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(54) **Title**: APP GADGETS AND METHODS THEREFOR

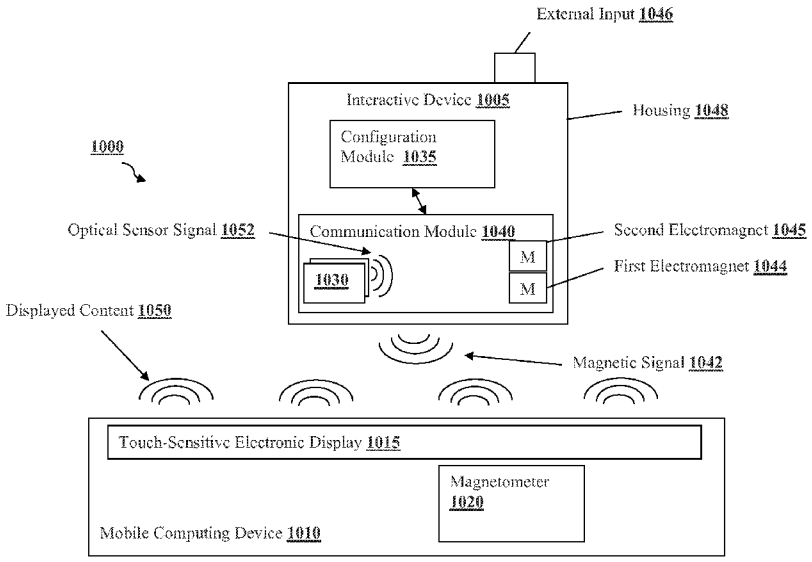

Figure 10

(57) **Abstract**: Systems and methods for interactive toys are presented in which the toy is configured to react to displayed content on a touch-sensitive electronic display of a mobile computing device and in which the toy provides a modulated magnetic field perceptible to the mobile computing device. Thus, bidirectional communication between the toy and the computing device is possible. Most preferably, the displayed content is updated by user interaction where the user uses touch or motion as an input modality to the mobile computing device.

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APP GADGETS AND METHODS THEREFOR

[0001] This application claims the benefit of U.S. provisional application number 61/764931, filed February 14, 2013, U.S. provisional application number 61/804912, filed March 25, 2013, and U.S. provisional application number 61/808940, filed Apr 5, 2013, all of which are incorporated herein by reference in their entirety.

Field of the Invention

[0002] The field of the invention is toys, and particularly electronic toys for use with tablet computing devices.

Background

[0003] Mobile computing devices, such as the Apple® iPad™, Blackberry® PlayBook™, Samsung® Galaxy Tab™, Acer® Iconia™, Google® Nexus Tablet™, HP® TouchPad™, HP® Slate Tablet™, etc, have gained enormous popularity among consumers. These mobile devices allow for new ways of interacting with the users using their touch-sensitive displays, and other sensors that are incorporated into the devices (e.g., accelerometer, magnetometer, etc.). As a result, many applications (e.g., game applications) that allow users and/or objects (e.g., toys) to interact with the display of the tablet device have been developed.

[0004] In addition, electronic toys have been made to integrate the toys with the display activities of the devices (see e.g., US6773344B1, US7397464B1, US20060223637A1, US20080081694A1, US20100268359A1, US2011/0304651, or WO 2012/162090). All publications herein are incorporated by reference to the same extent as if each individual publication or patent application were specifically and individually indicated to be incorporated by reference. Where a definition or use of a term in an incorporated reference is inconsistent or contrary to the definition of that term provided herein, the definition of that term provided herein applies and the definition of that term in the reference does not apply.

[0005] In other efforts, magnetometer and/or accelerometer information have been used in various manners in mobile computing devices. For example:

- MagnetMeter on iPhone 3GS User Manual by plaincode.com published in 2012 discloses an iPhone® application that presents a three-dimensional arrow on the display that follows a magnet source.

- U.S. patent publication 2012/0169327 to Parco et al. entitled "System and Method for Using Magnetometer Readings to Control Electronic Devices", filed January 5, 2011 discloses a mobile device that detects a magnetic signature of an object (e.g., cradle) to determine or enable certain actions based on the detected magnetic signature from the object.
- International patent publication WO 2012/120302A1 to Markham et al. entitled "System for Providing Information and Associated Devices", filed March 7, 2012 discloses mobile devices that detect and process magnetic beacons that are encoded with locality information.
- U.S. patent publication 2010/0085216 to Ajith entitled "Vibration Based User Input for Mobile Devices", filed October 2, 2008 discloses using vibration as input signal to send instructions to mobile devices.

[0006] Therefore, numerous toys are known to operate with mobile devices, and numerous dedicated applications for mobile devices are known to make use of various sensors. However, there is still a need to provide simple and effective toys that interact with display content of a mobile device while fully taking advantage of the sensors in the mobile device.

Summary of The Invention

[0007] The inventive subject matter is drawn to various interactive toys and methods therefor in which the toy reacts to displayed content on mobile computing device and in which the toy provides a modulated magnetic field perceptible to the mobile computing device. In most typical aspects, bidirectional communication between the toy and the computing device is therefore possible. It is further preferred that the displayed content changes as a function of user interaction in which a player uses touch and/or motion as an input modality to the mobile computing device.

[0008] In one aspect of the inventive subject matter, an interactive device for interacting with a mobile computing device having a touch-sensitive electronic display includes a communication module that generates a magnetic signal perceptible to a magnetometer of the mobile computing device. Most typically, the magnetic signal comprises a modulated magnetic field. Contemplated interactive devices further include an optical sensor that receives a communication from the display and produces an optical sensor signal, as well as a

configuration module that configures the device to be responsive to displayed content on the display based the magnetic signal and the optical sensor signal.

[0009] For example, the modulated magnetic field is modulated by frequency, amplitude, position, orientation, and/or an additional magnetic field, and it is generally contemplated that the additional magnetic field (where present) is generated by an electromagnet and/or a permanent magnet. It is further contemplated that the magnetic signal is generally suitable for identification by the mobile computing device (especially where the interactive device is placed onto the display) of the position of the interactive device relative to the display, the orientation of the device relative to the display, a state (e.g., on/off, sleeping temporarily disabled, etc.) of the interactive device, a type of the interactive device, a (typically game-related) feature of the interactive device, a (typically game-related) capability of the interactive device, the identity of the device's owner, and/or external input to the interactive device (e.g., signal from a button, a transducer, a touch-based input surface, or a light sensor).

[0010] In further preferred aspects, the configuration module further configures the interactive device to take an action based on the displayed content. The action can be an actuation, signal generating a signal, triggering a mechanical actuator, transacting with another device, communicating with another device, and generating a user interface. It is further contemplated that the device has a housing holding the communication module, the optical sensor, and the configuration module. The interactive device, in preferred aspects, is a toy car, a toy spaceship, a toy character, a toy mythical creature, or a toy animal.

[0011] In further preferred aspects, the screen of the mobile computing device displays content, and that displayed content is a pixel pattern, a color, a symbol, an object, a temporal display pattern, a pixel location, a set of unlit pixels, and polarization. The inventors additionally contemplate that the optical sensor of the interactive device can be a camera, a charge-coupled device (CCD) sensor, a complementary metal-oxide-semiconductor (CMOS) sensor, a solar cell, a photo-resistor, a phosphorescent sensor, a fluorescent sensor, and a scintillator. Finally, the communication module can have one or two electromagnetic that are used to generate interacting magnetic fields (i.e., the first electromagnet can be oriented differently from the second electromagnet such that the fields generated by each interact with each other). The communication module of another preferred aspect can include one or many optical sensors.

[0012] In another aspect of the inventive subject matter, an interactive device for interacting with a mobile computing device having a touch-sensitive electronic display is contemplated where the interactive device includes a shell containing a component that provides an identifier signal and a base that the shell can physically connect to. The base contains a communication module that, in combination with the identifier signal, generates a magnetic signal perceptible to a magnetometer in mobile computing device. The base additionally contains an optical sensor that receives a communication from the display and a configuration module that configures the interactive device to respond to content displayed by the mobile computing device. The configuration module configures the interactive device based on the one or both of the magnetic signal and the communication.

[0013] The shell component can include one or more of a permanent magnet, an electromagnet, a near field communication module, an RFID chip, a Bluetooth module, and a wireless communication module. Additionally, the communication module preferably generates a magnetic signal that is a modulated magnetic field that is modulated by frequency, amplitude, position, orientation, and/or an additional magnetic field (e.g., via an electromagnet and/or a permanent magnet). With respect to the magnetic signal it is generally contemplated that the signal is suitable for identification by the mobile computing device the position of the interactive device relative to the display, the orientation of the device relative to the display, the state of the interactive device, the type of the interactive device, a (typically game related) feature or capability of the interactive device, the identity of the device's owner, and/or an external input to the interactive device (e.g., a signal from a button, a transducer, a touch-based input surface, and/or a light sensor).

[0014] While not limiting to the inventive subject matter it is generally preferred that the configuration module configures the interactive device to take an action (e.g., an actuation, generating a signal, triggering a mechanic actuator, transacting with another device, communicating with another device, and generating a user interface) based on the displayed content, and/or that the communication module comprises first and second electromagnets (e.g., first electromagnet generates a magnetic field that is oriented differently than the magnetic field generated by the second electromagnet. Likewise, it is typically preferred that the communication module comprises the optical sensor, and/or that the interactive device further includes a plurality of additional optical sensors.

[0015] In a further aspect of the inventive subject matter, the inventors also contemplate a method of facilitating game play using an interactive device and a mobile computing device having a touch-sensitive electronic display. In particularly preferred aspects, the method comprises a step of configuring the interactive device such that the interactive device provides a modulated magnetic field to the mobile computing device to thereby provide at least one of positional and identity information to the mobile computing device, and yet another step of configuring the interactive device to receive an optical communication from the display of the mobile computing device to thereby prompt an action by the interactive device.

[0016] In at least some preferred embodiments the action comprises emission of a second modulated magnetic field by the interactive device. While not limiting to the inventive subject matter, the modulated magnetic field may be a frequency modulated magnetic field, an amplitude modulated magnetic field, and/or a modulation by a second magnetic field.

[0017] With respect to the mobile computing device it is contemplated that suitable devices will particularly include tablet computers, cell phones, and phablets, and especially preferred interactive devices are configured as a toy car, a toy spaceship, a toy character, a toy mythical creature, or a toy animal.

[0018] Consequently, the inventors also contemplate a method of facilitating interaction of an interactive device with a mobile computing device having a touch-sensitive electronic display, and especially preferred methods include a step of configuring a communication module of the interactive device to generate a first magnetic signal that is perceptible to a magnetometer of the mobile computing device, wherein the first magnetic signal comprises a modulated magnetic field, a further step of configuring an optical sensor in the interactive device to receive a communication from the display and to generate an optical sensor signal, and yet another step of configuring the communication module of the interactive device to respond to the optical sensor signal, wherein the response comprises a second magnetic signal that is different from the first magnetic signal.

[0019] Most typically, first and second magnetic signals are generated by at least one of an electromagnet and a permanent magnet, or by at least one electromagnet. For example, the first magnetic signal may indicate the type of the interactive device, a feature of the interactive device, a memory capacity of the interactive device, a game capability of the

interactive device, and/or an external input to the interactive device (e.g., a signal from at least one of a button, a transducer, a touch-based input surface, a light sensor). Where desired, the optical sensor signal will also configure a configuration module that causes the interactive device to take an action (e.g., actuation, generating a signal, triggering a mechanic actuator, transacting with another device, communicating with another device, and generating a user interface) based on the displayed content.

