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Golf ball dispenser with embedded display device, separate front waterfall panel and/or blower assembly

Abstract

A system includes: a golf range; targets on the golf range; a building including golf bays including golf ball dispensers, each including a receptacle, a passageway, a gateway, and a display device embedded in the golf ball dispenser; at least one golf ball sensor; one or more computers communicatively coupled with the at least one golf ball sensor and the golf ball dispensers, the one or more computers being configured to track a golf ball in flight on the golf range, identify where the golf ball lands on the golf range, identify the golf bay from which the golf ball was hit, and present information, regarding the golf ball hit from the golf bay, on the display device of the golf ball dispenser associated with the golf bay, the information being in accordance with where the golf ball lands on the golf range.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 17/699,020 filed on Mar. 18, 2022, which is a continuation-in-part application of PCT/US2020/051607, filed Sep. 18, 2020, and published on Mar. 25, 2021 as WO 2021/055832, which claims the benefit of priority to U.S. Patent Application No. 62/902,902, entitled “GOLF BALL DISPENSER WITH EMBEDDED DISPLAY DEVICE”, filed Sep. 19, 2019, which is hereby incorporated by reference.

BACKGROUND

(1) This specification relates to apparatus for holding golf balls and for controllably dispensing a single golf ball at a time for use in a golf game.

(2) Many apparatus for delivering golf balls to facilitate playing golf have been produced over the years. For example, U.S. Pat. No. 6,129,242 to Chan describes a ball dispensing apparatus including a container to house golf balls and a gate member to allow selective control of the dispensation of a single golf ball, without requiring the golfer to alter his or her stance prior to each swing or putt. U.S. Pat. No. 6,607,123 to Jolliffe et. al. describes a golf driving range in which golf balls are delivered to golfers using an automatic tee device that reads a radio frequency identification (RFID) tag in the golf ball to identify the golf ball so as to match the ball to the player at the tee area. In addition, U.S. Pat. No. 9,132,326 to Caster et. al. mentions a golf ball delivery device that sits next to a tee area in a golf bay and includes an RFID reader to identify RFID equipped golf balls after triggering of a ball release mechanism and a light emitting diode (to alert the player that the golf ball is coming) in response to the golfer waving his or her club in front

of a proximity sensor located in the golf ball delivery device. Moreover, some golf ranges have provided display devices near tee areas for use in displaying information about a golf shot derived from sensors that detect the golf ball in flight.

SUMMARY

(3) This specification describes systems and techniques relating to holding and dispensing golf balls at a golf facility, e.g., a driving range. In general, one or more aspects of the subject matter described in this specification can be embodied in a golf ball dispenser including: a receptacle configured to hold multiple golf balls; a passageway connecting an outlet of the golf dispenser with the receptacle; a gateway coupled between the passageway and the receptacle to restrict a passage of the multiple golf balls into the passageway, the gateway being selectively moveable to allow a golf ball to pass into the passageway for delivery to a tee area; and a display device embedded in the golf ball dispenser to present at least information regarding the golf ball in flight after the golf ball is hit from the tee area. Further, one or more aspects of the subject matter described in this specification can be embodied this golf ball dispenser and optionally include one or more of the following features.

(4) A golf ball dispenser can include: a metal frame that holds the receptacle, the passageway, and the gateway, wherein the metal frame defines at least one recess configured to receive the display device in an angled top portion of the golf ball dispenser; a gasket positioned over the display device in the angled top portion of the golf ball dispenser; and an impact resistant shield positioned over the gasket and over the display device in the angled top portion of the golf ball dispenser.

(5) A golf ball dispenser can include a front panel and a back panel, each of the front panel and the back panel including: a first piece having reinforcing ribs and a first strength derived at least in part from the reinforcing ribs, the first piece being configured to attach with the metal frame; a second piece configured to cover and attach with the first piece, the second piece having a second strength less than the first strength, and the second piece including two distinct foam materials.

(6) A golf ball dispenser can include a top panel, a left side panel, and a right side panel; wherein the front panel, the left side panel, the right side panel, the back panel, and the top panel include tongues and grooves to interlock the panels together about the frame.

(7) A golf ball dispenser can include: a back door including a metal piece to which the first piece of the back panel attaches, wherein the metal piece is coupled with the metal frame through a quick release hinge mounted inside the golf ball dispenser such that the quick release hinge is not visible when the back door is closed, and the metal piece includes wing sections; and a ramp assembly attached to the metal piece with a piano hinge, the ramp assembly including rollers supporting a ramp positioned between the wing sections of the metal piece such that golf balls are contained by the wing sections when dropped onto the ramp.

(8) A golf ball dispenser can include a camera integrated with the golf ball dispenser and arranged to capture a full swing of a golf club, including impact of the golf club with the golf ball when the golf ball is hit from the tee area, for use in generating information for display on the display device integrated with the golf ball dispenser. Further, the golf ball dispenser can include a second camera integrated with the golf ball dispenser and arranged to capture a full swing of a second golf club, including impact of the second golf club with a second golf ball when the second golf ball is hit from an adjacent tee area served by a second golf ball dispenser, for use in generating information for display on a second display device integrated with the second golf ball dispenser.

(9) The display device in a golf ball dispenser can be a touchscreen display device that is at least forty inches in a diagonal dimension of the touchscreen display device, and the touchscreen display device and the camera can be communicatively coupled with one or more computers programmed to control operations of a golf bay in which the golf ball dispenser is located based on inputs to the touchscreen display device, facial recognition processing performed on imagery from the camera, or both.

(10) A golf ball dispenser can include an angled top portion of the golf ball dispenser that includes

a protruding lip along an upper end of the angled top portion of the golf ball dispenser, the protruding lip being configured to redirect golf balls travelling along the angled top portion of the golf ball dispenser and toward an adjacent golf bay.

(11) A golf ball dispenser can include at least one light source separate from the display device, the at least one light source configured to provide a full spectrum of colors, and the at least one light source being coupled with at least one controller configured to adjust the colors of the at least one light source in response to one or more events selected from a group including a golf ball dispense, a golf ball dispenser service request, a current state of the golf bay in which the golf ball dispenser is located, and a current aspect of a game being played from the tee area served by the golf ball dispenser. The at least one light source can be a light emitting diode (LED) bar.

(12) The at least one light source can be a light source proximate to the outlet of the golf dispenser, and the at least one controller can be configured to adjust a color of the light source proximate to the outlet by changing the color of the light source proximate to the outlet from a first color to a second color in response to release of a golf ball by the gateway from the receptacle into the passageway, and changing the color of the light source proximate to the outlet from the second color to at least one third color once the released golf ball reaches the outlet of the golf dispenser.

(13) The at least one controller can include a computer programmed to change the color of the light source proximate to the outlet to a color corresponding to a target to be hit in accordance with the game being played from the tee area served by the golf ball dispenser.

(14) The target can be a physical target on a golf range in front of the tee area and the golf ball dispenser. The target can be a virtual target in the game being played from the tee area served by the golf ball dispenser.

(15) A golf ball dispenser can include a distance measurement device configured to detect how full the receptacle is. The gateway in a golf ball dispenser can include a screw inside a hopper underneath an opening in a bottom portion of the receptacle, and the golf ball dispenser can include a steel frame positioned around the opening and between the bottom portion of the receptacle and the hopper containing the screw.

(16) The receptacle in the golf ball dispenser can include an access panel positioned on a bottom portion of a side of the receptacle, the access panel being configured to be opened to facilitate emptying the golf balls from the receptacle. Moreover, a golf ball dispenser can include a second receptacle configured to hold additional golf balls, the second receptacle being accessible (e.g., during a power outage) via an upper back door of the golf ball dispenser, wherein the second receptacle includes two baskets configured to be linked together once removed from the golf ball dispenser.

(17) In addition, one or more aspects of the subject matter described in this specification can be embodied in methods, systems, and apparatus, including medium-encoded computer program products, for performing the operations described in this application in connection with a golf ball dispenser.

(18) The details of one or more embodiments of the subject matter described in this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages of the invention will become apparent from the description, the drawings, and the claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIGS. 1A and 1B show an example of a golf ball dispenser with a display device integrated into the golf ball dispenser.

(2) FIG. 1C shows the metal frame from the golf ball dispenser of FIG. 1A, with all other

components removed.

(3) FIG. 1D shows a cross section of the golf ball dispenser of FIG. 1A.

(4) FIG. 1E shows a closer view of another cross section of the golf ball dispenser of FIG. 1A.

(5) FIG. 1F shows additional cross sections of the golf ball dispenser of FIG. 1A.

(6) FIG. 2A is a rear perspective view showing an exploded version of a golf ball dispenser.

(7) FIG. 2B is a cross section of an example of a front panel from the golf ball dispenser of FIG. 2A.

(8) FIG. 2C is a perspective, exploded view of respective pieces of the front panel from FIG. 2B.

