwise making game play active. Upon activation of the game in this manner, game play, in the case of a pinball machine, is defined upon an inclined playfield assembly **14** that supports a number of playfield accessories or devices. More particularly, in the case of a pinball machine, game play is generally defined through the use of a pair of flippers **18** to propel a ball relative to the playfield **14** and input devices/accessories associated with the playfield **14**. The playfield **14** is usually inclined from the horizontal such that the ball tends to eventually roll back down the playfield **14** in the direction of the flippers **18**. While not intended to be limiting, the playfield accessories or input devices **16** may include elements such as bumpers, ramps, and/or targets. The playfield **14** may be covered by a transparent or glass sheet cover **25** to permit viewing of the playfield **14**. In addition to the foregoing, the playfield **14** includes a plunger element **32** which shoots the ball up an alley **34** onto the playfield **14**. The playfield **14** may also include lighting elements **22** and/or other features as desired. Other player-activated input elements, typically in the form of push-buttons on the sides of the cabinet **12**, are usually provided for controlling operation of the flippers **18**. The amusement game **10** may also include a backbox **26** which is mounted to overlay a top rear portion of the cabinet **12** and which contains a game display **28**, such as a dot matrix display, CRT, or the like. The backbox **26** may also support speakers associated with the game sound system. Within the backbox **26** may be located various of the electronic devices/circuits for controlling the operation of the playfield, the display, general illumination, and the sound system. Such electronic devices/circuits could also, in whole or in part, be carried within the game cabinet **12**.

[0009] For sensing a tilting of the amusement game device **10**, the amusement game device **10** is provided with an accelerometer **40**. As shown in FIG. 2, the accelerometer **40** is coupled to the processing device **42** which processing device **42** is, in turn, coupled to game input devices **44**, such as

switches associated with the cabinet 12, playfield 14, etc., and game output devices 46, such as lights 22, flippers 18, display 28, etc. via one or more bus systems. A memory device 48, such as a RAM, ROM, or the like, stores instructions and data usable by the processing device 42 to control play of the game, the game output devices 44, and the game input devices 44 as necessary based upon signals provided by the game input devices 44 and/or the accelerometer 40. It is to be understood that this illustrated embodiment is not intended to be limiting and that other manners for arranging the devices illustrated in FIG. 2 to provide for control of play of the amusement game can be utilized as needed.

[0010] In an exemplary embodiment, a microelectromechanical system (MEMS) device is utilized as the accelerometer 40. As will be understood, a MEMS device is a very small mechanical device with an electronic interface. As will be further understood, a MEMS accelerometer device comprises a reference mass on a cantilever beam. Flexing of the beam in response to a tilting of the amusement game device 10 is measured by the MEMS accelerometer device and a signal indicative of the measured tilting is provided to the processing device 42 for processing in accordance with the appropriate instructions as stored on memory device 48. As described below, the signal indicative of the measured tilting of the amusement game device can be in the form of an interrupt signal that is generated when a measured tilting force applied to the amusement device 10 exceeds a predetermined threshold.

[0011] As will be appreciated, the use of an accelerometer 40 to detect tilting of the amusement device 10, e.g., to sense both inclination and impact, has many benefits when compared to the aforementioned plumb tilt mechanism that is conventionally utilized in amusement games. For example, a MEMS accelerometer device is much less costly when considered against the cost of the components required to construct a plumb tilt mechanism. A MEMS accelerometer device is also easier to setup and adjust when compared to a plumb tilt mechanism, e.g., with a MEMS accelerometer device no mechanical components need to be arranged and sensitivity can be adjusted in software rather than by physically adjusting the plumb bob relative to the conductive ring. Yet further, a MEMS accelerometer device provides a more consistent response when compared to a plumb tilt mechanism, e.g., because the devices can be adjusted in software multiple devices can be set to provide near identical responses (which is particularly useful for tournament play) whereas the mechanical plumb tilt mechanism has more room for adjustment/calibration errors. Still further, a MEMS accelerometer device can be auto-calibrated via use of software, e.g., the software can be used to determine which direction is straight down and using this information can provide for compensation even if the board carrying the MEMS accelerometer device is installed on an angle. In addition, a MEMS accelerometer device can be used to measure applied forces in any direction not just horizontally.

[0012] While accelerometers can be found with one, two or three axes of measurement, in a preferred embodiment a three-axis (x, y, and z) MEMS accelerometer is utilized as the three-axis accelerometer provides, in keeping with the advantages above-noted, easy auto-calibration and the ability to detect motion in any direction.