[0020] With respect to the communication it is contemplated that the communication includes at least one of the following: a pixel pattern, a color, a symbol, an object, a temporal display pattern, a pixel location, a set of unlit pixels, and polarization, and with respect to the communication module it is preferred that the communication module comprises at least a first and second electromagnet (e.g., first electromagnet may generate a magnetic field that is oriented differently than the magnetic field generated by the second electromagnet), and also optionally the optical sensor.

[0021] Viewed from a different perspective, the inventors also contemplate a non-transitory computer-readable storage medium storing computer-executable code for using an interactive device with a touch-based electronic display, that when executed by a processor causes the processor to perform the steps of (a) configuring a rules engine to receive data from a magnetometer; (b) determining, by the rules engine, at least one of a position and an identity of the interactive device based on at least a portion of the magnetometer data; (c) configuring the display to present content based on at least one of the position and the identity of the interactive device; and (d) using the displayed content to generate an optical signal to the interactive device and wherein the interactive device is configured to provide a modulated magnetic field to the magnetometer.

[0022] Most typically, the magnetometer data is indicative of or suitable for determination of the position of the interactive device relative to the display, the orientation of the interactive device relative to the display, the state of the interactive device, the type of the interactive device, the make or model of the interactive device, an interactive device feature, an interactive device memory capacity, an interactive device capability, a revision number, an identity of the interactive device's owner, a transaction, and/or an external input to the interactive device. In general, it is contemplated that the magnetometer data corresponds to a modulated magnetic field generated in the device, and the modulated magnetic field is modulated by at least one of frequency, amplitude, position, orientation, and an additional

magnetic field. It should further be recognized that the additional magnetic field can be generated by one or more electromagnets, and/or that the interactive device has an electromagnet and/or a permanent magnet (e.g., interactive device has a first and second magnet, the first and second magnets comprising at least one of an electromagnet and a permanent magnet).

[0023] Various objects, features, aspects and advantages of the inventive subject matter will become more apparent from the following detailed description of preferred embodiments, along with the accompanying drawing figures in which like numerals represent like components.

Brief Description of The Drawings

[0024] Figure 1 conceptually illustrates an interactive device of some embodiments.

[0025] Figure 2 conceptually illustrates a process of an interactive device interacting with an electronic display.

[0026] Figure 3 illustrates an example electronic toy interacting with a tablet computer of some embodiments.

[0027] Figure 4 illustrates different example interactions between an electronic toy and a tablet computer.

[0028] Figure 5 illustrates another example electronic toy interacting with a tablet computer of some embodiments.

[0029] Figure 6 illustrates another example electronic toy interacting with a tablet computer of some embodiments.

[0030] Figure 7 illustrates another example electronic toy interacting with a tablet computer of some embodiments.

[0031] Figure 8 illustrates another example electronic toy interacting with a tablet computer of some embodiments.

[0032] Figure 9 illustrates another example electronic toy interacting with a tablet computer of some embodiments.

[0033] Figure 10 illustrates another interactive device of some embodiments.

[0034] Figure 11 illustrates yet another interactive device of some embodiments.

Detailed Description

[0035] It should be noted that while the following description is drawn to tablet computers, servers, services, interfaces, portals, platforms, or other systems formed from computing devices, various alternative configurations are also deemed suitable and may employ various computing devices including servers, interfaces, systems, databases, agents, peers, engines, controllers, or other types of computing devices operating individually or collectively. One should appreciate the computing devices comprise a processor configured to execute software instructions stored on a tangible, non-transitory computer readable storage medium (*e.g.*, hard drive, solid state drive, RAM, flash, ROM, etc.). The software instructions preferably configure the computing device to provide the roles, responsibilities, or other functionality as discussed below with respect to the disclosed apparatus. In especially preferred embodiments, the various servers, systems, databases, or interfaces exchange data using standardized protocols or algorithms, possibly based on HTTP, HTTPS, AES, public-private key exchanges, web service APIs, known financial transaction protocols, or other electronic information exchanging methods. Data exchanges preferably are conducted over a packet-switched network, the Internet, LAN, WAN, VPN, or other type of packet switched network.

[0036] The following discussion provides many example embodiments of the inventive subject matter. Although each embodiment represents a single combination of inventive elements, the inventive subject matter is considered to include all possible combinations of the disclosed elements. Thus if one embodiment comprises elements A, B, and C, and a second embodiment comprises elements B and D, then the inventive subject matter is also considered to include other remaining combinations of A, B, C, or D, even if not explicitly disclosed. As used herein, and unless the context dictates otherwise, the term "coupled to" is intended to include both direct coupling (in which two elements that are coupled to each other contact each other) and indirect coupling (in which at least one additional element is located between the two elements). Therefore, the terms "coupled to" and "coupled with" are used synonymously.

[0037] According to some aspects of the present invention, an interactive device (e.g., a toy object) that is configurable to interact with another electronic device (e.g., a tablet computing

device) having a touch-sensitive display is presented. Specifically, the interactive device is responsive to the content that is displayed on the display portion of the electronic device. Instead of or in addition to being responsive to the displayed content, the interactive device interacts with the touch- sensitive display to affect the displayed content, preferably while the user interacts with the device to further affect the displayed content.

[0038] It should be appreciated that traditional touch-sensitive displays are transformed into a control surface for an object (e.g., a toy) that interacts with the display surface. Known electronic devices (e.g., tablet computers), and software applications for the devices, typically require a user to control the object (e.g., moving the object around the touch-sensitive display) in order to interact with the display of the electronic devices. Using the inventive concept illustrated herein, it is therefore contemplated that the interactive device is responsive to the content that is displayed on the display without interference by the user. In other words, the interactive device is triggered to perform an action solely by the displayed content without additional inputs by the user.

[0039] It should be noted that the term 'tablet computer' as used herein generally refers to a computing device having a display portion that is typically (but not necessarily) sensitive to touch. Therefore, the term 'tablet computer' includes, but not limited to, laptop computers, smart phones, and other display-only devices receiving a video input via wired or wireless connections. Examples of tablet computers are Apple® iPhone™, Apple® iPad™, Blackberry® PlayBook™, Samsung® Galaxy Tab™, Acer® Iconia™, Google® Nexus Tablet™, HP® TouchPad™, HP® Slate Tablet™, and Motorola® Xoom™, Microsoft® Surface™, Nintendo® DS™, PlayStation® Vita™, etc.

[0040] According to other aspects of the present invention apparatus, systems, and methods are provided in which an interactive device is configured to send modulated magnetic signals to a mobile computing device. The interactive device has a communication module that generates the modulated magnetic field that is perceptible to a magnetometer located within the computing device. Additionally, an optical sensor is coupled to the communication module such that when the device is placed on the computing device's screen it is capable of collecting visual information. Finally, some aspects of the invention also include a configuration module used to configure the interactive device to be responsive to content displayed on the computing device based on either the magnetic signal or the content presented on the screen or both. Of course, it should be appreciated that the modulated

magnetic signals can also be used to alter operation of the mobile computing device, and particularly to implement alternate displays or game rules as a function of the mobile computing device receiving modulated magnetic signals.

[0041] To communicate with the computing device, the magnetic field can be modulated by a number of different means. Frequency can be modulated by applying a time-varying electrical signal to electromagnetic coils. Amplitude can be modulated by applying electrical signals at varying intensities to electromagnetic coils. Position and orientation of the magnetic field can be modulated through movement or coupling of multiple magnetic fields. Additionally, multiple magnetic fields can be generated to interfere with each other to achieve a desired resultant magnetic field. Each magnetic field coupled with another can individually be modulated as described above. Magnetic fields in the interactive device can be generated using one or more electromagnetic coils, or it can be generated using one or more permanent magnets. Alternative, or additionally, one or more permanent magnets can be combined with one or more electromagnetic coils. In further aspects of the inventive subject matter, it is noted that a magnetic field may also be modulated to change into a second magnetic field having at least one different parameter (e.g., field strength, orientation, additional magnetic field, etc.).

[0042] It should be particularly appreciated that since the mobile computing device typically includes a 3D-magnetometer (i.e., has one or more magnetometers that can detect and measure magnetic field strength in all three dimensions), the position of the interactive device (e.g., when placed on the display) can be accurately determined as well as a characteristic of the interactive toy can be transmitted to the mobile computing device without changing position. Viewed from another perspective, it should be noted that the modulated magnetic field is therefore also useful in providing toy capabilities to the software running on the mobile computing device. Thus, a toy parameter can be changed (e.g., in response to the interactive toy receiving optical information from the display) and the so changed parameter can be transmitted back to the mobile computing device via a modulated magnetic field. Consequently, it should be appreciated that contemplated interactive toys can operate in a bi-directional manner by (1) receiving via one or more optical sensors from the display of the mobile computing device an optical signal or communication, and in response to the received particular signal or communication, (2) provide an updated modulated magnetic field that is different from a modulated magnetic field that was earlier provided by the interactive device,

wherein (3) the updated modulated magnetic field is received by the mobile computing device to so prompt the mobile computing device to provide an updated display (or updated game rules) to the user and/or the interactive device.

[0043] Alternatively, or additionally, the interactive device is responsive to the displayed content on the touch-sensitive display, preferably while the user interacts with the device to further affect the displayed content. For example, the interactive device will be responsive to one or more moving virtual objects on the display, while the user controls movement of the moving virtual object via interaction with the device (by way of touching the touch-sensitive display, use of motion detected by the accelerometer of the tablet computing device, and/or use of an magnetic signal detected by the magnetometer of the tablet computing device).

[0044] Therefore, and in at least some embodiments, the interactive device will include a communication module that is configured to generate a magnetic signal perceptible to the magnetometer of the mobile computing device. Where desired, the communication module may be coupled to an optical sensor that is configured to receive a communication from the display. The interactive device also includes a configuration module that configures the interactive device to be responsive to the content that is displayed on the touch-sensitive display based on at least one of the magnetic signal and the communication received from the display. The communication module can be configured with one or more electromagnets, and when more than one electromagnet is included, the plurality of electromagnets can further be arranged so as to produce magnetic fields in different directions and in different orientations from one another.

[0045] Alternatively, or additionally, an interactive device for interacting with a touch-sensitive electronic display is contemplated where the interactive device includes an electromagnet configured to generate a signal perceptible to the magnetometer of the tablet computer. The interactive device also includes a configuration module that configures the interactive device to be responsive to the content that is displayed on the touch-sensitive display based on at least one of the magnetometer signal and the communication received from the display.

[0046] In yet further contemplated aspects, the interactive device is responsive to displayed content, and particularly moving displayed content on touch-sensitive electronic display. In such devices, it is especially preferred that a user interacts with the table computer such as to

control movement of the moving displayed content (e.g., virtual object; preferably virtual animal, character, game element, obstacle, etc.). The interactive device is then configured to recognize presence and/or location of the moving displayed content, and is further configured to perform a particular action upon recognition presence and/or specific location of the moving displayed content (e.g., within the perimeter of the interactive device, or within a footprint of the interactive device). Particularly preferred actions include movement of the device or portion of the device (e.g. jumping, jiggling of the device, or ejection of a portion of the device, etc.)