(9) FIG. 2D is another cross section of an example of a front panel from the golf ball dispenser of FIG. 2A showing an example of a light source for the outlet of the golf ball dispenser.

(10) FIG. 2E is a cross section of the golf ball dispenser showing an example of a gateway for golf ball release.

(11) FIG. 2F shows an example of an access panel useable to empty the golf ball receptacle.

(12) FIG. 3A is a cross section of a golf ball dispenser.

(13) FIG. 3B is a perspective view showing a ramp assembly.

(14) FIGS. 3C and 3D are perspective views showing respective portions of a back door assembly.

(15) FIG. 4A shows an example of a basket of golf balls stored in a golf ball dispenser for emergency use.

(16) FIGS. 4B-4E show examples of the back door and ramp assemblies in use.

(17) FIG. 5A shows an example of a system that can be used in combination with the golf ball dispensers of the present application.

(18) FIG. 5B shows an example of a layout for golf bays, as can be used in the system of FIG. 5A.

(19) FIG. 5C shows an example of view angles for a camera system, as can be used in the golf bay layout of FIG. 5B.

(20) FIG. 5D is a cross section of a golf ball dispenser showing an example of the camera system, as can be used with the view angles of FIG. 5C.

(21) FIG. 6 is a schematic diagram of a data processing system.

(22) FIG. 7 is a flowchart showing an example of processes that can be implemented in combination with the golf ball dispensers of the present application.

(23) FIG. 8A shows another example of a golf ball dispenser, which has an angled top portion that is attached through a hinge, which allows the top of the golf ball dispenser to be tilted upwards.

(24) FIG. 8B shows an example of a hinge for the top panel of the ball dispenser of FIG. 8A.

(25) FIG. 8C shows an example of an internal latching structure for the top panel of the ball dispenser of FIG. 8A.

(26) FIGS. 8D-8J show examples of various structures that can be included in any of the ball dispensers described in this application.

(27) Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

(28) FIG. 1A shows an example of a golf ball dispenser **100** with a display device **102** integrated into the golf ball dispenser **100**, and FIG. 1B is a partially exploded view of the golf ball dispenser **100** from FIG. 1A. In this example, the display device **102** is embedded in the golf ball dispenser **100**, meaning the display device **102** is fully enclosed in the golf ball dispenser, protected from golf ball strikes (e.g., from errant golf shots), and forms an essential part of the golf ball dispenser. The display device can be at least forty inches in a diagonal dimension and/or be a touchscreen display device. The display device **102** can be an LCD (liquid crystal display), OLED (organic light emitting diode) or other type of display device, and the display device **102** is configured to be connected (with wires, wirelessly, or both) to a computer system that is programmed to present information on the display device **102** for viewing by a user of the golf ball dispenser **100**. For example, the presented information can include information regarding a golf ball in flight after the golf ball is hit from a tee area served by the golf ball dispenser **100**, e.g., an animation showing the

golf ball flight in a virtual world (the ball flight characteristics being determined from sensor data of the ball's actual flight in the real world) and/or other dynamically determined or other content, such as a television show or other video data, static images, brand elements, and/or interactive user interface screens for the game being played by the golfers using the golf ball dispenser **100**, etc.

(29) The golf ball dispenser **100** includes an outlet **104**, which is connected with a passageway **106**, through which a golf ball is delivered to the tee area served by the golf ball dispenser **100**. The golf ball dispenser **100** can further include a metal frame **108** with which other components of the golf ball dispenser **100** attach, e.g., with screws, bolts, and/or tabs. In some implementations, the frame is constructed from sheet metal to reduce the costs of manufacture. The other components include a top panel **110**, a front panel **120**, a right side panel **122R**, a left side panel **122L**, and a back door **124**. The metal frame **108** can be made of steel, e.g., powder coated steel, and the panels **110**, **120**, **122R**, **122L** can be made of one or more types of plastic or similar materials, e.g., High Density Polyethylene (HDPE) material, which can have varying degrees of thickness and can be designed to stand up to extreme temperatures as well as impact from objects, such as balls, clubs, other devices, etc.

(30) As shown, the upper portion of the golf ball dispenser **100** is angled. Note that having the display device **102** be more vertical facilitates viewing of the information presented on the display device **102** by the player and decreases the risk of a player in an adjacent bay being hit, but also increases the risk that an errant golf ball that hits the display portion of the golf ball dispenser **100** will bounce straight back and hit the player. Thus, an angled orientation for the display device **102** facilitates viewing while also reducing the risk of injury. In some implementations, the angle is between forty and fifty degrees with respect to the ground horizontal. In some implementation, the angle is between forty two and a half degrees and forty seven and a half degrees with respect to the ground horizontal. In some implementation, the angle is between forty four and forty six degrees with respect to the ground horizontal. In some implementation, the angle is forty four and a half, forty five, or forty five and a half degrees with respect to the ground horizontal.

(31) In addition, because the golf ball dispenser **100** is often used to serve a tee area that has adjacent tee areas, a golf ball that travels at the same angle up and along the top portion of the golf ball dispenser **100** can potentially hit a player in the adjacent tee area. Thus, in some implementations, the top panel **110** forming the angled top portion of the golf ball dispenser **100** includes a protruding lip **112** (e.g., a molded plastic protrusion) along an upper end of the angled top portion of the golf ball dispenser. The shape of this structure **112** will redirect golf balls travelling along the angled top portion of the golf ball dispenser **100** and toward an adjacent golf bay, when the golf balls hit the protruding lip **112**, to thereby provide additional protection to the player in the adjacent tee area. Moreover, in some implementations, the protruding lip **112** includes an extended portion **112A** to house a camera system, as described in further detail below.

(32) FIG. 1C shows the metal frame **108** from the golf ball dispenser of FIG. 1A, with all other components removed. As shown, the metal frame **108** defines a recess **108A** that receives the display device **102** in an angled top portion of the golf ball dispenser **100**. In some implementations, the metal frame **108** defines another recess to receive an impact resistant shield **115**. In other implementations, the top panel **110** defines a recess to receive the impact resistant shield **115**, as shown in FIG. 1D, which shows a cross section of the golf ball dispenser **100**.

(33) In FIG. 1D, a portion of the metal frame **108** is shown underneath and supporting a receptacle **130**, which can hold multiple golf balls, e.g., one thousand four hundred and fifty golf balls to two thousand golf balls, and the passageway **106** connects the outlet (not shown) of the golf ball dispenser with the receptacle **130**. Further, a recessed portion **108A** of the metal frame **108** holds the display device **102** in place in an angled top portion of the golf ball dispenser **100**. FIG. 1E shows a closer view of another cross section of the golf ball dispenser **100**. As shown, the left side panel **122L** attaches to the metal frame **108**, the display device **102** rests in the recess portion **108A** of the metal frame **108**, and the top panel **110** attaches to the left side panel **122L** and/or the metal

frame **108**. The top panel **110** includes a recess that is shaped to receive the impact resistant shield **115** and also defines an opening through which the display device **102** can be viewed.

(34) A gasket **117** (e.g., a foam gasket) is positioned over the display device **102** (around the perimeter of the display device **102** and adjacent the opening in the top panel **110**) in the angled top portion of the golf ball dispenser, and the impact resistant shield **115** is positioned over the recessed portion of the top panel **110**, over the gasket **117**, and over the display device **102** in the angled top portion of the golf ball dispenser. Thus, the impact resistant shield **115** protects the display device **102**. Further, the method of installation of the shield **115** using the gasket **117**, as shown, can provide environmental protection against dust, dirt and sand, as well as general water resistance, e.g., an ingress protection (IP) rating of up to IP54.

(35) In some implementations, the impact resistant shield **115** is an acrylic shield, which is good for shatter proofing. In some implementations, the acrylic shield **115** has a polycarbonate film that protects the acrylic material from scratches and scuffs. In some implementations, a texture is applied to the acrylic to reduce glare and mask aesthetic imperfections. Other materials or combinations of materials are also possible, such as a layering of materials designed to improve impact performance and durability. In any case, the impact resistant shield **115** serves to embed and protect the underlying display device **102** in the angled top portion of the golf ball dispenser.

(36) Further, in some implementations, the various exterior panels that connect with the metal frame **108** are modular, employing an independently interlocking panel design, e.g., using tongues and grooves to securely lock the panels together about the metal frame **108**. FIG. 1F shows additional cross sections of the golf ball dispenser of FIG. 1A. A first tongue and groove connection **170** is used to interlock the top panel **110** with the right side panel **122R**. Note that a mirror image of the tongue and groove connection **170** is used for the left side panel **122L**. A second tongue and groove connection **172** is used to interlock the top panel **110** with the front panel **120**. An aligned portion **174** is used to match the front panel **120** with the right side panel **122R**. Note that a mirror image of the first aligned portion **174** is used for the left side panel **122L**. A first tongue and groove aligned portion **176** is used to match the back panel **124** with the right side panel **122R**. Note that a mirror image of the tongue and groove aligned portion **176** is used for the left side panel **122L**. A second tongue and groove aligned portion **178** is used to match an upper back door **128** with the top panel **110**.