[0013] In keeping with this preferred embodiment, before the MEMS accelerometer device is used to sense tilting of the amusement game device 10 during operation of the amuse-

ment game device 10, a small amount of configuration is generally required to set operational parameters, such as the range of sensitivity. In this regard, the accelerometer 40 may be configured to generate an interrupt signal (for provision to the processing device 42) when a specified tilting threshold is exceeded, such as when the amusement game device receives an impact, is in sensed free-fall, etc. As will be understood, providing a signal in the form of an interrupt helps to reduce the amount of communication necessary with the processing device 42. While it is preferred that the accelerometer 40 perform such threshold evaluations (which would require that the accelerometer 40 be a component part of an integrated circuit having a processing device, be placed on a board carrying a processing device, etc.), it is contemplated that such threshold evaluations could be performed by the processing device 42 using signals having data indicative of any forces applied to the amusement game device as provided to the processing device 42 by the accelerometer 40.

[0014] To calibrate the amusement game device 10, the amusement game device 10 is placed into idle, i.e., a state in which the amusement game device 10 is at rest with no external forces acting upon the amusement game device 10 other than gravity. In this state, an acceleration of approximately 1 g straight down is measured by the accelerometer 40 due to gravity. The three axes of the amusement game device 10 can then be referenced to this measured reference (idle) position (the reference position being in effect the position of the plumb bob hanging at rest centered within the contact ring). As this calibration is to be done when the amusement game device 10 is idled, it is preferred that the calibration be operator controlled, i.e., that it be initiated via use of a secure menuing system (e.g., a menuing system which is accessed by unlocking and opening the amusement game machine) such as described in U.S. Pat. No. 7,967,681 which patent is incorporated herein by reference in its entirety.

[0015] Once the idle position is referenced in the amusement game device 10, it will be appreciated that the system can be used to determine if, for example, the amusement game device 10 is shoved horizontally. In this regard, any force horizontally applied to the amusement game device 10 can be measured as an acceleration in a plane which is roughly perpendicular to what was calibrated as straight down. In a first embodiment, an acceleration threshold would be set in this plane and any acceleration that exceeds the threshold would be treated as a tilt event and an interrupt signal would be generated as noted above. Preferably, the threshold can be operator adjusted in software via the secure menuing system, e.g., via a selection of a desired numeric threshold on a pre-defined sensitivity scale or range, which setup is simpler and more repeatable across plural machines as compared to adjusting the height of a mechanical plumb bob.

[0016] In a second embodiment, an algorithm could be employed to emulate the behavior of the plumb bob. This may help to maintain the feel of the mechanical tilt mechanism. A "virtual plumb bob" could be implemented as a pendulum in two axes. Forces in the plane perpendicular to straight down would add energy to or subtract energy from the accelerometer pendulum, depending on the direction of movement of the pendulum and the direction of the incident force. If the position of the "virtual plumb bob" exceeds a predetermined radius a tilt event is sensed and a corresponding interrupt signal can be sent to the processing device 42.

[0017] It will be additionally appreciated that beyond simply measuring force in the plane parallel to the ground a 3-axis accelerometer can accurately detect more subtle changes such as if the amusement game device is lifted off the ground. For example, if a game is being operated as part of a tournament the accelerometer device may be able to detect, e.g., by detecting a repositioning force being applied to the machine whereupon the repositioning of the machine remains unchanged over time, that someone applied a shim or otherwise raised the front legs of the amusement game device 10 to slow down the play of the amusement game device 10. In this manner the accelerometer 40 can serve as a deterrent to cheating in a tournament.

[0018] While a specific embodiment of the invention has been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangement disclosed is meant to be illustrative only and not limiting as to the scope of the invention which is to be given the full breadth of the appended claims and any equivalents thereof.

What is claimed is:

1. A method for controlling operation of an amusement game device, comprising:

using an accelerometer positioned with a game cabinet of the amusement game device to establish a reference idle position for the amusement game;

determining if a force applied to the amusement game device as sensed by the accelerometer during play of the amusement game exceeds a threshold that is set relative to the reference idle position for the amusement game device; and

when it is determined that a force applied to the amusement game device as sensed by the accelerometer during play of the amusement game device exceeds the threshold that is set relative to the reference idle position for the amusement game device, causing play of the amusement game device to be inhibited in whole or in part.

2. The method as recited in claim 1, comprising causing the accelerometer to generate an interrupt signal when it is determined that a force applied to the amusement game device as sensed by the accelerometer during play of the amusement game device exceeds the threshold that is set relative to the reference idle position for the amusement game device and causing a processing device in communication with the accelerometer to inhibit play of the amusement game device in whole or in part in response to receipt of the interrupt signal.

3. The method as recited in claim 1, wherein the amusement game device comprises a secure menuing system and wherein the method comprises accepting a first user input via the secure menuing system to cause the accelerometer to establish the reference idle position for the amusement game device.