[0047] In yet further contemplated aspects, the interactive device comprises a data storage unit (e.g., flash memory, hard drive, a memory chip, etc.) for storing an interactive state of the interactive device. The interactive state indicates a level of historic interactions between the interactive device and the electronic display. In some embodiments, the data storage stores a state of the interactive device that can be updated through different interactions with the electronic display. The interactive device can also displays the interactive state and communicate the interactive state to the electronic device.

[0048] In another aspect of the inventive subject matter, an interactive device for interacting with a different electronic device having a display is contemplated. In some embodiments, the interactive device includes a communication module that is configured to generate a magnetic signal perceptible to the electronic device. The interactive device also includes an optical sensor that is configured to receive a communication from the display. Preferably, the optical sensor is coupled with a configuration module that configures the device to be responsive to the content that is displayed on the display based on the magnetic signal and the communication.

[0049] In some embodiments, the magnetic signal that is generated by the communication module of the interactive device indicates some information about the interactive device. For example, the magnetic signal may indicate one or more of the following information about the interactive device: the position of the interactive device relative to the display, the orientation of the interactive device relative to the display, the state of the interactive device, the device type, the device make, the device model, one or more of the device features, the device memory capacity, the interface type, one or more capabilities of the device, the revision number, the identity of the device's owner, an alert, an alarm, and a transaction.

[0050] As mentioned above, the communication module of the interactive device generates a magnetic signal that is perceptible to the magnetometer. Instead of or in addition to the magnetic signal, the communication module generates a magnetic signal that involves non-touch modalities. Some examples of the non-touch modalities include an audio modality, a visual modality, a kinesthetic modality, a vibration modality, a temperature modality, and a magnetic modality. In still further contemplated aspects, the interactive device may also operate without providing a magnetic signal at all.

[0051] In some embodiments, the interactive device generates multiple magnetic signals that are perceptible to the magnetometer. In these embodiments, the multiple magnetic signals are simultaneous magnetic signals, multiple time-based magnetic signals, or multiple location based magnetic signals. In addition, the interactive device of some embodiments includes multiple communication modules to generate the multiple magnetic signals.

[0052] As mentioned, the interactive device receives a communication from the display through the optical sensor. In some embodiments, the communication includes a set of optical communication. Instead of or in addition to the optical communication, the interactive device can be configured to receive communication in other non-optical modalities such as an audio modality, a touch modality, a kinesthetic modality, a vibration modality, a temperature modality, and a magnetic modality. In some of these embodiments, the interactive device includes multiple optical sensors to receive communication from different locations on the display.

[0053] In some embodiments, the optical sensor includes one of the following: a camera, a charge-coupled device (CCD) sensor, a complementary metal-oxide-semiconductor (CMOS) sensor, a solar cell, a photo-resistor, a phosphorescent sensor, a fluorescent sensor, and a scintillator. Also in some embodiments, the communication module comprises the optical sensor.

[0054] As mentioned, the configuration module of the interactive device configures the device to be responsive to displayed content on the display. In some embodiments, the configuration module further configures the interactive device to take an action based on the displayed content. In some embodiments, the configuration module configures the interactive device to take at least one of the following actions: an actuation, generating a signal,

triggering a mechanic actuator, transacting with another device, communicating with another device, and generating a user interface.

[0055] Thus, it should be appreciated that user interaction with the touch-sensitive display, accelerometer, and/or magnetometer will modify the displayed content on the touch-sensitive display, typically in a manner that controls movement of at least one virtual object on the display, and that the interactive device is configured to recognize presence and/or specific location of the virtual object. Upon detection of the presence and/or specific location of the virtual object, the interactive device will then perform an action (e.g., that is preferably thematically integrated with the displayed content. For example, a user may interact with the device to so control display of a moving race track and/or moving obstacles, and upon detection of an obstacle within the footprint of the interactive device, the interactive device may then perform an action (e.g., car losing a bumper, ejection of a shell from the car base, etc.). In another example, a user may touch the touch-sensitive display to so 'flick' a virtual bug in the direction of the interactive device sitting on the display. Upon the interactive device detecting the moving bug within its footprint, the interactive device (e.g., configured as a bug-eating monster) may then open his mouth or 'explode' (e.g., eject an outer shell).

[0056] In some embodiments, the displayed content includes at least one of the following: a pixel pattern, a color, a symbol, an object, a temporal display pattern, a pixel location, a set of unlit pixels, and polarization. In addition, the displayed content includes at least one of the following contents: game content, educational content, medical content, reference content, and advertising content. Preferably, the displayed content is moving on the screen, and even more preferably, movement of the displayed content is controlled by the user via interaction with the tablet computer.

[0057] Additionally, it should be recognized that the display may not only be used to provide animation to the user and an optical communication to the interactive device, but also to provide a signal to the interactive device to change a current modulated magnetic field to an updated modulated magnetic field. Such signal is preferably persistent to the interactive device, which advantageously allows the user to play on one mobile computing device with an interactive device having attained a particular status for the device (e.g., by completing a level to obtain an advanced status for the interactive device), and then to continue play at a later point in time on the same or other computing device without losing the particular status. Of course, it should be appreciated that updating the interactive device via optical (or other)

signal from the mobile computing device is not limited to maintaining or changing the status of the device, but may also be used to provide to the mobile computing device an actual or updated information (e.g., state of the interactive device, a type of the interactive device, a feature of the interactive device, a capability of the interactive device, an identity of the device's owner, etc.).

[0058] In a preferred embodiment, the interactive device includes a housing in which the communication module, the optical sensor, and the configuration module are disposed. In some embodiments, the housing of the interactive device is shaped as a toy, while the housing of the interactive device in some other embodiments may be shaped in form of an educational tool, a medical tool, a construction tool, a weapon, an appliance, or a smart phone.

[0059] Moreover, it should be appreciated that the display that interacts with the interactive device need not be limited to a mobile computing device (e.g., iPhone, iPad, etc.) but may also be a portion of an electronic device such as a phablet, a computer, a kiosk, an interactive surface, a game console, an appliance, or an interactive advertisement, and that the interactive device is placed during game play on the display.

[0060] Thus it should be appreciated that preferred interactive devices may interact with the mobile computing device via a magnetometer. For example, a remote interactive device may comprise an input device, a configuration module, and a magnetic field generator. The input device can be implemented in many ways. In some embodiments, the input device is implemented as one or more buttons such that a user can manually provides one or more different input signal to the remote interactive device. Instead of, or in addition to, buttons, the input device can be implemented as a sensor (e.g., optical sensor, audio sensor, a magnetometer, an accelerometer, etc.).

[0061] The input device in some aspects of the invention can include a transducer, where the transducer is configured to convert energy of many different types into electrical energy. For example, it can convert mechanical, acoustic, electromagnetic, or magnetic energy into electrical energy. Additionally, the interactive device can be configured to accept inputs in the form of a button, a touch-based sensor, and a light sensor.

[0062] In either case, the input device allows the user or the environment to provide an input signal to the remote interactive device. Once receiving the input signal, the input device sends

the input signal to the configuration module. Based on the input signal, the configuration module configures the magnetic field generator to produce a magnetic field with a particular temporal magnetic pattern.

[0063] In some embodiments, the magnetic field generator is an electronic device (e.g., a coil) that can produce a magnetic field when an electric current runs through the device. In some of these embodiments, the configuration module is coupled with a power source for the magnetic field generator. Thus, the configuration module can control the magnetic field generator (e.g., turning it on and off, adjusting the power/voltage supplied to the magnetic field generator, etc.).

[0064] Generally, the stronger the voltage that supplied to the device, the stronger the strength of the generated magnetic field. As such, the configuration module of some embodiments can control/adjust the magnetic field that is produced by the magnetic field generator by manipulating the power that is supplied to the magnetic field generator (e.g., by turning the power on/off and adjusting the voltage of the power being supplied to the magnetic field generator).

[0065] By oscillating the power supply and/or by adjusting the voltage of the power supply to the magnetic field generator over a period of time, the configuration module can configure the magnetic field generator to generate magnetic signals with different temporal magnetic patterns. For example, the configuration module can configure the magnetic field generator to generate magnetic fields with different temporal magnetic patterns by oscillating the power supply to the magnetic field generator at a certain frequency (e.g., 10MHz, 100MHz, 1Hz, etc.). In these embodiments, the temporal magnetic pattern is defined by the frequency of the magnetic field produced by the magnetic field generator 140.

[0066] In some other embodiments, the configuration module configures the magnetic field generator to generate magnetic fields with different temporal magnetic patterns by adjusting the strength of the magnetic field at different time intervals. For example, a temporal magnetic pattern can be defined by having a constant strength of magnetic field for 0.2 seconds, and then increase the strength by two fold for 0.2 seconds, and then back to the original strength for another 0.2 seconds.

[0067] Preferably, the remote interactive device is placed close enough to the mobile device such that the remote interactive device can interact with the mobile device by sending

magnetic signals with different temporal magnetic patterns. Thus, it is typically preferred that the interactive device is directly placed onto the display of the mobile computing device.

[0068] In some embodiments, the mobile device comprises a magnetometer, a display, and a processor. The magnetometer of the mobile device is a sensor that measures the strength and direction of a magnetic field. Many electronic devices (e.g., smart phones, tablet computers, etc.) have utilized a built-in magnetometer for taking measurements for different applications. For example, Apple®'s iPhone uses measurements from a built-in magnetometer for a compass application. U.S. patent publication 2012/0169327 to Parco et al. entitled "System and Method for Using Magnetometer Readings to Control Electronic Devices", filed January 5, 2011, also discloses several mobile phone applications that make use of magnetometer readings.

[0069] The magnetometer of the mobile device is configured to take magnetic readings that include at least a magnetic strength and a direction of the magnetic source. In some embodiments, the magnetometer is configured to measure the direction of the magnetic source along a three-dimensional coordination system (e.g., a Cartesian coordination system, etc.). Additionally, the magnetometer in some embodiments is configured to take the magnetic readings periodically (e.g., every 1/50th of a second, every 1/100th of a second, every 1/1000th of a second, etc.) to capture any temporal changes to the magnetic field, in order to detect any temporal magnetic pattern as described above.

[0070] In some embodiments, the processor is configured to retrieve the magnetometer readings from the magnetometer, and to cause the mobile device to perform different actions based on the magnetometer readings. In some embodiments, when the processor detects a particular pre-defined temporal magnetic pattern in the magnetometer readings, the processor is configured to cause the mobile device to perform a certain action. In some of these embodiments, the processor is communicatively coupled with a database that stores a mapping between temporal magnetic patterns and actions to be performed by the mobile device. Thus, as the processor retrieves the magnetometer reading from the magnetometer, the processor compares the magnetometer readings over a period of time against the temporal magnetic patterns in the database, and causes the mobile device to perform the corresponding action when a pattern is matched.

[0071] In some embodiments, at least some of the actions corresponding to magnetic patters are related to causing the mobile device to present a particular output via the display.

[0072] In one example, the remote interactive device is a toy car that can interact with a car game application executed on a mobile device. The game includes different car characters that the player can select. The toy car comprises a base and a shell. The user can purchase different shells for the same car base, and each shell represents a different car characters in the car game. The shell of the toy car is interchangeable so that the user can switch to play the car game using different car characters by changing the toy car shell.