(37) Thus, constructing the golf ball dispenser can proceed as follows: attach all internal components, including the display device **102**, to the frame **108**; attach the side panels **122R**, **122L** to the frame **108**; attach the front panel **120** to the frame **108**; attach the top panel **110** to the frame; insert the gasket **117** in the opening in the top panel **110**, around the perimeter of the display device **102**; insert the impact resistant shield **115** into the recess defined by the top panel **110**; and attach the back door assembly to the frame. Plastic panels of the dispenser can include threaded inserts molded into the plastic, and screws can be inserted through holes in the frame **108** and/or any metal plates of any access door (e.g., the back door assembly and optionally a front door assembly with the front panel **120** attached to it) and then be screwed into the threaded inserts to attach the panels to the frame/metal plates. Weather proofing can be achieved with the interlocking panel design and using gasket material around doors or removable panels.

(38) FIG. 2A is a rear perspective view showing an exploded version of a golf ball dispenser **200**. The golf ball dispenser **200** can be the golf ball dispenser **100** with an embedded display device, or the golf ball dispenser **200** can be a golf ball dispenser that does not include a display device. The golf ball dispenser **200** includes a front panel **220**, a right side panel **222R**, a left side panel **222L**, a back door **224**, a receptacle **230**, and a frame **208** (e.g., the front panel **120**, the right side panel **122R**, the left side panel **122L**, the back door **124**, the receptacle **130**, and the metal frame **108** of golf ball dispenser **100**). Further, the golf ball dispenser **200** includes a back panel **226** and an upper door **228**, and the receptacle **230** can include a rear access panel **232**.

(39) In some implementations, the upper door **228** provides access to another receptacle (positioned

above the receptacle **230**) that holds additional golf balls and is accessible during a power outage via the upper door **228** on the back side of the golf ball dispenser **200**. The additional receptacle can be a set of one or more baskets that are prefilled with golf balls and can be locked and stored inside the dispenser **200**. FIG. 4A shows an example of a basket of golf balls **410** stored in a golf ball dispenser **200** for emergency use. In the event of an emergency (e.g., game is down, etc.) an employee can unlock the back door and remove two baskets **405**, e.g., two pieces due to size constraints within the dispenser **200**, link the two baskets **405** together so as to create the “single” basket **410**, and set the basket **410** down for the guest to use as “emergency balls” while the game system is repaired to get back to online status.

(40) FIG. 2B is a cross section of an example of the front panel **220** from the golf ball dispenser **200** of FIG. 2A. The front panel **220** can be constructed from separate pieces that attach with each other. A first piece **202** has reinforcing ribs **202A**, **202B** that increase the strength of the first piece **202**, above and beyond the strength of the material (e.g., plastic) itself. The first piece **202** is configured to attach with the metal frame **208**, e.g., using screws, bolts, and/or tabs, and the first piece **202** can be made from HDPE material. A second piece covers and attaches with the first piece **202** and forms a pad that reduces the speed of golf balls that hit the pad. The second piece can itself be constructed from two or more pieces of different materials. In some implementations, the second piece includes a base piece **204** that has a strength that is less than the strength of the first piece **202**. For example, the base piece **204** can be made from Polyethylene (PE) material. Further, the second piece can include a padding piece **206** that attaches with the second piece **204**. For example, the padding piece **206** can be made from one or more foam materials.

(41) In some implementations, the padding piece **206** includes a PE foam **206A** and a memory foam **206B**, and both of these pieces **206A**, **206B** attach with a PE board **204**. For example, a fabric material **206C** can be used as an outside covering that attaches together the pieces **204**, **206A**, **206B** into a single pad that can then be attached to any of the panels facing a tee area, e.g., the front panel **220**. FIG. 2C is perspective, exploded view of respective pieces of the padding piece **206** on the front panel from FIG. 2B. In this example, the single pad is constructed from a 4 mm thick PE board **204**, a 6 mm thick Expanded Polyethylene (EPE) foam **206A**, and a 25 mm thick memory foam **206B**. Note that foam layers **206A**, **206B** can be adhesively attached to the PE board **204**, which is strong enough to hold inserted screws for use in attaching the pad to the first piece **202**, and facilitates quick changes of the pad, e.g., due to damage.

(42) This layered design for the padding on a panel provides strength to withstand errant ball and club hits, but also facilitates replacement of damaged pieces. The outermost piece **206** helps reduce the speed of golf balls that bounce off the dispenser **200**, and thus reduce injury, and the separate pieces forming the panel can be individually replaced when they are damaged. Note that the other exterior surfaces of the golf ball dispenser **200** can also employ this three layered design, in particular, those exterior surfaces that generally face a tee area. Thus, the back door **224** and the back panel **226** can also use the same multi-piece construction.

(43) FIG. 2D is another cross section of an example of a front panel from the golf ball dispenser **200** showing an example of a light source **240** for the outlet of the golf ball dispenser **200**. In this example, the light source **240** is a light emitting diode (LED) bar, but other types of light sources are also possible, such as a flexible strip or custom printed circuit board. In any case, the light source **240** provides a full spectrum of colors in response to signals from a controller. The controller can be included in the golf ball dispenser **200** or be separate from it; the controller can be connected to the light source **240** with wires, wirelessly, or both. The controller can be configured (by circuitry and/or program code) to adjust the colors and/or intensity of the light source **240** in response to one or more events, including: a golf ball dispense, a golf ball dispenser service request, a current state of the golf bay in which the golf ball dispenser is located, and a current aspect of a game being played from the tee area served by the golf ball dispenser.

(44) In addition, the golf ball dispenser **200** can include more than one light source, which can be

used to indicate the same or different events associated with the golf ball dispenser **200** and/or the tee area or golf bay served by the golf ball dispenser **200**. For example, the golf ball dispenser can include four light sources, a first light source **240** near the outlet (e.g., outlet **104** in FIG. **1A**), a second light source to light up a word **140** or other symbol(s) on the front of the golf ball dispenser, a third light source to light up a right side logo **242R** or other symbol(s) on the right side of the golf ball dispenser, and a fourth light source to light up a left side logo **242L** or other symbol(s) on the left side of the golf ball dispenser. Note that the logos **242R**, **242L** and the word **140** TOPGOLF® are images of registered trademarks of Topgolf International, Inc. A control system for the golf ball dispenser **200** can control the four light elements on the dispenser **200** independently. For example, each light source can be uniquely controlled through one controller, where the controller sends an RGB (Red/Green/Blue) profile indicating what color to change the respective lights to.

(45) Other light elements can be controllable as well including intensity and special effects, e.g., pulsating, gradients, etc. Further, other lighting sources/elements are also possible, such as a light source on the top of the dispenser **200**, and lighting control can be synchronized across multiple golf ball dispensers located at a golf facility. In some implementations, each light across multiple dispensers can be systematically controlled using software and/or manually controlled through an application program interface (API) to a provided lighting control interface program.

(46) FIG. **2E** is a cross section of the golf ball dispenser **200** showing an example of a gateway **250** for golf ball release. The gateway **250** is coupled between the receptacle **230** and a passageway **260** to restrict a passage of the multiple golf balls (not shown) held in the receptacle **230** into the passageway **260**. The gateway **250** is selectively moveable to allow a golf ball to pass from the receptacle **230** into the passageway **260** for delivery to a tee area. Various drive systems can be employed for the gateway **250**. For example, the gateway **250** can include a screw **252** inside a hopper **254** underneath an opening in a bottom portion of the receptacle **230**, as shown. A motor **256** is configured (by circuitry and/or program code) to controllably release a single ball based on a given input signal, e.g., in response to a sensor positioned near the outlet of the golf ball dispenser **200** detecting a club passing in front of the outlet.

(47) Other drive systems are also possible. Further, in some implementations, the golf ball dispenser **200** includes a steel frame **258** positioned around the opening and between the bottom portion of the receptacle **230** and the hopper **254** containing the screw **252**. The steel frame **258** facilitates withstanding additional pressure from the golf balls, reducing the chances of the ball screw **252** jamming due to pressure when the receptacle **230** is completely full. In some implementations, the receptacle **230** is made from steel, e.g., powder coated steel.

(48) In some implementations, the golf ball dispenser **200** includes a sensor **270** within the receptacle **230**. The sensor **270** can be a distance measurement device, such as an infrared proximity sensor, where the number of golf balls in the receptacle **230** can be estimated based on the distance to the golf balls in the receptacle **230**. The sensor **270** detects how full the receptacle **230** is, and sends a signal when the golf ball dispenser **200** needs to be refilled. This signal can be sent to a central computer system for the golf facility and/or or to the lighting controller for the golf ball dispenser. For example, such signals from multiple sensors **270** in multiple golf ball dispensers **200** can be sent to a central computer to give a live view of the ball counts across all dispensers in a golf facility, providing the ability to proactively monitor and refill dispensers. As another example, the light source(s) for one or more of the symbols **140**, **242R**, **242L** can be changed in color and/or intensity in response to a signal that the golf ball dispenser **200** needs to be refilled.