4. The method as recited in claim 3, comprising accepting a second user input via the secure menuing system to set the threshold.

5. The method as recited in claim 4, wherein the second user input comprises a user selected value from a predefined scale or range of threshold values.

6. The method as recited in claim 1, comprising determining if a force applied to the amusement game device as sensed by the accelerometer indicates that the amusement game device has been moved into a tilted position that is different than the reference idle position for the amusement game;

determining if the amusement game device remains in the tilted position that is different than the reference idle position for the amusement game for a threshold amount of time; and when it is determined that the amusement game device has been moved into a tilted position that is different than the reference idle position for the amusement game device and that the amusement game device has remained in the tilted position that is different than the reference idle position for the amusement game for the threshold amount of time, causing play of the amusement game device to be inhibited in whole or in part.

7. The method as recited in claim 6, wherein the amusement game device comprises a pinball machine and the tilted position comprises a changing of an angle of inclination of a playfield of the pinball machine as compared to an angle of inclination of the playfield of the pinball machine in the reference idle position.

8. The method as recited in claim 1, wherein the amusement game device comprises a pinball machine.

9. An amusement game device, comprising:

a game cabinet;

game output devices supported by the game cabinet;

game input devices supporting by the game cabinet;

a processing device supported by the game cabinet for controlling operations of the game output devices during play of the amusement game at least in part based upon signals received from the game input devices; and

an accelerometer in communication with the processing device, the accelerometer being used to establish a reference idle position for the amusement game, for determining if a force applied to the amusement game device during play of the amusement game device exceeds a threshold that is set relative to the reference idle position for the amusement game device, and for issuing a signal to the processing device when a force applied to the amusement game device as sensed during play of the amusement game device exceeds the threshold that is set relative to the reference idle position for the amusement game device for the purpose of causing the processing device to inhibit play of the amusement game device in whole or in part.

10. The amusement game device as recited in claim 9, wherein the accelerometer comprises a microelectromechanical accelerometer device.

11. The amusement game device as recited in claim 9, wherein the accelerometer generates an interrupt signal when it is determined that a force applied to the amusement game device as sensed during play of the amusement game exceeds the threshold that is set relative to the reference idle position for the amusement game device and wherein the processing device in communication with the accelerometer is caused to inhibit play of the amusement game in whole or in part in response to receipt of the interrupt signal.

12. The amusement game device as recited in claim 9, wherein the amusement game device has a secure menuing system and wherein a first user input provided via the secure menuing system causes the accelerometer to establish the reference idle position for the amusement game device.

13. The amusement game device as recited in claim 12, wherein a second user input provided via the secure menuing system is used to set the threshold.

14. The amusement game device as recited in claim 9, wherein the accelerometer determines if a force applied to the amusement game device indicates that the amusement game

device has been moved into a tilted position that is different than the reference idle position for the amusement game; determines if the amusement game device remains in the tilted position that is different than the reference idle position for the amusement game for a threshold amount of time; and when it is determined that the amusement game has been moved into a tilted position that is different than the reference idle position for the amusement game and that the amusement game device has remained in the tilted position that is different than the reference idle position for the amusement game for the threshold amount of time, causing a signal to be sent to the processing device for inhibiting play of the amusement game in whole or in part.

15. The amusement game device as recited in claim **14**, wherein the amusement game device comprises a pinball machine having a playfield and the tilted position comprises a changing of an angle of inclination of the playfield as compared to an angle of inclination of the playfield in the reference idle position.

16. The amusement game device as recited in claim **9**, wherein the amusement game device comprises a pinball machine.

17. An amusement game device, comprising:
 a game cabinet;
 game output devices supported by the game cabinet;
 game input devices supporting by the game cabinet;
 a processing device supported by the game cabinet for controlling operations of the game output devices during

play of the amusement game at least in part based upon signals received from the game input devices; and

an accelerometer in communication with the processing device, the accelerometer being used to establish a reference idle position for the amusement game and being used as a virtual plumb bob during play of the amusement game device whereby forces in a plane perpendicular to straight down causes energy to be added to or subtracted from the virtual plumb bob and whereby a sensed movement of the virtual plumb bob, with energy added thereto or subtracted therefrom as a result of forces in the plane perpendicular to straight down in a direction of an incident force, exceeding a threshold radius causes a tilt event interruption signal to be issued to the processing device for the purpose of causing the processing device to inhibit play of the amusement game device in whole or in part.

18. The amusement game device as recited in claim **17**, wherein the accelerometer comprises a microelectromechanical accelerometer device.

19. The amusement game device as recited in claim **18**, wherein the amusement game device has a secure menuing system and wherein a first user input provided via the secure menuing system causes the accelerometer to establish the reference idle position for the amusement game device.

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