[0073] The toy car base includes a coil for generating magnetic fields, a processor, and a memory unit that stores a set of instructions that is executable by the processor. The toy car base also has an optical sensor that can detect different optical patterns. Each toy car shell also has a unique optical pattern located at a place that would allow the optical sensor of the toy car base to detect the pattern when the shell is placed on the toy car base. Thus, when the user place a particular toy car shell onto the base, the toy car base's optical sensor detects the pattern on the shell and passes a signal to the configuration module of the toy car.

[0074] The configuration module of the toy car then configures the coil to generate a magnetic signal with a particular temporal magnetic pattern based on the received signal. Thus, the configuration module can configure the coil to generate magnetic signals with different temporal magnetic patterns when different shells are placed on the toy car base.

[0075] When the toy car is placed near the mobile device running the game application, the game application retrieves magnetometer readings from a magnetometer of the mobile device to determine whether a pre-defined temporal magnetic pattern exists in the readings. Preferably, the game application has access to a database that corresponds different temporal magnetic patterns to different toy car characters within the game. Thus, by analyzing the magnetometer readings, the game application can detect the presence of a particular toy car shell. In addition, based on the magnetometer readings, the game application can determine the location of the toy car. As such, the game application can customize the game presented to the user via the display of the mobile device by using the information derived from the magnetometer readings.

[0076] In addition to the optical sensor, the toy car base of some embodiments can include one or more buttons. Each button corresponds to an action for the toy car character. For

example, some buttons correspond to movement (e.g., moving forward, backward, turning, etc.), some buttons correspond to an action item (e.g., firing a missile, etc.). Based on the selection of one or more buttons, the processor of the toy car base would configure the coil to send magnetic signals with different temporal magnetic patterns to the mobile device.

[0077] Upon receiving the magnetic signals, the game application would perform the corresponding actions, and cause the mobile device to reflect the actions on the display.

[0078] The above example illustrates a system that allows a remote interactive device (e.g., the toy car) to unilaterally send communication signals (e.g., magnetic signals) to the game application running on the mobile device. In some embodiments, the system also provides mechanisms that allow the remote interactive device to receive communication from the game application through the mobile device, to accomplish bi-directional communications between the remote interactive device and the mobile device.

[0079] In one embodiment, the remote interactive device includes an optical sensor that is configured to receive communication from the display of the mobile device. The optical sensor provides readings to the configuration module of the remote interactive device periodically. When the configuration module determines that an optical pattern is being displayed on the mobile device, the configuration module causes the remote interactive device to perform an action (e.g., causes the magnetic field generator to generate a magnetic signal as described above).

[0080] According to the above toy car example, the toy car can be placed on top of the mobile device's display while a racing game is in progress. The user (driver) can control the car to go along the race track. Based on what is displayed directly underneath the toy car, the optical sensor of the toy car can determine whether the car is on or off the race track. When the toy car senses that it is off the race track via the optical sensor, the configuration module can cause the magnetic generator to produce a distinct magnetic signal to the mobile device. Upon receiving such a magnetic signal, the game application can change the display as a result (e.g., display car crashing, etc.).

[0081] In some embodiments, instead of using a magnetic field generator, the remote interactive device can perform similar interactions with a mobile device using a vibration generator, when the mobile device has a motion sensor (e.g., accelerometer, etc.). In these embodiments, the configuration module of the interactive device can configure the vibration

generator to generate different vibration patterns based on the received input from the input device. The vibration pattern can be defined by frequency, strength, or a combination of the frequency and strength. The mobile device having a motion sensor can detect the vibration pattern and perform actions according to the detected pattern.

[0082] In still further contemplated embodiments, the inventors discovered that the interactive device can be removably retained on the display screen in a manner that does not leave a residue on the screen while holding the interactive device securely coupled to the screen. More particularly, the inventors used micro "suction cup" foam material for at least a portion of the bottom surface of the interactive device. In especially preferred aspects, the foam material comprises open cell polymeric foam that has a surface area that is sufficient to retain the interactive device on the screen in the same position, even when the screen is moved in a side-to-side motion by a player, or when the player is subject to motion of his/her environment (e.g., as encountered in a driving vehicle or airplane). Of course, it should be noted that closed-cell foam materials are also suitable for use herein, so long as a plurality of the closed cells are open to the surface with which the foam contacts the display screen.

[0083] With respect to suitable materials, it is generally preferred that the foam material is an open- or closed-cell polymeric foam, with average pore diameter of between 50 micron and 3 mm, and a pore density of at least 1-10/5mm2, and more typically at least 10-100/5mm2. It is still further preferred that the area of the polymeric foam is at least 1cm2, and more typically at least 2-5cm2, and in some cases even larger. Of course, it should be recognized that the area can be a single area, or distributed over at least two sub-areas. For example, where the interactive device is a car, the area may be distributed over four or more sub-areas (e.g., at the position where the wheels contact the display screen). Moreover, it is noted that the polymeric material need not necessarily be limited to an open- or closed cell material, but that all materials with intrinsic (i.e., non-glue) adhesive interaction are suitable for use herein.

[0084] In one preferred aspect of the inventive subject matter, an interactive device for interacting with a touch-sensitive electronic display is contemplated. In some embodiments, an interactive device for interacting with a touch-sensitive electronic display is contemplated. In some embodiments, the interactive device includes a communication module that is configured to generate a magnetic signal perceptible to the configured to generate a magnetic signal perceptible to the magnetometer. The communication module is coupled to an optical sensor that is configured to receive a communication from the display. The interactive device

also includes a configuration module that configures the interactive device to be responsive to the content that is displayed on the touch-sensitive display based on at least one of the magnetic signal and the communication received from the display.

[0085] In another aspect of the inventive subject matter, an interactive device for interacting with a different electronic device having a display is contemplated. In some embodiments, the interactive device includes a communication module that is configured to generate a magnetic signal perceptible to the magnetometer. The interactive device also includes an optical sensor that is configured to receive a communication from the display. Preferably, the optical sensor is coupled with a configuration module that configures the device to be responsive to the content that is displayed on the display based on the magnetic signal and the communication.

[0086] Alternatively, it is also contemplated a method of a device interacting with a touch-sensitive electronic display. In some embodiments, the method generates, via a communication module, a magnetic signal perceptible to the magnetometer. The method receives, via a optical sensor, a communication from the display. The method then configures, via a configuration module, the device to be responsive to displayed content on the display based on at least one of the magnetic signal and the communication.

[0087] Consequently, it should be appreciated that a physical 3-D object can be placed in contact with (or in close proximity to) a display screen and causes and/or reacts to events that are displayed on the display screen. Various examples and play options are provided below in more detail. With respect to suitable physical 3-D objects, it should be appreciated that the particular nature and configuration is not limiting so long as the object is responsive to events on the display and/or can provide feedback to the display.

[0088] **Figure 1** illustrates an example of the interactive device of some embodiments. As shown in **Figure 1**, interactive device 105 includes a communication module 120, an optical sensor 125, a configuration module 130, and an action module 135. When the interactive device 105 is placed on top of (or near) display 110 of another electronic device 115, communication module 120 of the interactive device 105 generates a magnetic signal and sends the magnetic signal to electronic device 115 through the display 110. In some embodiments, the electronic device 115 is a tablet computer and the display 110 is a touch-sensitive display screen 110.

[0089] A touch-sensitive display screen is an electronic display that can detect the presence and the location of a touch of the display. Different techniques can be used to implement the touch-sensitive display. In some embodiments, the touch-sensitive display includes two electrically-resistive layers separated by a thin space. A voltage is sent through one of the layers and sensed at the other layer. Thus, when an object (e.g., a fingertip, a stylus tip, etc.) presses down on the outer layer, the two layers connect at a particular location, and allow the position of the contact point to be detected. In other embodiments, the touch-sensitive display includes an insulator (e.g., glass) that is coated with a transparent conductor such as indium tin oxide. When another electrical conductor such as human body or other conductive object touches the surface of the display, the display's electrostatic field is distorted that is measurable as a change of capacitance. In addition, other technologies such as surface acoustic wave, infrared, etc. may also be used to implement the touch-sensitive display.

[0090] Different embodiments of the interactive device use different techniques to generate the magnetic signal. For instance, the interactive device of some embodiments uses a conductive base to create a distortion on the display's electrostatic field when the conductive base is in contact with the touch sensitive display screen. In other embodiments, the interactive device simply provides a base for contacting different locations on the surface of the touch-sensitive display. In this manner, the interactive device 105 communicates the position of the interactive device with respect to the display by sending the magnetic signal at a particular location on the display.

[0091] In addition to the position of the interactive device, the device of some embodiments send multiple signals at the same location or at different locations of the display (e.g., generating a spatial and/or temporal pattern of magnetic signals by concurrently or iteratively sending the magnetic signals at different locations on the display, or by sending multiple time-based magnetic signals to indicate a particular temporal pattern) to indicate other information about the interactive device to the display. Examples of these other information include, but not limited to, the orientation of the interactive device relative to the display, the state of the interactive device, the device type, the device make, the device model, one or more of the device features, the device memory capacity, the interface type, one or more capabilities of the device, the revision number, the identity of the device's owner, an alert, an alarm, and a transaction. In some embodiments, the interactive device 105 uses a single communication module to generate the multiple magnetic signals while the interactive device

105 of some other embodiments include more than one communication module to generate the multiple magnetic signals to the display.

[0092] In some embodiments, the magnetic signal that is generated by the communication module 120 is a magnetic signal. For example, the communication module 120 may generate a current, a magnetic field, etc., or simply providing a contact, at a particular location on the touch-sensitive display 110. Instead of or in addition to the magnetic signal, the communication module 120 may generate a magnetic signal that involves non-touch modalities. Some examples of the non-touch modalities include an audio modality, a visual modality, a kinesthetic modality, a vibration modality, a temperature modality, or a magnetic modality.

[0093] After generating one or more magnetic signals to the display 110 of the electronic device 115, the communication module 120 sends a signal to the optical sensor 125. In some embodiments, the communication module 120 sends the signal to the optical sensor 125 only after the communication module 120 receives an acknowledgment (e.g., in a form of an acknowledgment signal) from the electronic device 115.

[0094] Upon receiving the signal from the communication module 120, the optical sensor 125 of the interactive device 105 begins to receive communications from the display 110. Different embodiments of the interactive device include different types of optical sensor. For instance, the optical sensor 125 may be any one of the following: a camera, a charge-coupled device (CCD) sensor, a complementary metal-oxide-semiconductor (CMOS) sensor, a solar cell, a photo-resistor, a phosphorescent sensor, a fluorescent sensor, or a scintillator.

[0095] In a preferred embodiment, the optical sensor is located on the side of the device that is closest to the display in order to efficiently detect light and changes in light on the display. In some embodiments, the optical sensor is smaller than the size of the display and thus only detects lights and changes of lights from only a portion of the display.

[0096] In some embodiments, the optical sensor 125 is a module separate from the communication module 120, while in other embodiments, the optical sensor 125 is part of the communication module 120. In addition, the interactive device 105 of some embodiments includes more than one optical sensor for receiving optical communication from different locations of the display 110. Upon receiving the communications from the display 110, the optical sensor 125 sends the received communications to the action module 135.