(49) As noted above, various different events can trigger different lighting effects. Additional details regarding lighting effects are provided below, but an example is now given with reference to FIGS. **2D** and **2E**. In this example, the controller is configured to adjust a color and/or intensity of the light source **240** around the outlet by changing the color and/or intensity of the light source **240** from a first color and/or intensity to a second color and/or intensity in response to release of a golf ball by the gateway **250** from the receptacle **230** into the passageway **260**, and changing the color

and/or intensity of the light source **240** from the second color and/or intensity to at least one third color and/or intensity once the released golf ball reaches the outlet of the golf dispenser **200**. For example, the light source **240** changes to a different color when the ball release signal is received, and then the light source **240** changes across a color gradient during the time it takes for a golf ball to be pushed into the passageway **260** by the screw **252**, and then for the golf ball to roll through the passageway **260** to the outlet. Thus, the player is provided immediate feedback regarding the ball release and is provided continuous feedback regarding the progress of the ball to the outlet.

(50) FIG. 2F shows an example of an access panel **232** useable to empty the golf ball receptacle **230**. In this example shown, the access panel **232** slides in and out of two flanges **230A** that hold the access panel **232** in place on a bottom portion of a back side of the receptacle **230**. In some implementations, the access panel **232** is hinged at a proper height to allow golf balls to naturally flow down over the hinged door (which becomes a ramp) out of the dispenser **200** and into a portable storage container.

(51) FIG. 3A is a cross section of a golf ball dispenser **300**. The golf ball dispenser **300** can be the golf ball dispenser **100** and/or the golf ball dispenser **200**. The golf ball dispenser **300** includes a front panel **302**, a back door **304**, and a receptacle **306** (e.g., the front panel **120**, **220**, the back door **124**, **224**, and the receptacle **130**, **230** of golf ball dispenser **100**, **200**). In addition, the golf ball dispenser **300** includes a ramp assembly **310**.

(52) FIG. 3B is a perspective view showing the ramp assembly **310**. The ramp assembly **310** is a sliding shelf that uses rollers (e.g., casters) **312** that roll along rails **314** within the dispenser, e.g., along the top of support and cross bars **314** attached to the top of the receptacle **306**. The ramp assembly **310** includes a piano hinge **316**, e.g., a zinc plated steel piano hinge, which is used to attach the ramp **318** to a metal plate **324** of the back door **304**. As shown, when the back door **304** is closed, the ramp **318** covers the receptacle **306**, and when the back door **304** is opened, the ramp **318** extends out the back of the dispenser **300** to allow for easy refilling with golf balls, and then when the back door **304** is closed, the ramp **318** returns to its resting position inside the golf ball dispenser **300**.

(53) FIGS. 3C and 3D are perspective views showing respective portions of a back door assembly **320**. The back door assembly **320** includes the back door **304** and a back panel **330** below the back door **304**. As with the back door **224** and the back panel **226** from golf ball dispenser **200**, the back door **304** and the back panel **330** can also use the same multi-piece construction with foam padding. Thus, the back panel **330** can be constructed from an HDPE piece **334** and a three layer pad **332**, including a memory foam, with fabric over the pad **332**.

(54) The back door **304** attaches to the metal plate **324**, e.g., using screws, bolts and/or tabs. The back panel **330** attaches to a metal plate **326**, e.g., using screws, bolts and/or tabs. In some implementations, the metal plate **326** is a portion of the metal frame for the golf ball dispenser **300**. Further, the metal plate **324** attaches with the metal plate **326** using one or more hinges, which allows the back door **304** to be opened and closed. In some implementations, two quick release hinges **340** are mounted inside the golf ball dispenser **300** (as shown in FIG. 3D) such that the quick release hinge **340** is not visible when the back door **304** is closed. Using a quick release hinge facilitates removing the back door entirely when this is needed for servicing of the golf ball dispenser **300**.

(55) Moreover, in some implementations, the front panel **302** (e.g., front panel **120**, **220**) is implemented as a front door in the manner described for the back door **304**, with quick release hinges that are not visible when the front door is closed. This facilitates removing the front door entirely as well, and allows easy servicing from either side of the golf ball dispenser. Enabling servicing of the golf ball dispenser from either side minimizes disturbance of guests in the tee area that is not served balls by the dispenser being serviced by a technician.

(56) In addition, the back door assembly **320** can include wings **322**, which can be made of metal, e.g., the wings **322** can be bent side portions of the metal plate **324**. In some implementations, the

wings **322** and metal pieces **324**, **326** are made from steel, e.g., powder coated steel. The wings **322** serve to keep golf balls on the ramp **318** during loading of the receptacle **306**. FIGS. **4B-4E** show examples of the back door and ramp assemblies in use. In FIG. **4B**, the back door is initially closed **420**, then partially opened **422**, and then opened fully **424**, revealing the wings **322** on either side of the ramp **318**. As shown in FIG. **4C**, the rollers (e.g., casters) **312** run along the rails **314** from their storage positions **426** to their fully open position **428**, as the back door moves from the closed position **420** to the fully open position **424**. In the fully open position **424**, the golf ball dispenser is ready to be refilled.

(57) As shown in FIG. **4D**, the receptacle **306** can be refilled by dumping balls **440** onto the ramp **318**. The force of gravity will naturally pull the balls down the ramp **318** and into the receptacle **306**; note that the rails **314** are narrow enough that the balls are unlikely to balance and come to rest on them. During this process, the wings **322** help keep the balls on their intended course into the receptacle **306**. As another example, FIG. **4E** shows a moveable golf ball delivery device **460**, which is used to deliver golf balls **462** to the receptacle **306** by directing the golf balls **462** onto the ramp **318**. Again, the force of gravity will naturally pull the balls down the ramp **318**, past the rails **314**, and into the receptacle **306**, while the wings **322** will prevent the golf balls **462** from falling off the ramp **318**.

(58) When the refilling is completed, the back door **304** is closed, and the ramp **318** and wings **322** return to their storage positions inside the golf ball dispenser. Thus, the roller system of the ramp assemble **310** facilitates the filling of the golf ball dispenser **300**, as it maximizes storage space for golf balls by enabling refill of the dispenser **300** at the upper most point of the receptacle **306** without having to take the top off the dispenser **300**, and in a manner that minimizes the risk of spilling golf balls, impacting electronics, etc. The dispenser **300** can be refilled from the back rather than from the top, while also ensuring loading of the balls is from a point higher than the top of the receptacle **306**, thus maximizing the number of balls that can be stored during a single refill.

(59) FIG. **5A** shows an example of a system **500** that can be used in combination with the golf ball dispensers of the present application. In this example, the system **500** is part of a golf facility that includes targets **520** on a golf range **510**, and a building **515** including golf bays **530**. The golf bays **530** can include the golf ball dispensers of the present application. In FIG. **5A**, the building **515** is shown as being rectangular, but note that typical implementations will have a curved portion of the building facing the golf range **510** so the golf bays **530** form a crescent shape. The golf ball dispensers of the present application and the targets **520** can include Radio Frequency Identification (RFID) tag interrogators that read RFID equipped golf balls hit from the golf bays **530** located on more than one level of the building **515**. The RFID tag interrogator in each golf ball dispenser can be positioned along the passageway from the ball receptacle to the ball outlet. Further, one or more of the targets **520** can include discrete sections of netting that funnel the golf balls into respective RFID reader boxes associated with the different sections. However, in some implementations, no such RFID tags and RFID tag interrogators are required.

(60) The system **500** includes one or more computers **551**, which are communicatively coupled (e.g., by wires, wirelessly, or both) to the golf ball dispensers in the bays **530** to control the operation of the golf ball dispensers. For example, the computer(s) **551** can be programmed to (1) present information on the embedded display device **102** for viewing by a user of the golf ball dispenser **100** (e.g., dynamically determined content or other content, such as a television show or other video data, static images, brand elements, interactive user interface screens for the game being played by the golfers using the golf ball dispenser **100**, etc.), (2) use the sensor **270** to detect how full the receptacle **230** is to trigger a refill of the golf ball dispenser **200** when needed (e.g., trigger a lighting change on the golf ball dispenser **200** to alert staff that the dispenser **200** should be refilled). The one or more computers **551** can include a central computer system for the golf facility, dispenser controller(s) and/or game system computer(s).

(61) In some implementations, at least one golf ball sensor **540** (e.g., one or more stereo camera

sensors) is included in the system **500**, and the computer(s) **551** use golf ball sensor(s) **540** to track the golf balls in flight (after being released from a golf ball dispenser and hit from a golf bay **530**) and identify where the golf balls land on the golf range **510**, with or without the use of RFID systems. Thus, the computer(s) **551** and sensor(s) **540** can form a golf ball sensor system **540**, **551** that performs in flight 3D tracking of golf balls through the three dimensional space of the golf range **510**. The golf range **510** can be flat or include small hills or one or more inclines, and can also include hazards, such as water and sand traps. Note that such hazards need not include actual water and sand, but can simply be colored to look like water and sand. The golf range **510** can be composed of real grass or artificial turf. Moreover, the targets can be grouped into categories that generally represent their distances from the building **515**, and the targets can have various shapes, such as the circular shapes of the main targets and the rectangular shape of the trench target at the end of the range **510**, as well as separate colors for each target **520** or groups of targets **520**. Other shapes and sizes for the targets **520**, as well as different numbers of targets **520** than shown, are also possible.

(62) The golf ball sensor system **540**, **551** can be used to identify from which of golf bays **530** the golf balls have been hit, and then present information regarding the golf ball hit from a given bay **530** on the embedded display device in the golf ball dispenser in that bay, e.g., golf ball statistics relating to the current shot in the current game and/or an animation showing the golf ball flight in a computer generated representation of the physical world of the golf range **510** and/or of a virtual world correspond to the game being played. The golf ball sensor system **540**, **551** includes at least one golf ball sensor **540** and at least one computer **551** communicatively coupled with the golf ball sensor **540**. The golf ball sensor **540** can be one or more sensors of one or more different types. For example, the golf ball sensor(s) **540** can be an optical sensor (e.g., a stereo camera or two cameras operated together to provide stereo vision of the golf balls in flight), a radar sensor, or a combination of these. In some implementations, two or more stereo cameras **540** are used to track golf balls in flight in three dimensional space.

(63) The golf ball sensor(s) **540** are communicatively coupled with one or more computers **551**. In some implementations, at least one computer **551** is connected or integrated with each of two or more sensors **540** to create discrete sensor systems, which independently/separately detect and track golf balls in the three dimensional space, thus providing distinct trajectory predictions based on distinct observations of the same golf balls traveling through the three dimensional space. Such discrete golf ball sensor systems can also be communicatively coupled with a central computer system **551**, e.g., one or more server computer systems, which coordinate the trajectory predictions received from the discrete golf ball sensor systems and make a final determination as to which of the golf bays **530** and which of the golf ball dispensers should be confirmed and reported as the origin for a specific golf ball being tracked. Note that the central computer(s) **551** can be part of a computer system (e.g., for the golf facility) that manages golf games and sends information about the golf shot (e.g., a simulated golf shot animation in a virtual golf game and/or a ball tracing overlay in an augmented reality golf shot viewer) to a display device associated with or embedded in the golf ball dispensers in the golf bays **530**. In any case, the computer(s) **551** include at least one hardware processor and at least one memory device coupled with the at least one hardware processor, that have been built and/or programmed to perform the operations detailed in this disclosure.

(64) FIG. 5B shows an example of a layout for golf bays **540A**, **540B**, as can be used in the system of FIG. 5A. The golf bays **540A**, **540B** can include furniture **545**, such as couches and tables, to facilitate dining and conversation during the game. As will be appreciated, many layouts for the furniture **545** are possible, and the furniture **545** and layout in the golf bays **540A**, **540B** can be designed to provide flexibility in how the golf bays **540A**, **540B** are assigned to one or more groups of people for playing games together or separately.

(65) Each of the golf bays **540A**, **540B** can include two tee off locations, where each tee off

location includes a tee area **550** and a golf ball dispenser **555**. Each golf ball dispenser **555** can include any suitable combination of features described herein for a golf ball dispenser. For example, the golf balls can be collected from a central location in the building **515** and manually dropped into a receptacle **306** in golf ball dispenser **555** using the ramp assembly **310** described above. But in some implementation, the ramp assembly **310** is not used, and each golf ball dispenser **555** is directly connected with a pneumatic tube system, such that golf balls can be automatically retrieved from the targets and fed back to the players without human intervention. In either case, each of the golf ball dispensers **555** can include the embedded display device, the modular interlocking panels, the multi-layer padding, and/or other golf ball dispenser feature described in this application. In the implementations that use an embedded display device in each golf ball dispenser **555**, each display device can include a touchscreen device that connects with a central computer system for the building **515** and provides the players with direct control over their game play, including selecting the type of game to play and the current player.

(66) In any case, one or more players can step into respective tee areas **550**, obtain a golf ball from a respective dispenser **555**, and then hit their respective balls. In some implementations, the computer(s) **551** uses video data obtained by respective camera systems in each golf ball dispenser **555**. For example, a camera system in a golf ball dispenser **555A** can provide video of both a served tee area **550A** and an adjacent tee area **550B**. This video data can be used by the golf ball sensor system **540**, **551** to help locate an initial tee off location of the golf ball, for use in 3D ball flight reconstruction and to help identify an embedded display device on which to show information regarding the golf shot, e.g., golf shot statistics and/or golf shot rendering or animation in a virtual golf game, which can include a representation of a golf course or other virtual game features. In some implementations, with or without ball flight tracking, this video data can be used by the computer(s) **551** to provide swing analysis information to the player, e.g., an instant replay of the swing on the embedded display device along with computer generated tips for how to improve your golf swing.

(67) FIG. 5C shows an example of view angles for a camera system in the golf ball dispenser **555A**. FIG. 5C shows the golf ball dispenser **555A** from the perspective of the golf range **510** looking back into the golf bays **530**. Thus, the tee area **550A** that is served by the golf ball dispenser **555A** is now on the right, and the adjacent tee area **550B** is now on the left. The camera system in the golf ball dispenser **555A** provides a field of view that includes a view **560A** directly to the tee area **550A**, and also a field of view that includes a view **560B** directly to the adjacent tee area **550B**. As will be appreciated, the camera system in the golf ball dispenser **555A** will thus have a clear view of the club swing of a right handed golfer in tee area **550A**, and will also have a clear view of the club swing of a left handed golfer in the tee area **550B**. FIG. 5D is a cross section of the golf ball dispenser **555A** showing an example of the camera system that provides views **560A**, **560B**.

(68) The camera system is integrated into the golf ball dispenser **555A** and includes a controller **570** coupled with a first camera **572** directed toward tee area **550A**, and a second camera **574** directed toward tee area **550B**. Each camera **572**, **574** can be a wide angle camera that is positioned to capture a full swing of a golf club, including impact of the golf club with the golf ball when the golf ball is hit from the tee area, e.g., for use in generating information for display on the display device integrated with the golf ball dispenser **555A** or to a third party monitor/video playback device anywhere else, including over the Internet. In some implementations, a camera system **570**, **572** and/or **570**, **574** includes a video recording housing, a detachable wide-angle lens, a video grabber to process the video, and a computer programmed with software that processes the video and relays feedback.

(69) Note that the placement and angles of the cameras **572**, **574** within the golf ball dispenser **555A**, as well as the size and position of the golf ball dispenser **555A** in relation to tee areas **550A**, **550B**, provide clear views through the holes in the top panel and the upper back door that allow

simultaneous capture of two golf swings (left and right) in adjacent golf bays/tee areas. Moreover, the spacing to the tee areas **550A**, **550B** for the front and back cameras **572**, **574** can be set so as to allow for the video capture to work for a left handed golfer without changing the software for differences in viewing distance. And each of the cameras **572**, **574** can have enough aperture to capture both the impact of the club with the ball in the tee area and the full range of swing of the club, regardless of whether the golfer is left handed or right handed.

(70) FIG. **6** is a schematic diagram of a data processing system including a data processing apparatus **650** that can be used to control one or more golf ball dispensers as described in this application. The data processing apparatus **650** can be connected with one or more computers **690**, display devices **690** or both, through a network **680**. While only one computer is shown in FIG. **6** as the data processing apparatus **650**, multiple computers can be used.

(71) The data processing apparatus **650** can include various software modules, which can be distributed between an applications layer and an operating system. These can include executable and/or interpretable software programs or libraries, which can include a program **670** that operates one or more golf ball dispensers. The number of software modules used can vary from one implementation to another, and the software modules can be distributed on one or more data processing apparatus connected by one or more computer networks or other suitable communication networks. Moreover, in some cases the functions described are implemented (in part or fully) in firmware and/or hardware of the data processing apparatus **650** to increase the speed of operation. Thus, program(s) and/or circuitry **670** can be used to implement the golf ball dispenser control operations described in this application.

(72) The data processing apparatus **650** can include hardware or firmware devices including one or more hardware processors **652**, one or more additional devices **654**, a computer readable medium **656**, a communication interface **658**, and one or more user interface devices **660**. Each processor **652** is capable of processing instructions for execution within the data processing apparatus **650**. In some implementations, the processor **652** is a single or multi-threaded processor. Each processor **652** is capable of processing instructions stored on the computer readable medium **656** or on a storage device such as one of the additional devices **654**. The data processing apparatus **650** uses its communication interface **658** to communicate with one or more computers/display devices **690**, for example, over a network **680**. Thus, in various implementations, the processes described can be run in parallel or serially, on a single or multi-core computing machine, and/or on a computer cluster/cloud, etc.