[0097] After generating one or more magnetic signals, the communication module 120 of some embodiments also sends a signal to the configuration module 130 after sending the magnetic signal to the display 110. Upon receiving the signal from the communication module 120, the configuration module 130 configures the action module 135 of the interactive device 105 to be responsive to the content that is displayed on the display. Thus, the interactive device of some embodiments is configured to react to the events in the virtual world displayed on the display. In some embodiments, the configuration module 130 configures the action module 135 to take a certain action in response to the content (or communications) that is received by the interactive device 105 through the optical sensor 125. For example, the configuration module 130 of some embodiments configures the action module 135 to perform one of the following actions based on the received content: vibrating, jumping, rolling over, standing up, changing shape, triggering a mechanical actuator within the interactive device 105, providing an output (e.g., a light, a display of a message, etc.), and generating a communication with another device. It should be apparent to those skilled in the art that this list of action items is not exhaustive and the action module can be configured to perform many other actions based on the received content.

[0098] In some embodiments, the configuration module 130 configures the action module 135 to perform the action only when a particular content is received through the optical sensor 125. For example, the action module 135 of some embodiments is configured to perform the action only when a particular pixel pattern, a particular color, a particular symbol, a particular object, a particular temporal display pattern, a particular pixel location, a particular set of unlit pixels, a particular intensity of light, or a particular polarization is received. Those who are skilled in the art would appreciate that the particular displayed content can fall within the spectral range of visible light or beyond the spectral range of visible light, such as infrared light and ultraviolet light. In these embodiments, the display would generate an image of which a portion includes light emitting elements in the non-visible range to so produce an entire high resolution frame of metadata. Furthermore, the configuration module 130 of some embodiments configures the action module 135 to perform different actions when different contents are received.

[0099] Instead of or in addition to reacting to the optical content that is displayed on the display 110, the interactive device 105 of some embodiments is configured to react to other types of inputs, such as sound, motion, radio (e.g., Bluetooth , 802.11, etc.). In these

embodiments, the interactive device 105 includes other types of sensors or receivers, such as an audio receiver, a motion sensor, etc., (not shown in **Figure 1**) for receiving communications that are in other non-optical modalities. Examples of these other non-optical modalities include an audio modality, a touch modality, a kinesthetic modality, a vibration modality, a temperature modality, and a magnetic modality.

[00100] It should be appreciated by those skilled in the art that the interactive device can also communicate information or instructions back to the device at any time. The communication can be conducted through the conductive base(s) of the device and the touch sensitive display screen or any other method listed above (e.g., Bluetooth, 802.11, sound, Zigbee, wireless USB, near field communication, radio frequency identification technology etc.).

[00101] It is also contemplated that the interactive device of some embodiments includes an array of sensors such that a larger amount of information/instructions can be sent from the display to the interactive device. In this manner, it is possible to send data such as emails, sound bytes, or instructions for more complicated actions to the interactive device. As a result, the interactive device can be instructed to perform complicated actions. For example, a small model person could dance and/or sing on the display where the dance moves and songs are dynamically transmitted to the interactive device through the display. A robotic arm built into the interactive device could also be controlled in this way. In addition, the user can further remotely control an interactive device that is placed on a tablet computer's display by remotely controlling the tablet computer via Bluetooth, WiFi, or cellular data.

[00102] It is also contemplated that the interactive device 105 of some embodiments further stores an interactive state of the device 105. In some embodiments, the interactive device 105 has an initial interactive state before it begins to interact with the electronic device 115. The interactive state can change as the interactive device 105 interacts with the electronic device 115. For example, when a user uses the interactive device 105 to play a computer game with the electronic device 115 and reaches a certain accomplishment in the computer game (e.g., passes a level, successfully performs a certain task in the game, etc.), the electronic device can display a certain pattern on the display 110 to instruct the interactive device 105 to update the interactive state. The interactive state of the interactive device 105 will continually be updated as the game is being played.

[00103] The interactive device 105 can indicates its interactive state in many different ways. In some embodiments, the interactive device 105 comprises a display (e.g., a screen, a graphical display, a set of lights, etc.) configured to display a representation of the interactive state. The representation can be a number, a string of characters, a color, a pattern, etc.

[00104] In addition, the interactive device 105 of some embodiments is configured to communicate the interactive state of the device 105 to the electronic device 115. The interactive state can be communicated to the electronic device 115 in many different ways, such as through magnetic field generated by the interactive device 105 as described above. The interactive state can also be communicated via other conventional methods such as Bluetooth, 802.11, sound, Zigbee, wireless USB, near field communication, radio frequency identification technology, etc. Once the electronic device 115 receives the interactive state information, the electronic device 115 can play the computer game according to the interactive state (e.g., immediately jump to the game level indicated by the interactive state, etc.) With the stored interactive state in the interactive device 105, the user can use the interactive device 105 to play a game on one electronic device and later continue to play the same game (without having to start over again) on a different electronic device.

[00105] Preferably, the interactive state is stored in a non-volatile memory of the interactive device 105 such that the interactive state information is retained (persistent) even when the interactive device 105 is not powered. In some embodiments, the interactive device 105 can also communicate with a server over a network (e.g., Internet) so that the interactive state associated with the interactive device 105 can be stored on the server (i.e., cloud computing). In these embodiments, the interactive device 105 can retrieve the previously stored interactive state from the cloud even when the interactive device 105 is reset accidentally.

[00106] In one example, the interactive device is a toy pony that can be used to play a computer game related to the toy pony. The toy pony includes a non-volatile memory that stores the interactive state and also a set of RGB light-emitting diodes (LED) to indicate the interactive state. As the user accomplishes a level of play, the toy pony is updated with a new interactive state through the interaction with the electronic device. The LED on the toy pony will continue to light up after the toy pony is removed from the electronic device. The interactive state LED can serve as a living bookmark to what the user has accomplished in the game as well as a status symbol.

[00107] When the user brings the toy pony to a friend's house and puts the toy pony on the friend's electronic device, the electronic device will automatically opens to the level that the user has been working on, based on the interactive state that is communicated from the toy pony to the electronic device.

[00108] In another example of "My Littlest Pet Shop," the interactive device is a toy pet comprises a mechanical heart that can display light and pulsate. The user can feed or play games with the toy pet which makes the toy pet's heart grow brighter and pulsate stronger. Once the toy pet is off the electronic device and the user has not fed or played with it for a while, the heart may grow weaker or change color. Then when user puts the toy pet back onto the electronic device and uses with it to interact with the electronic device, the toy pet's heart can appear to be stronger again. In addition to changes to the toy pet's heart, other characteristics of the toy pet can change (e.g., the pet's hair can grow, the pet can change its physical shape, the pet's eyes can open, etc.) based on its interaction (or lack thereof) with the electronic device.

[00109] **Figure 2** conceptually illustrates a process 200 of an interactive device interacting with an electronic display. In some embodiments, the process is performed by the interactive device 105 of **Figure 1**. The process begins by generating (at 205) a magnetic signal. In some embodiments, the magnetic signal is generated by the communication module 120 of the interactive device 105. The magnetic signal is received by the electronic display to register the interactive device with the electronic display in order to begin the interaction between the interactive device and the electronic display.

[00110] The process then receives (at 210) a communication from the display. In some embodiments, the communication is received by the optical sensor 125 of the interactive device 105. Next, the process configures (at 215) the interactive device to be responsive to displayed content on the display. In some embodiments, the configuration is performed by the configuration module 130 of the interactive device 105. As mentioned above, the configuration module of some embodiments configures the action module of the interactive device to take an action based on a particular content that is displayed on the display. In some embodiments, the content is received at the interactive device 105 through the optical sensor 125.

[00111] The process then performs (at 220) an action when a particular displayed content is detected. As mentioned, the action module of some embodiments is configured to perform a certain action when a particular displayed content is detected. Then the process ends.

[00112] In another preferred aspect of the inventive subject matter, software in various formats is therefore contemplated to allow operation of the interactive device and the tablet computer as described herein. It should be noted that the software contemplated herein is typically stored in a non-transitory medium (*e.g.*, computer hard drive, DVD, memory element, flash memory, etc.) and that the software can be transferred from one computing device to another. Therefore, in one especially preferred aspect, the software is configured as a downloadable app (*e.g.*, app from iTunes).

[00113] It is generally contemplated that the software contemplated herein will typically reside on the interactive device and/or the tablet computer, and will be operable as a stand-alone software. However, it should also be appreciated that the interactive device may also independently operate software that may be only responsive to signals from the tablet computer (or other signal source, including audio, RF, or optical) or that the software in the interactive device may be interactive with the software operating in the tablet computer.

[00114] In one typical example, the software of the tablet computer will produce a video output on the tablet computer to so deliver a visual playground for the interactive device. Most typically, the software is programmed to integrate signals from the gyroscopic or accelerometric sensors and will adjust the display in response to such signals. Additionally, or alternatively, the software may also be responsive to input from other sources, including an audio source (especially including voice), an RF source, an IR source, and/or touch. In less preferred aspects, the software is not responsive to external signals. Therefore, it should be appreciated that the software may be employed to enhance the experience by allowing the user to modify the display content to at least some degree by interacting with the display and/or table computer.

[00115] Similarly, where software is also executed in the interactive device, it should be noted that the software may produce a preprogrammed action in the interactive device, either in response to display content, and/or in response to a non-display signal. Consequently, the software in the toy may be responsive to the display and/or user input. Most typically, where the interactive device executes software, the software is hard coded into a chip. Alternatively,

the software may also be uploaded via wired USB port, wireless protocol, or taught by the user.

[00116] For example, where the software is a car racing game application for a tablet computer, the software executes a program to display a race track on the tablet computer's display screen. Once an interactive device (e.g., an interactive device that is shaped like a race car) is positioned on the touch sensitive display, the race track will then proceed to move to simulate the race car driving on the track. Sounds may be used to enhance the experience. In some embodiments, the displayed track may be further modified by the user tilting the display, or the tilt may be used to generate specific sound effects (*e.g.*, screeching tires). Once the light sensor of the toy passes over a specific pixel pattern, the race car may be programmed to execute an action (*e.g.*, release of a spring-loaded mechanism, blinking headlights, etc.), and/or may provide a signal (*e.g.*, via Bluetooth) to the tablet computer to interact with the software of the tablet computer (*e.g.*, to generate a visual effect associated with the toy position, or to produce a sound effect).

[00117] Consequently, the software on the tablet computer may be programmed to be responsive to user input via one or more sensors of the tablet computer and/or input from the race car via positioning of the race car and/or signals provided by the race car. Additionally, the software in the tablet computer may also be programmed to be responsive to direct user input (*e.g.*, via voice control).

Use Cases of the Interactive Device

[00118] The Race Car (1): **Figure 3** illustrates one example embodiment of an interactive device. As shown, an interactive device 305 that is shaped as a toy car is located on top of a touch sensitive display 310 of a tablet computer 315. The tablet computer 315 includes software instructions stored in memory that when executed runs a race car game application. As shown, the tablet computer 315 displays a scene of the race car game application on the display 310 that includes virtual race track and virtual obstacles.

[00119] **Figure 3** also shows that the toy race car 305 has an optical sensor 325 that is located on the undercarriage of the toy car for receiving optical communications/inputs from the display 310. Thus, the race car game application can communicate with the interactive device by providing light/pixel patterns at a location of the display 310 below the optical sensor 325 of the toy race car 305. The toy race car 305 also includes four wheels 320. At

least one or more of the wheels 320 includes a conductive base for generating signals to the touch sensitive display 310. The signals indicate the location and orientation, among other things, about the toy race car 305 to the display 310. In addition, the interactive device 305 includes a small arm 340 attached to a motor that makes the toy race car "jump" when the motor is triggered.