(73) Examples of user interface devices **660** include a display device, a touchscreen display device, a camera, a speaker, a microphone, a tactile feedback device, a keyboard, and a mouse. The data processing apparatus **650** can store instructions that implement operations detailed in this disclosure, for example, on the computer readable medium **656** or one or more additional devices **654**, such as one or more of a floppy disk device, a hard disk device, an optical disk device, a tape device, and a solid state memory device. In general, computer readable medium **656** and one or more additional devices **654** storing instructions are examples of at least one memory device encoding instructions configured to cause at least one hardware processor to perform operations as detailed in this disclosure.

(74) The additional device(s) **654** can also include one or more sensors **540**. The one or more sensors **540** can also be located remotely from the data processing apparatus **650**, and the data from such sensor(s) **540** can be obtained using one or more communication interfaces **658**, such as interfaces for wired or wireless technologies. Such communication interface(s) **658** can also be used to communicate information to display devices embedded in the golf ball dispenser(s) and/or control signals to light source(s) in the golf ball dispenser(s), and/or other data to another computer system. For example, two or more data processing apparatus **650** can be discrete golf ball sensor systems that independently track golf balls in a three dimensional physical space, report their results to another data processing apparatus **650** that decides which result to use and which tee area

to identify as the origin for the golf shot and thus to which golf display device in which golf ball dispenser to send information about the golf shot in the game being played.

(75) FIG. 7 is a flowchart showing an example of processes that can be implemented in combination with the golf ball dispensers of the present application using the computer systems described above. Input data is obtained **700** from a golf ball dispenser. For example, the input data can include a fill level signal from sensor **270**, input signals from a touchscreen display device **102**, and/or video data from a camera **572**, **574**. A check **710** can be made to determine if the input data relates to control of the golf ball dispenser. If so, the input data is processed and output is sent **712** to effect a change in the dispenser. For example, if the input signal is the detection by a proximity sensor (e.g., an infrared sensor) of a club being waved in front of the outlet **104**, this can be processed to trigger a ball release by the gateway **250** as well as the color and/or intensity change of the light source **240**, as described above. In addition, the control of the dispenser can be tied into the game played, such as when the final color of the light source **240** (or a final flashed color of the light source **240**) is selected to indicate a target to be hit with the dispensed golf ball (e.g., a physical target on a golf range in front of the tee area and the golf ball dispenser, or a virtual target in the game being played from the tee area served by the golf ball dispenser). As another example, if the input signal is the fill level signal from sensor **270**, this can be processed to determine if the dispenser **100** needs to be refilled, and if so, a signal is sent to change the color of the right side logo **242R**.

(76) Further, a check **720** can be made to determine if the input data relates to control of the game or the golf bay. If so, the input data is processed and output is sent **722** to effect a change in the game of golf bay. For example, the input data can be a new game selection detected on the touchscreen display device **102**, a new game gesture detected with the camera **572**, or a face of a player (recently assigned to the golf bay) detected by facial recognition software, and the output can be to a game control computer, which starts a new game and updates the display device **102** accordingly. As another example, the input data can be a food or drink order request detected on the touchscreen display device **102**, or a food or drink order gesture detected with the camera **572**, and the output can be to a wait staff management computer, which sends a signal to a mobile device held by the person responsible for the golf bay in which the golf bay dispenser is located.

(77) In addition, a check **730** can be made to determine if the input data relates to a game action. If so, the input data is processed and output is sent **732** to represent the game action. For example, the input can be sensor data received by the golf ball sensor system **540**, **551**, which can process this sensor data to detect and track the 3D trajectory of the golf ball hit from the tee area served by the golf ball dispenser, and the output can be a visualization on the display device embedded in the golf ball dispenser that shows the ball flight in a representation of the physical world (e.g., the golf range **510**, or a real world golf course) or of a virtual world (e.g., a game world having a 3D space registered with that of the golf range **510**).

(78) In addition, as noted above, lighting control can be synchronized across multiple golf ball dispensers located at a golf facility. In some implementations, each lighting controller can have a local timebase, and the local timebases for all the dispensers can be synchronized via a network synchronization protocol such as NTP (Network Time Protocol). Lighting effects scripts can be executed by the controller which determines the color and intensity of the lighting device and how they change over time. Lighting effects scripts can be sent to the controller for execution by an outside entity such as a centralized server or personal computer. Multiple lighting effects scripts can be stored on each controller and be scheduled for execution by the outside entity.

(79) Script execution schedule can be changed at any time by the outside entity. The currently executing lighting effects script can be preempted due to a local event (originating from within the dispenser) or a remote event; preemption causes the running script to be halted and immediately replaced by an alternate script; normal operation may be restored when the alternate script finishes; the preempted script resumes at the point it would have been had it not been preempted rather than

the point at which it left off so as to maintain synchronicity with other controllers or dispensers. Scripts can be mainly comprised of state transition instructions; each instruction includes an initial state (optionally automatically derived from the end of the previous transition), a final state, a transition duration, and a transition function (linear being the most basic example). Scripts can include control instructions for repetition of part of the script.

(80) Scripts can also include instructions that define how transitions between them and other scripts are to be handled when they are preempted. Scripts can be configured to execute only once or to automatically restart. A script synchronizes its starting point to a modulo of the timebase plus an offset; the base time modulus is the script's repetition period. Scripts set to run only once can be either asynchronous to the timebase or synchronized to an absolute time marker reference in the timebase. Script preemption events can be synchronized between controllers and dispensers by scheduling the transition from the currently running script to a new one on an absolute or relative (to the script execution repetition cycle) marker reference of the timebase; the script being transitioned to can have been transferred to the controller in advance.

(81) FIG. 8A shows another example **800** of a golf ball dispenser. The golf ball dispenser **800** can include any combination of feature described above for the golf ball dispensers **100**, **200**, **300**. The ball dispenser **800** includes an angled top portion **810** that is attached through a hinge with the rest of the ball dispenser **800**. Thus, the angled top portion **810** of the ball dispenser **800** can be lifted **812** (tilted upwards) to a fully open position **814**, thereby providing ready access **816** (from the top) to the inside of the ball dispenser **800**. For example, the top **810** of the ball dispenser **800** can be lifted to provide easy access for cleaning the display device inside the ball dispenser **800** and a backside of an impact resistant shield **115** held by the top **810**. Moreover, lifting the top **810** can facilitate repair or replacement of the display device inside the ball dispenser **800**. In some implementations, the top **810** can be lifted off once in the open position **814**, and in some implementations, the hinge holds the top **810** in place such that the top can be allowed to rest in the open position **814** while any cleaning or servicing is performed.

(82) In some implementations, the angled top portion **810** includes a top panel, such as the top panel **110** described above. In some implementations, the top portion of the ball dispenser **800** includes two distinct exterior pieces, namely, a top panel **810**, which can receive an impact resistant shield **115** in a recess defined in the top panel **810** just as done for top panel **110** (see FIG. 1D) and a curved (“waterfall”) panel **830** located between the top panel **810** and a front panel **820**. The top panel **810** can be coupled with the curved panel **830** or with the metal frame **108** through a hinge, which allows the top panel to be tilted upwards along with the impact resistant shield **115**, thereby providing access to the display device **102**.

(83) FIG. 8B shows an example of a hinge for the top panel **810** of the ball dispenser **800**. The hinge in this example is composed of at least one tab **812** (included as part of the top panel **810**) and at least one slot **832** (included as part of the curved panel **830**). The slot(s) **832** are configured and arranged to receive the tab(s) **812** and allow the top panel **810** to be tilted upwards along with the impact resistant shield **115**, thereby providing access to the display device. Other hinge structures are also possible, such as a swivel or a pivot; note that there is no requirement for rotation about a central axis. Further, using a tab and slot hinge (or similar tongue and groove structure) is advantageous in that the top panel **810** can be tilted upwards (without being removed) for ease of cleaning and maintenance, e.g., repair or replacement of the display device **102**, and the top panel **810** is also readily removable without the use of tools. Moreover, the overlapping tab & slot (or tongue & groove) design keeps the top portion of the ball dispenser water resistant, e.g., up to IP54.

(84) In addition, in order to hold the top panel **810** in place during normal operation, at least one back door **124**, **128**, **224**, **228**, **304** of the ball dispenser **800** can include a catch configured to hold the top panel **810** closed. For instance, FIG. 8C shows an example of a latching structure **840** for the top panel **810** of the ball dispenser **800**. In this example, the upper back door **228** includes a tab

842 configured and arranged to interact with and lock (through friction) against a tab **844** coupled with the top panel **810**. Together, the tabs **842**, **844** form the catch **840**, such that, when the upper back door **228** is closed, the tab **842** prevents the tab **844** (and thus the top panel **810**) from lifting upward on the hinge, but when the upper back door **228** is open, the tab **844** (and thus the top panel **810**) is free to be raised. Various other latching structures can be used as the catch, including various types of spring latches, hooks, snaps, clasps, or fasteners.