[00120] **Figure 4** shows another view of the toy race car 305 interacting with the tablet computer 315. As shown, the user can "drive" or control the toy race car in the virtual track of the race car game application by tilting the display 310. The virtual race track scrolls by on the display 310. **Figure 4** also shows that if the user drives the toy race car off the virtual road, or hit a virtual obstacle (such as virtual obstacle 404), the race car game application will instruct the tablet computer 315 to display a particular pixel/light pattern on the display 310 that is detectable by the optical sensor 325 of the toy race car. Upon detecting the particular pixel/light pattern on the display 310, the toy race car 305 triggers the motor to make the toy race car "jump". Additionally or alternatively, the toy race car includes other mechanical parts that would make the car to perform other actions (e.g., fold in half, slide, rotate, etc.) upon the occurrence of some other events in the virtual world of the race car game. For example, the toy race car 305 of some embodiments is configured to flip over or jump off the tablet computer entirely in a fiery explosion if the toy race car hit too many of these virtual bumps, or crash badly. In some other embodiments, the chassis of the toy race car decouples when crashed in the virtual world of the race car game, and by pushing down the chassis to its original position, the toy race car could reset the stored energy component. In yet some other embodiments, the toy race car includes a hinge and weight to "fishtail" when the user tilts the tablet. In some embodiments, the toy race car includes flashing lights (i.e., a toy police car) when chasing a virtual "bad guy". The tablet computer 315 provides the siren sound effects.

[00121] In the above example, when the race car crashes in the virtual world, the toy race car is triggered to fly off the display or to fold in half. In this case, the user must "fix" the car (put the car back to its original configuration) in order to play the race car game again. In some embodiments, this "fixing" comprises resetting the spring or rubber band that stores the energy needed to fling the car off the screen. Instead of, or in addition to the above, the "destruction" of the race car could take place slowly as the race car is damaged bit by bit by minor crashes in the virtual world.

[00122] In addition, because more information (instead of just an on/off signal) can be transmitted to the toy race car, the race car application can transmit different signal for different event occurred in the virtual world. For example, when the race car is braking in the virtual world, the race car application can send a braking signal to the toy race car to trigger the toy race car to turn on the tail-lights. In some embodiments in which the toy race car includes other components (e.g., a set of speakers, an actuators, etc.), the race car application can trigger the toy race car to produce other action (e.g., different sound, different movement).

[00123] The Race Car (2): Similar to the example illustrated in The Race Car (1), except that the wheels (or the area that is in contact with the display 310) of the toy race car are made with very low friction material so that the toy race car actually slides around the display 310 when the display 310 is tilted. If the car hits a bump or crashes, the tablet displays a particular light/pixel pattern on the display 310. Upon detecting the particular light/pixel pattern, the toy race car 305 "crashes" in real life by turning over or being flung off the screen in a huge and epic explosion.

[00124] The Race Car (3): The toy race car has motors and wheels and will drive around the display screen, as commanded by the tablet through the interaction between the display of the tablet and the optical sensor of the toy race car. This could be an open loop system or a closed loop system with feedback provided by the conductive/capacitive pads.

[00125] The Race Car (4): The toy race car is coupled to a fishing line or Kevlar for pulling the car from one side to the other on the display of the tablet computer. The road scrolls by on the display. Everything else is similar to the examples illustrated above. This could be an open loop system where the barricades are displayed in a certain color. When the car hits a barricade, the car detects the barricade by the color and performs a certain action in response. Alternatively, it is a closed loop system where the tablet computer determines where the car is on the display. When the tablet computer determines that the car has hit a virtual obstacle, it displays a particular light/pixel pattern for the car to detect and react.

[00126] The Race Car (5): The toy race car is placed onto the display of the tablet computer, preferably with a micro-suction cup foam contacting the display screen at least on one area. The road scrolls by on the display, and a user uses the accelerometer of the tablet computer to control movement of the road and/or obstacles on or near the displayed road.

Alternatively, the control of the display may also be implemented with designated touch areas (e.g., area for increase/decrease of speed, turn left/right, etc.). When the car hits a barricade or other virtual moving object on the display, the car detects the barricade by the color and performs a certain action in response. For example, the car could vibrate for one type of obstacle and eject one or more pieces for another type of obstacle.

[00127] The Race Car (6): The toy race car is placed in a fixed and predetermined position onto the display of the tablet computer, preferably with a micro-suction cup foam contacting the display screen at least on one area. The road scrolls by on the display, and a user uses a touch control surface of the touch-sensitive display to control movement of the road and/or obstacles on or near the displayed road. A display event (e.g., the car hitting a barricade or other virtual moving object on the display) can now be simply determined by the fixed position of the car relative to the displayed content that is driven by the software (e.g., the software determines position of the obstacle, optionally in conjunction with user input to modify the position according to user input). Upon determination of the event, the software will cause the display to provide an optical signal to the interactive toy, typically not visible to the user. The signal will then be detected by the sensor in the interactive toy and trigger a certain action in response. For example, the car could vibrate for one type of obstacle and eject one or more pieces for another type of obstacle. Therefore, it should be noted that the signal can be provided directly from the virtual moving object, or be a signal that is a function of the location of a displayed moving virtual object. Viewed from another perspective, the signal may be part of or indicative of the presence and/or location of the moving displayed virtual object.

[00128] The "Moon Lander": In this example, the interactive device has a shape of the Apollo moon landing vehicle. The moon landing vehicle also has a light sensor in the bottom for detecting communication/displayed content from the display. The moon landing vehicle also has stored energy in the form of a spring or rubber band, or alternatively, a small battery, electric motor, and a microcontroller. At the start of this moon landing game application, the moon landing vehicle is placed in the center of the display.

[00129] The moon landing game application produces imagery on the display that simulates a perspective when one looks down from the top of the moon landing vehicle as it approaches the moon. To control the moon landing vehicle, the user tilts the tablet for rotational control and presses a virtual button for thrust control. When the user hits the

thruster, the moon landing game application displays fire from the rocket engines on the display screen. The moon landing application also limits the amount of virtual fuel a user may use during each session such that the user has to land successfully on the lunar surface or at the moon base before the virtual fuel is used up. The user can also pick up more fuel via power-ups. If the fuel is run out, the game application displays the scenes to simulate the moon landing vehicle falling onto the moon surface.

[00130] When the moon landing vehicle hits the virtual moon surface with excessive velocity, the game application displays a large explosion on the screen, produces large noise. In addition, the toy moon landing vehicle is triggered through a displayed light/pixel pattern on the display to rocket off the screen and onto the floor. Specifically, at the moment of impact, the game application sends a visual signal to the moon landing vehicle's optical sensor to instruct the vehicle to jump/crash. The motor of the moon landing vehicle turns on and releases the stored energy, catapulting the vehicle off the display. If the user lands successfully, the game application produces a simulation on the display of lunar dust being blown away by the rocket engine. The user is able to re-fuel the vehicle and given another target destination, indicated by an arrow with distance.

[00131] Alternatively, a rescue helicopter game application can be designed using similar concept as the moon landing game, in which the moon landing vehicle is replaced by a rescue helicopter.

[00132] Dart Board: **Figure 5** illustrates an example dart board game application that runs on a tablet computer 515 and interacts with an interactive device 505 that is shaped as a dart. The dart 505 has a conductive base located at the tip of the dart 505. The tablet computer 515 is placed at a horizontal distance from the user with the display 510 facing the user. The user can throw the conductive darts 505 at the display that displays an imagery that simulates a dart board. As the dart 505 hits the display 510 (i.e., the conductive base of the dart 505 comes in contact with the display 510), the game application registers a hit. In addition, the game application can automatically compute the score. The game application also produces a cool ripple effect outwards from the impact point on the screen. The conductive dart 505 would stick or fall off. If the dart 505 is designed to fall off, the game application displays a virtual dart on the screen at the contact point.

[00133] Golf: **Figure 6** illustrates an example golf game application that runs on a tablet computer 615 and interacts with an interactive device 605 that is shaped as a golf ball. The golf ball 505 is preferably conductive to interact with the display 610. As shown, the user places a spring loaded club "launcher" on the edge of the display 610. The user may control the club launcher to send the golf ball 505 at the display 610. The ball is preferably tethered to the club launcher, but doesn't have to be. The golf ball is preferably sticky so it doesn't easily roll off the screen. The ball is preferably not round in shape for the same reasoning.

[00134] Shooting Game: **Figure 7** illustrates an example shooting game that runs on a tablet computer 715 and interacts with an interactive device 705 that is shaped as a pellet or a dart. The pellet or dart is preferably conductive to interact with the display 710. The user uses a gun that shoots a pellet at different virtual targets that are shown on the display. The user gets many of these pellets to shoot at the "virtual" moving targets or "virtual" stationary targets. These targets could be "virtual" people who can shoot back, dinosaurs, zombies, or metal targets.

[00135] Fly Swatter: **Figure 8** illustrates an example fly swatting game application that runs on a tablet computer 815 and interacts with an interactive device 805 that is shaped as a fly. The fly 805 is placed at a location on the display 810 at the start of the game. The game application generates virtual flies on the display 810. The user uses a fly swatter (with the flat area being conductive to interact with the display 810) to hit the virtual flies on the display 801. The first two times the user successfully hits a virtual fly, the fly 805 bounces upwards (the game application generates a pixel/light pattern for the fly 805 to detect and trigger a movement, using the mechanism as described above). The third time the user successfully hits a virtual fly, the game application produces virtual blood and guts on the screen and the fly 805 careens off the tablet.

[00136] Skate Board: **Figure 9** illustrates an example skateboard game application. In this example, the interactive device 905 is shaped as a skateboard, a snowboard, or a surfboard. The skateboard is preferably conductive at the bottom to interact with the display 910. The user uses fingers to operate skate board to perform different tricks (e.g., a jump, a turn, etc.) at the appropriate time. The user must keep the board in contact with the display 910 or the user loses. The user also loses if the board crashes.

[00137] The Penguin: For this example penguin game application, a model penguin (i.e., the interactive device) is placed on the center of the display screen. In the virtual world created by the penguin game, the model penguin is on a slippery ice surface. The user guides/controls the penguin by tilting the tablet. If the penguin falls off the iceberg in the virtual world, the game application produces imagery that simulates the penguin being eaten by a killer whale with lot of blood being displayed on the screen. The penguin game application also uses the same techniques illustrated above to trigger the model penguin to jump off the screen. If the user wins, the game application would trigger the model penguin to flap its wings and produce "chirps" sound.

[00138] The snow-boarder: This snow-boarder game application combines the features of the race car and the penguin game application. The model snow-boarder is placed on the center of the display screen. When the snow-boarder goes over a bump or performs a jump in the virtual world created by the game, the game also uses similar techniques as illustrated above to trigger the model snow-boarder to jump also. If the snow-boarder crashes in the virtual world, the game also triggers the model snow-boarder to jump off the display. Those skilled in the art would appreciate that this game concept may apply to different games for a biker or a skier.

[00139] The flopping fish/Kayaker: This flopping fish game application interacts with a model fish (i.e., the interactive device). The user navigates the model fish through the virtual rapids created by the game application. If the model fish gets washed ashore or onto a sandbar in the virtual world, the flopping fish game triggers the model fish to flop all around on the display.