(85) Moreover, a collapsing weather stripping piece **811** can be included to prevent water from getting into the ball dispenser **800** (e.g., from rain, snow or other precipitation) through the seam that runs between the top of the upper back door **228** and the top panel **810**, thus helping to maintain an ingress protection rating of up to IP54. Further, in addition to handling water, the ball dispenser **800** can be designed to handle hot environments, e.g., from direct sun exposure. Thus, in some implementations, the ball dispenser **800** includes a blower or fan located inside the exterior panels of the golf ball dispenser **800**.

(86) FIGS. **8D** & **8E** show an example of a blower assembly **850** (i.e., a blower/fan assembly **850**) for the ball dispenser **800**. FIG. **8D** is a cross-sectional view showing the blower assembly **850** in place within the exterior panels of the golf ball dispenser **800**, where the blower assembly **850** is configured and arranged to direct air at the display device **102**. FIG. **8E** is a perspective view of the blower assembly **850**. As shown, the blower/fan assembly **850** can include a blower/fan **852** and a surface **854** (e.g., a metal or plastic structure) that is configured and arranged to shape the air into a curtain of air, by forcing the air into an enclosed space that runs most of the width of the ball dispenser **800** (e.g., at least as wide as the display device **102**) where the only outlet of that enclosed space is an opening **856**, which can also be long enough to extend across most of the width of the ball dispenser **800** (e.g., at least as wide as the display device **102**). After passing through the opening **856**, the air is guided by a surface **858** to the space between the display device **102** and the back sides of the top panel **810** and the shield **115**.

(87) Note that the gasket **117** is not included in these implementations, and so the curtain of air passes between the display device **102** and the impact resistant shield **115**. Nonetheless, a similar gasket can be included between the shield **115** and the top panel **810**, e.g., around the perimeter of the impact resistant shield **115**, as needed. In some implementations, the thickness of the impact resistant shield **115** and/or the recess in the top panel **810** that receives the impact resistant shield **115** is made with dimension(s) that ensure enough air will pass over the front of the display device **102** to keep the display device **102** sufficiently cool during operation. In some implementations, the recess in the top panel **810** includes two or more cutout portions (or indents) that ensure there is sufficient space between the top panel **810** and the display device **102** (i.e., sufficient clearance in one or more places where the recess defines an opening through which the display device **102** can be viewed) for the air to both enter and exit the space between the top panel **810** and the impact resistant shield **115**.

(88) For example, FIG. **8F** shows an underside of the top panel **810**. In this example, the top panel **810** includes an indented portion **818A** at the bottom, where the indented portion **818A** provides an opening for at least a portion of the curtain of air passing out of the opening **856** of the blower assembly **850**, and along the surface **858**, to flow between the edge of the top panel **810** (which holds the impact resistant shield **115** in place above the display device **102**) and the edge of the display device **102**, and thereby flow above the display device **102**. Likewise, the top panel **810** includes indented portions **818B** at the top sides of the panel **810**, where the indented portions **818B** provide an opening for the curtain of air passing over the display device **102** to flow around the edges of the display device **102** and back into the main interior of the ball dispenser **800**.

(89) Since the majority of heat generated inside the ball dispenser **800** comes from display device **102** (e.g., the light emitting diodes (LEDs) of the display device) and the solar exposure that the display device **102** receives through the shield **115**, cooling the front of the display device **102** (e.g., cooling the LEDs) in addition to (or in alternative to) cooling the back of the display device

102 facilitates long periods of operation of the ball dispenser **800** without significant risk of damage to the display device **102** or other components of the ball dispenser **800**.

(90) Note that the air need not be actively cooled in order to achieve the cooling effect, but it may be preferable to ensure that fresh air is available for the cooling, rather than simply recycling air inside the ball dispenser **800**. Thus, in some implementations, one or more outflow vents **860** are included near the top of the ball dispenser **800** to allow hot air to escape. One or more inflow vents can also be included in the ball dispenser **800**. However, in some implementations, no designated inflow vents are needed since there can be gaps between the exterior panels of the ball dispenser **800** and/or at the bottom of the ball dispenser **800** (where the front, back and side panels get close to, but do not touch the ground) to provide sufficient air intake.

(91) The outflow vent(s) **860** can be included in the top panel **810** (as shown in FIG. **8F**) and/or in one or more other exterior panels of the ball dispenser **800**. Preferably, the outflow vent(s) **860** are located near the top of the ball dispenser **800**, thus facilitating natural convection and release of heated air from within the dispenser **800**. Moreover, the outflow vent(s) **860** can include waterproof, breathable fabric (e.g., PTFE (polytetrafluoroethylene) or TPU (thermoplastic polyurethane) or another, similar type of material) which ensures the desired water resistance, e.g., an ingress protection rating of up to IP54, is maintained, thus protecting the internal components (e.g., electronics) of the ball dispenser **800**. For example, FIG. **8G** shows the upper back door **228** with outflow vents **860** included therein, along with waterproof, breathable fabric **862** that allows air to pass out of the vents **860** but prevents water from passing through the vents **860** and into the interior of the dispenser **800**.

(92) Further, as noted above, the top portion of the ball dispenser **800** can include two distinct exterior pieces: the top panel **810** and the curved panel **830**. The curved panel **830** can be attached (e.g., bolted) to the metal frame **108**, and the top panel **810** can be attached with the curved panel **830**, e.g., by inserting the tabs **812** into the slots **832**. By using separate pieces **830**, **810** instead of a single piece **110**, these parts **830**, **810** can be separately repaired or replaced, which can save costs over time for operation of the ball dispenser **800**. Moreover, these parts **830**, **810** can readily be made of different materials, e.g., metal for the core of the curved panel **830** and plastic for the top panel **810**.

(93) The vast majority of ball strikes on the dispenser (i.e., when the golfer hits the ball poorly and the ball then hits the dispenser) hit the front side, which includes the front panel **820** and the waterfall **830**. The front panel **820** can be constructed from separate pieces that attach with each other, such as described above for front panel **220**. Moreover, the curved panel **830** can likewise be constructed from separate pieces that attach with each other, thus helping to prevent breakage and/or damage to the waterfall **830**.

(94) FIG. **8H** shows an example of the curved (“waterfall”) panel **830** of the ball dispenser **800**. The curved panel **830** includes a metal plate **836** (e.g., steel) and a rubberized covering **834**, which slows incoming golf balls and prevents aggressive ricochets. The metal plate **836** can be attached to the metal frame **108** using brackets **838**. Making the waterfall **830** out of a metal plate **836** combined with a rubberized covering **834** dampens ball strikes and decreases the chance of damage to, or breakage of, the waterfall **830**. A similar trim piece can also be added to the front of the ball dispenser **800**.

(95) FIG. **8I** shows the front of the ball dispenser **800** with a trim piece **870** to be located between the curved panel **830** and the front panel **820**. In some implementations, the trim piece **870** attaches to the front panel **820**, as shown in FIG. **8J**, which is a cross-sectional view. The trim piece **870** can be made out of a metal plate **874** combined with a rubberized covering **872**. In addition, the trim piece **870** can attach to the front panel **820** using magnetic forces. For example, the trim piece **870** can include one or more magnets **876** positioned to interact with one or more magnets **822** included in the front panel **820**.

(96) The trim piece **870** can serve to protect the lock(s) that retain the front panel **820** to the metal

frame **108**, as well as potentially some otherwise exposed edges of the front panel **820**. Similar to the waterfall piece **830**, the trim piece **870** can provide this protection with a steel core **874** and an overmolded, rubberized outer covering **872**, which slows incoming golf balls and prevents aggressive ricochets. Moreover, the use of a magnetic coupling facilitates ease of maintenance since the lock(s) that retain the front panel **820** to the metal frame **108** can be readily accessed even though they are also protected from ball strikes by the trim piece **870**. The magnet(s) **876**, **822** can be made strong enough to hold the trim piece **870** against the front panel **820**, but weak enough that a person can readily pull the trim piece **870** off, thus exposing the lock(s) that retain the front panel **820** to the metal frame **108**.

(97) Embodiments of the subject matter and the functional operations described in this specification can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the structures disclosed in this specification and their structural equivalents, or in combinations of one or more of them. Embodiments of the subject matter described in this specification can be implemented using one or more modules of computer program instructions encoded on a computer-readable medium for execution by, or to control the operation of, data processing apparatus. The computer-readable medium can be a manufactured product, such as hard drive in a computer system or an optical disc sold through retail channels, or an embedded system. The computer-readable medium can be acquired separately and later encoded with the one or more modules of computer program instructions, such as by delivery of the one or more modules of computer program instructions over a wired or wireless network. The computer-readable medium can be a machine-readable storage device, a machine-readable storage substrate, a memory device, or a combination of one or more of them.

(98) The term “data processing apparatus” encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a runtime environment, or a combination of one or more of them. In addition, the apparatus can employ various different computing model infrastructures, such as web services, distributed computing and grid computing infrastructures.