[00140] Frogs and flies This frogs and flies game application interacts with a model frog (i.e., the interactive device). When the game is executed on a tablet computer, the model frog is placed at the edge of the display screen of the tablet computer. The game application produces imagery on the display that simulates an environment with many virtual flies for a frog to catch. The game application also detects the orientation and position of the model frog/frogs based on one or more conductive pads around the model frog's /frogs' base. The user controls how the model frog interacts with the game application. For example, when the user presses a button on the model frog, the game application creates a virtual tongue sticking out of the frog's mouth to catch virtual flies. If the virtual tongue hits a virtual fly. The virtual fly would disappear from the display screen with a "squeak" and 100 points would be

displayed on the screen. This is done by having a conductive pad that touches the screens surface when the model frog's button is pressed down. Additionally or alternatively, the model frog can be designed in a way such that the model frog can be triggered by the content displayed on the display screen to open the model frog's mouth to catch virtual flies.

[00141] Gobble monster: In this example game application, the interactive device is configured as a monster that attempts to eat certain bugs as his diet, but will 'explode' when eating other types of bugs. The bugs will be displayed on the touch-sensitive display, and a user uses a finger to flick the displayed bugs into the monster's mouth. Thus, the user interacts with the displayed object to impart a velocity and/or direction to the virtual object. If the virtual object is within the footprint of the interactive device and is detected by a sensor (e.g., by way of a specific pixel pattern), the device will then actuate a mechanism that opens the mouth of the monster and so simulate the monster gobbling up the virtual object. In the event that different virtual objects are provided (e.g., 'good' bugs and 'bad' bugs), the actions by the device may be distinct (e.g., 'good' bugs are eaten, and 'bad' bugs lead to ejection of a shell or body part).

[00142] Cute prey animal: The purpose of this cute prey animal game is to avoid having a cute prey animal that is represented by an interactive device that is shaped as a cute animal being eaten/killed in the virtual world created by the game. The user navigates the model animal in the virtual world by using different input methods provided by the tablet computer. If the model animal is killed in the virtual world, the game uses similar techniques as illustrated above to trigger the model animal to react.

[00143] Additionally, the cute prey animal game can be designed in a way such that the user has the ability to scare away virtual predators with other control input for the tablet computer (e.g., shaking the screen, etc). Furthermore, when there is a flood in the virtual world, the user builds a virtual sand castle around the model animal for protection. The game triggers the model animal to perform a certain action (e.g., flapping its wings) occasionally when the user has done a good job building the sand castle. If the animal "dies" in the virtual world, the game triggers the model animal to jump off the display screen or to tip over.

[00144] Hot Potato: This hot potato game application interacts with an interactive device that is shaped as a model potato guy. The model potato guy is put on the display screen. The user navigates the model potato guy through a landscape of frying pans and fire in the virtual

world created by the game. If the potato guy hits a fire in the virtual world, the game triggers the model potato guy to bounce up and down and produce "Hot! Hot! Hot!" sounds. When the potato guy jumps into water, the game displays steam rising from the potato guy and triggers the model potato guy to produce a different sound such as "Ahhhhh."

[00145] Tarzan vs. Crocodiles: This Tarzan vs. Crocodiles game application is designed to interact with an interactive device that is shaped like a model Tarzan. The model Tarzan is attached to a model tree wine that is placed near the tablet computer. The user can swing the model Tarzan along the vine. Preferably, the model Tarzan includes conductive bases on the bottom of the model Tarzan's feet so that as the model Tarzan is being swung by the user over the display, the game application detects the location of the model Tarzan. The game application creates an imagery that simulates the Amazon rivers full of virtual crocodiles, piranhas, snakes, etc. swimming towards the bank to eat virtual Jane. The user time the Tarzan swing as to bonk the crocodile on the head making it turn upside down and sink to the bottom of the river.

[00146] Construction Zone: This construction zone game application interacts with one or more model dump trucks, cranes, front-loaders, backhoes etc. These model dump trucks, cranes, front-loaders, and backhoes are placed on or near the screen. The user controls the crane to lift an actual beam and place it properly on the screen where a virtual beam will appear. The player could build a virtual building, blast a tunnel, lay railroad tracks, pour concrete etc.

[00147] App Pets: A model pet, chicken, farm animal, monster, etc. could be put on the display screen. The app pets game application creates a virtual world on the display screen where the model pet could hunt and peck for food, drink, be fed by its real owner, get run over by a car, move around the display screen, squawk, flap, or jump depending on its mood. The model pet's action is triggered by the game application using similar techniques illustrated above.

[00148] Rocket Man: This rocket man game application creates a virtual environment in which a man with a jet pack is plummeting to the earth with clouds rushing by him. The ground seen from above is getting closer. He must veer from side to side to pick up at least 3 power pellets to turn his jetpack on and fly to a higher altitude. If he does not get the power

pellets, he splats on the ground with a bounce and blood spurts everywhere. The game also triggers a model rocket man to bounce off the display screen.

[00149] It should be appreciated that in the example game application illustrated above, the interactive device is actually interacting with the display screen automatically, without interference by the user. In the case of the race car game applications, the interaction is quite dynamic: the user interacts with the game application by tilting the tablet computer; the game application interacts with the interactive device by signaling the interactive device (e.g., by displaying a particular light/pixel pattern on the display) when to perform a certain action (e.g., bump, explode, etc.); and the interactive device interacts with the game application by interfacing with the touch sensitive surface (e.g., through conductive bases, etc.). Moreover, it is generally preferred that the interactive devices are not attached to the display screen. However, there are some instances where one might want them attached (such as for the golf game application).

[00150] It is still further contemplated that the interactive device could be powered by the light produced by the display screen. For example, the rotors of a model helicopter could be spun by energy captured by the screen with a solar panel under the model helicopter in close proximity with a bright patch of light on the display screen. Alternatively, the interactive device can include a capacitor that stores up the energy from the light of the display screen so that a small motor can release the greater stored energy of the spring or rubber band.

[00151] More game application examples that illustrate the inventive subject matter will now be described.

[00152] Catapult 1: In this catapult game, a model catapult is attached or set on the edge of the screen. The user can activate the catapult by pulling it back and then pressing a physical button, or just letting the catapult go. The catapult launches small conductive items and the game application detects the location of the conductive item as the conductive item comes in contact with the display screen.

[00153] Different games can be designed to interact with the model catapult. For example, a battle ship game can be designed such that the user uses the catapult to attach and sink virtual ships on the display. In another example, the frogs and flies game application can be modified to include this model catapult device. In this example, the user can activate the model catapult to release the frog's tongue (i.e., a piece of conductive material attached to a

string so that it can be reeled back in). The model catapult can also be used in a fisherman game in which the user can "cast" the fishing pole using the model catapult device. The end of the fishing pole is attached to a conductive bait. The user can also use the fishing pole to drag the virtual fish to shore. In other sport related games, the user can use the model catapult to swing a conductive baseball or a conductive golf ball.

[00154] Catapult 2: Similar to Catapult 1, except that the catapult is placed on the display and is not triggered by the user, but by the game application through the display. The user or users would have to prevent or try to get the catapult to launcher to fire. This could be a competitive game with multiple players, launchers, and possibly multiple tablet computers.

[00155] Completing words: This is an educational application that is designed to interact with multiple interactive devices shaped as the twenty-six alphabets. The application generates different words with missing alphabets on the touch-sensitive display. When the user places the correct missing alphabet on the display, the application uses similar techniques as described above to trigger the alphabet to perform a certain action (e.g., jumping around and making noises).

[00156] Surgeons: This is another educational application that is designed to interact with different interactive devices shaped as model surgical tools. The application generates imagery that simulates a human body where the user can use the different model surgical tools to operate on the virtual human body. When the user makes a mistake during the procedure (e.g., cut a vital artery by mistake), the application displays lots of blood on the screen and also uses similar techniques as described above to trigger the surgical tool to vibrate.

[00157] **Figure 10** illustrates an example of such an interactive system 1000 of some embodiments. As shown, the interactive system 1000 comprises an interactive device 1005 and a mobile computing device 1010 having one or more magnetometers 1020 and touch sensitive display 1015 that provides displayed content 1050 to the user and the interactive device 1002.

[00158] As shown, the remote interactive device 1005 comprises an input device 1030, a configuration module 1035, and a magnetic field generator 1040 producing magnetic signals 1042, comprising first and second electromagnets 1044 and 1045, respectively. The input device 1030 can be implemented in many ways. In some embodiments, the input device 1030

is implemented as one or more buttons such that a user can manually provides one or more different input signal to the interactive device 1005. Instead of, or in addition to, buttons, the input device 1030 can be implemented as a sensor (e.g., optical sensor receiving optical sensor signals 1052, audio sensor, a magnetometer, an accelerometer, etc.). The interactive device further preferably comprises a housing 1048 to which external input devices 1046 are coupled.

[00159] In either case, the input device allows the user or the environment to provide an input signal to the remote interactive device 1005. Once receiving the input signal, the input device 1030 sends the input signal to the configuration module 1035. Based on the input signal, the configuration module 1035 configures the magnetic field generator 1040 to produce a magnetic field with a particular temporal magnetic pattern.

[00160] In some embodiments, the magnetic field generator 1040 is an electronic device (e.g., a coil) that can produce a magnetic field when an electric current runs through the device. In some of these embodiments, the configuration module 1035 is coupled with a power source for the magnetic field generator 1040. Thus, the configuration module 1035 can control the magnetic field generator 1040 (e.g., turning it on and off, adjusting the power/voltage supplied to the magnetic field generator, etc.).

[00161] Generally, the stronger the voltage that supplied to the device, the strong the strength of the generated magnetic field. As such, the configuration module 1035 of some embodiments can control/adjust the magnetic field that is produced by the magnetic field generator 1040 by manipulating the power that is supplied to the magnetic field generator 1040 (e.g., by turning the power on/off and adjusting the voltage of the power being supplied to the magnetic field generator 1040).

[00162] By oscillating the power supply and/or by adjusting the voltage of the power supply to the magnetic field generator 1040 over a period of time, the configuration module 1035 can configure the magnetic field generator 1040 to generate magnetic signals with different temporal magnetic patterns. For example, the configuration module 1035 can configure the magnetic field generator 1040 to generate magnetic fields with different temporal magnetic patterns by oscillating the power supply to the magnetic field generator 1040 at a certain frequency (e.g., 10MHz, 100MHz, 1Hz, etc.). In these embodiments, the

temporal magnetic pattern is defined by the frequency of the magnetic field produced by the magnetic field generator 1040.

[00163] In some other embodiments, the configuration module 1035 configures the magnetic field generator 1040 to generate magnetic fields with different temporal magnetic patterns by adjusting the strength of the magnetic field at different time intervals. For example, a temporal magnetic pattern can be defined by having a constant strength of magnetic field for 0.2 seconds, and then increase the strength by two fold for 0.2 seconds, and then back to the original strength for another 0.2 seconds.

[00164] Preferably, the remote interactive device 1005 is placed close enough to the mobile computing device 1010 such that the remote interactive device 1005 can interact with the mobile computing device 1010 by sending magnetic signals with different temporal magnetic patterns.