(99) A computer program (also known as a program, software, software application, script, or code) can be written in any suitable form of programming language, including compiled or interpreted languages, declarative or procedural languages, and it can be deployed in any suitable form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub-programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

(100) The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

(101) Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. The essential elements of a computer are a processor

for performing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. However, a computer need not have such devices. Moreover, a computer can be embedded in another device, e.g., a mobile telephone, a personal digital assistant (PDA), a mobile audio or video player, a game console, a Global Positioning System (GPS) receiver, or a portable storage device (e.g., a universal serial bus (USB) flash drive), to name just a few. Devices suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices, e.g., EPROM (Erasable Programmable Read-Only Memory), EEPROM (Electrically Erasable Programmable Read-Only Memory), and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

(102) To provide for interaction with a user, embodiments of the subject matter described in this specification can be implemented on a computer having a display device, e.g., LCD (liquid crystal display), OLED (organic light emitting diode) or other monitor, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

(103) The computing system can include clients and servers. A client and server are generally remote from each other and typically interact through a communication network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. Embodiments of the subject matter described in this specification can be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation of the subject matter described in this specification, or any combination of one or more such back-end, middleware, or front-end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network (“LAN”) and a wide area network (“WAN”), an inter-network (e.g., the Internet), and peer-to-peer networks (e.g., ad hoc peer-to-peer networks).

(104) While this specification contains many implementation details, these should not be construed as limitations on the scope of the invention or of what may be claimed, but rather as descriptions of features specific to particular embodiments of the invention. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination. Thus, unless explicitly stated otherwise, or unless the knowledge of one of ordinary skill in the art clearly indicates otherwise, any of the features of the embodiment described above can be combined with any of the other features of the embodiment described above.

(105) Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in

sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and/or parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

(106) Thus, particular embodiments of the invention have been described. Other embodiments are within the scope of the following claims. In addition, the actions recited in the claims can be performed in a different order and still achieve desirable results.

Claims

1. A system comprising: a golf range; targets on the golf range; a building including golf bays including golf ball dispensers, wherein each of the golf ball dispensers is a golf ball dispenser that is associated with a golf bay and comprises a receptacle configured to hold multiple golf balls, a passageway connecting an outlet of the golf ball dispenser with the receptacle, a gateway coupled between the passageway and the receptacle, the gateway being configured to allow a golf ball to pass into the passageway, and a display device embedded in the golf ball dispenser; at least one golf ball sensor; one or more computers communicatively coupled with the at least one golf ball sensor and the golf ball dispensers, the one or more computers being configured to track the golf ball in flight on the golf range, identify where the golf ball lands on the golf range, identify the golf bay from which the golf ball was hit, and present information, regarding the golf ball hit from the golf bay, on the display device of the golf ball dispenser associated with the golf bay, the information being in accordance with where the golf ball lands on the golf range; wherein the golf ball dispenser comprises at least one outflow vent located so as to facilitate natural convection and release of heated air from within the golf ball dispenser; and wherein the golf ball dispenser comprises a waterproof, breathable fabric that allows air to pass out of the at least one outflow vent but prevents water from passing through the at least one outflow vent and into an interior of the golf ball dispenser.
2. The system of claim 1, wherein the at least one golf ball sensor comprises a radar sensor.
3. The system of claim 1, wherein the at least one golf ball sensor comprises one or more stereo camera sensors.
4. The system of claim 1, wherein the at least one golf ball sensor comprises a combination of a radar sensor and an optical sensor.
5. The system of claim 1, wherein the one or more computers are configured to present golf shot statistics on the display device of the golf ball dispenser associated with the golf bay.
6. The system of claim 1, wherein the one or more computers are configured to present an animation showing the golf ball in flight on the display device of the golf ball dispenser associated with the golf bay.
7. The system of claim 6, wherein the one or more computers are configured to present the animation in a computer generated representation of the physical world, the computer generated representation being shown on the display device of the golf ball dispenser associated with the golf bay.
8. The system of claim 6, wherein the one or more computers are configured to present the animation in a computer generated representation of a virtual world, the computer generated representation being shown on the display device of the golf ball dispenser associated with the golf bay, and the virtual world corresponding to a game being played.
9. The system of claim 6, wherein the one or more computers are configured to present the animation in a virtual world using golf ball flight characteristics determined from sensor data of the golf ball's actual flight in the real world.

10. The system of claim 6, wherein the animation is a simulated golf shot animation in a virtual golf game.

11. The system of claim 1, wherein the golf ball dispenser comprises: a back door; and a ramp positioned between the back door and the receptacle, wherein each of two sides of the ramp are bent upward.

12. The system of claim 11, wherein the golf ball dispenser comprises a hinge that couples the ramp with the back door, such that the ramp extends out a back of the golf ball dispenser when the back door is opened.

13. The system of claim 1, wherein the gateway comprises a screw inside a hopper underneath an opening in a bottom portion of the receptacle.

14. The system of claim 13, wherein the golf ball dispenser comprises a steel frame positioned around the opening and between the bottom portion of the receptacle and the hopper containing the screw.

15. A system comprising: a golf range; targets on the golf range; a building including golf bays including golf ball dispensers, wherein each of the golf ball dispensers is a golf ball dispenser that is associated with a golf bay and comprises a receptacle configured to hold multiple golf balls, a passageway connecting an outlet of the golf ball dispenser with the receptacle, a gateway coupled between the passageway and the receptacle, the gateway being configured to allow a golf ball to pass into the passageway, and a display device embedded in the golf ball dispenser; at least one golf ball sensor; one or more computers communicatively coupled with the at least one golf ball sensor and the golf ball dispensers, the one or more computers being configured to track the golf ball in flight on the golf range, identify where the golf ball lands on the golf range, identify the golf bay from which the golf ball was hit, and present information, regarding the golf ball hit from the golf bay, on the display device of the golf ball dispenser associated with the golf bay, the information being in accordance with where the golf ball lands on the golf range; wherein the at least one golf ball sensor is at least two golf ball sensors, the one or more computers are three or more computers, at least a first of the at least two golf ball sensors is connected or integrated with at least a first of the three or more computers to create a first discrete sensor system, at least a second of the at least two golf ball sensors is connected or integrated with at least a second of the three or more computers to create a second discrete sensor system, and at least a third of the three or more computers is configured to coordinate discrete trajectory predictions received from the first discrete sensor system and the second discrete sensor system; and make a final determination as to which of the golf bays and which of the golf ball dispensers is confirmed and reported as the origin for a specific golf ball being tracked.

16. The system of claim 15, wherein the at least a third of the three or more computers is part of a computer system that manages golf games and sends the information for presentation on the display device of the golf ball dispenser associated with the golf bay, the information being a simulated golf shot animation in a virtual golf game.

17. The system of claim 15, wherein the three or more computers are configured to present a visualization on the display device of the golf ball dispenser associated with the golf bay, wherein the visualization shows the golf ball in flight on the golf range or on a golf course.

18. The system of claim 15, wherein the three or more computers are configured to present a visualization on the display device of the golf ball dispenser associated with the golf bay, wherein the visualization shows the golf ball in flight in a game world registered with the golf range.

19. A system comprising: a golf range; targets on the golf range; a building including golf bays including golf ball dispensers, wherein each of the golf ball dispensers is a golf ball dispenser that is associated with a golf bay and comprises a receptacle configured to hold multiple golf balls, a passageway connecting an outlet of the golf ball dispenser with the receptacle, a gateway coupled between the passageway and the receptacle, the gateway being configured to allow a golf ball to pass into the passageway, and a display device embedded in the golf ball dispenser; at least one

golf ball sensor; one or more computers communicatively coupled with the at least one golf ball sensor and the golf ball dispensers, the one or more computers being configured to track the golf ball in flight on the golf range, identify where the golf ball lands on the golf range, identify the golf bay from which the golf ball was hit, and present information, regarding the golf ball hit from the golf bay, on the display device of the golf ball dispenser associated with the golf bay, the information being in accordance with where the golf ball lands on the golf range; wherein the golf ball dispenser associated with the golf bay comprises: a first camera arranged to capture a full swing of a first golf club in the golf bay; and a second camera arranged to capture a full swing of a second golf club in an adjacent golf bay.

20. The system of claim 19, wherein the golf ball dispenser comprises at least one outflow vent located so as to facilitate natural convection and release of heated air from within the golf ball dispenser.

21. The system of claim 20, wherein the golf ball dispenser comprises a waterproof, breathable fabric that allows air to pass out of the at least one outflow vent but prevents water from passing through the at least one outflow vent and into an interior of the golf ball dispenser.

22. The system of claim 19, wherein the golf ball dispenser comprises a blower or fan configured and arranged to direct air at the display device.

23. The system of claim 22, wherein the blower or fan is part of an assembly comprising a surface that is configured and arranged to shape the air into a curtain of air that passes between the display device and an impact resistant shield placed over the display device.