[00165] In some embodiments, the mobile computing device 1010 comprises a magnetometer 1020, a display 1015, and a processor 1025. The magnetometer 1020 of the mobile computing device 1010 is a sensor that measures the strength and direction of a magnetic field. Many electronic devices (e.g., smart phones, tablet computers, etc.) have utilized a built-in magnetometer for taking measurements for different applications. For example, Apple®'s iPhone uses measurements from a built-in magnetometer for a compass application. U.S. patent publication 2012/0169327 to Parco et al. entitled "System and Method for Using Magnetometer Readings to Control Electronic Devices", filed January 5, 2011, also discloses several mobile phone applications that make use of magnetometer readings.

[00166] The magnetometer 1020 of the mobile computing device 1010 is configured to take magnetic readings that include at least a magnetic strength and a direction of the magnetic source. In some embodiments, the magnetometer 1020 is configured to measure the direction of the magnetic source along a three-dimensional coordination system (e.g., a Cartesian coordination system, etc.). Additionally, the magnetometer 1020 in some embodiments is configured to take the magnetic readings periodically (e.g., every $1/50^{th}$ of a second, every $1/100^{th}$ of a second, every $1/1000^{th}$ of a second, etc.) to capture any temporal changes to the magnetic field, in order to detect any temporal magnetic pattern as described above.

[00167] In some embodiments, the processor 1025 is configured to retrieve the magnetometer readings from the magnetometer 1020, and to cause the mobile computing device 1010 to perform different actions based on the magnetometer readings. In some embodiments, when the processor 1025 detects a particular pre-defined temporal magnetic pattern in the magnetometer readings, the processor 1025 is configured to cause the mobile computing device 1010 to perform a certain action. In some of these embodiments, the processor 1025 is communicatively coupled with a database that stores a mapping between temporal magnetic patterns and actions to be performed by the mobile device. Thus, as the processor 1025 retrieves the magnetometer reading from the magnetometer 1020, the processor 1025 compares the magnetometer readings over a period of time against the temporal magnetic patterns in the database, and causes the mobile computing device 1010 to perform the corresponding action when a pattern is matched.

[00168] In some embodiments, at least some of the actions corresponding to magnetic patters are related to causing the mobile computing device 1010 to present a particular output via the display 1015.

[00169] Similarly, **Figure 11** illustrates another exemplary system 1100 with an interactive device 1105 and mobile computing device 210 that includes one or more magnetometers 1120 receiving magnetic signals 1142 and a touch sensitive display portion 1115. Interactive device 1105 comprises a base 1148 and a shell/housing 1116. A Communication module 1140 includes first and second electromagnets 1144 and 1145, while 1130 are optical sensors that receive the displayed content 1150 and 1156. Optical sensors are preferably configured to provide a sensor signal 1052 to the communication module 1140.The device further includes external input 1146, and the communication module is coupled to the configuration module 1135. Shell 1116 further includes a component 1118 that provides an identifier signal 1154.

[00170] It should be apparent to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms “comprises” and “comprising” should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced

elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Where the specification claims refers to at least one of something selected from the group consisting of A, B, C …. and N, the text should be interpreted as requiring only one element from the group, not A plus N, or B plus N, etc. As used in the description herein and throughout the claims that follow, the meaning of "a," "an," and "the" includes plural reference unless the context clearly dictates otherwise. Also, as used in the description herein, the meaning of "in" includes "in" and "on" unless the context clearly dictates otherwise.

CLAIMS

What is claimed is:

1. An interactive device for interacting with mobile computing device having a touch-sensitive electronic display, the interactive device comprising:

a communication module configured to generate a magnetic signal perceptible to a magnetometer of the mobile computing device, wherein the magnetic signal comprises a modulated magnetic field;

an optical sensor configured to receive a communication from the display and to produce an optical sensor signal; and

a configuration module configured to configure the device to be responsive to displayed content on the display based the magnetic signal and the optical sensor signal.

2. The interactive device of claim 1, wherein the modulated magnetic field is modulated by at least one of frequency, amplitude, position, orientation, and an additional magnetic field.

3. The interactive device of claim 2, wherein the additional magnetic field is generated by at least one of an electromagnet and a permanent magnet.

4. The interactive device of claim 1, wherein the magnetic signal is suitable for identification by the mobile computing device of at least one of the following: a position of the interactive device relative to the display, an orientation of the device relative to the display, a state of the interactive device, a type of the interactive device, a feature of the interactive device, a capability of the interactive device, an identity of the device's owner, and an external input to the interactive device.

5. The interactive device of claim 4, wherein the external input to the device comprises a signal from at least one of a button, a transducer, a touch-based input surface, a light sensor.

6. The interactive device of claim 5, wherein the transducer converts at least one of mechanical energy, magnetic energy, acoustic energy, and electromagnetic energy to electrical energy.

7. The interactive device of claim 1, wherein the configuration module further configures the interactive device to take an action based on the displayed content.

8. The interactive device of claim 7, wherein the action comprises at least one of the following: an actuation, generating a signal, triggering a mechanical actuator, transacting with another device, communicating with another device, and generating a user interface.

9. The interactive device of claim 1 further comprising a housing in which are disposed the communication module, the optical sensor, and the configuration module.

10. The interactive device of claim 1, wherein the interactive device is configured as a toy car, a toy spaceship, a toy character, a toy mythical creature, or a toy animal.

11. The interactive device of claim 1, wherein the displayed content comprises at least one of the following: a pixel pattern, a color, a symbol, an object, a temporal display pattern, a pixel location, a set of unlit pixels, and polarization.

12. The interactive device of claim 1, wherein the optical sensor comprises at least one of the following: a camera, a charge-coupled device (CCD) sensor, a complementary metal-oxide-semiconductor (CMOS) sensor, a solar cell, a photo-resistor, a phosphorescent sensor, a fluorescent sensor, and a scintillator.

13. The interactive device of claim 1, wherein the communication module comprises a first and second electromagnet.

14. The interactive device of claim 13, wherein the first electromagnet is configured to generate a magnetic field that is oriented differently than the magnetic field the second electromagnet is configured to generate.

15. The interactive device of claim 1, wherein the communication module comprises the optical sensor.

16. The interactive device of claim 1 further comprising a plurality of additional optical sensors.

17. An interactive device for interacting with a mobile computing device having a touch-sensitive electronic display, the interactive device comprising:

a shell comprising a component configured to provide an identifier signal;

a base configured to matingly receive the shell, the base further comprising:

a communication module that, in combination with the identifier signal, is configured to generate a magnetic signal perceptible to a magnetometer of the mobile computing device;

an optical sensor configured to receive a communication from the display; and

a configuration module that configures the device to be responsive to displayed content on the display based on the magnetic signal and the communication.

18. The interactive device of claim 17, wherein the component of the shell comprises at least one of a permanent magnet, an electromagnet, a near field communication module, an RFID chip, a Bluetooth module, a wireless communication module.

19. The interactive device of claim 17, wherein the magnetic signal is a modulated magnetic field that is modulated by at least one of frequency, amplitude, position, orientation, and an additional magnetic field.

20. The interactive device of claim 19, wherein the additional magnetic field is generated by at least one of an electromagnet and a permanent magnet.

21. The interactive device of claim 17, wherein the magnetic signal is suitable for identification by the mobile computing device of at least one of the following: a position of the interactive device relative to the display, an orientation of the device relative to the display, a state of the interactive device, a type of the interactive device, a feature of the interactive device, a capability of the interactive device, an identity of the device's owner, and an external input to the interactive device.

22. The interactive device of claim 21, wherein the external input to the device comprises a signal from at least one of a button, a transducer, a touch-based input surface, a light sensor.

23. The interactive device of claim 22, wherein the transducer converts at least one of mechanical energy, magnetic energy, acoustic energy, and electromagnetic energy to electrical energy.

24. The interactive device of claim 17, wherein the configuration module is configured to configure the interactive device to take an action based on the displayed content.

25. The interactive device of claim 24, wherein the action comprises at least one of the following: an actuation, generating a signal, triggering a mechanic actuator, transacting with another device, communicating with another device, and generating a user interface.

26. The interactive device of claim 17, wherein the communication module comprises at least a first and second electromagnet.

27. The interactive device of claim 26, wherein the first electromagnet is configured to generate a magnetic field that is oriented differently than the magnetic field the second electromagnet is configured to generate.

28. The interactive device of claim 17, wherein the communication module comprises the optical sensor.

29. The interactive device of claim 17 further comprising a plurality of additional optical sensors.

30. A method of facilitating game play using an interactive device and a mobile computing device having a touch-sensitive electronic display, the method comprising:

configuring the interactive device such that the interactive device provides a modulated magnetic field to the mobile computing device to thereby provide at least one of positional and identity information to the mobile computing device; and

configuring the interactive device to receive an optical communication from the display of the mobile computing device to thereby prompt an action by the interactive device.

31. The method of claim 30 wherein the action comprises emission of a second modulated magnetic field by the interactive device.

32. The method of claim 30 wherein the modulated magnetic field is at least one of a frequency modulated magnetic field, an amplitude modulated magnetic field, and a modulation by a second magnetic field.

33. The method of claim 30 wherein the mobile computing device is a tablet computer, a cell phone, or a phablet.

34. The method of claim 30 wherein the interactive device is configured as a toy car, a toy spaceship, a toy character, a toy mythical creature, or a toy animal.

35. A method of facilitating interaction of an interactive device with a mobile computing device having a touch-sensitive electronic display, comprising:

configuring a communication module of the interactive device to generate a first magnetic signal that is perceptible to a magnetometer of the mobile computing device, wherein the first magnetic signal comprises a modulated magnetic field;

configuring an optical sensor in the interactive device to receive a communication from the display and to generate an optical sensor signal; and

configuring the communication module of the interactive device to respond to the optical sensor signal, wherein the response comprises a second magnetic signal that is different from the first magnetic signal.

36. The method of claim 35, wherein the first and second magnetic signals are generated by at least one of an electromagnet and a permanent magnet.

37. The method of claim 35, wherein the first and second magnetic signals are generated by at least one electromagnet.

38. The method of claim 35, wherein the first magnetic signal indicates at least one of the following: a type of the interactive device, a feature of the interactive device, a memory capacity of the interactive device, a game capability of the interactive device, and an external input to the interactive device.

39. The method of claim 38, wherein the external input to the device comprises a signal from at least one of a button, a transducer, a touch-based input surface, a light sensor.

40. The method of claim 39, wherein the transducer converts at least one of mechanical energy, magnetic energy, acoustic energy, and electromagnetic energy to electrical energy.

41. The method of claim 35, wherein the optical sensor signal further configures a configuration module that causes the interactive device to take an action based on the displayed content.

42. The method of claim 41, wherein the action comprises at least one of the following: an actuation, generating a signal, triggering a mechanic actuator, transacting with another device, communicating with another device, and generating a user interface.

43. The method of claim 35, wherein the communication comprises at least one of the following: a pixel pattern, a color, a symbol, an object, a temporal display pattern, a pixel location, a set of unlit pixels, and polarization.

44. The method of claim 35, wherein the optical sensor comprises at least one of the following: a camera, a charge-coupled device (CCD) sensor, a complementary metal-oxide-semiconductor (CMOS) sensor, a solar cell, a photo-resistor, a phosphorescent sensor, a fluorescent sensor, and a scintillator.

45. The method claim 35, wherein the communication module comprises at least a first and second electromagnet.

46. The method of claim 45, wherein the first electromagnet generates a magnetic field that is oriented differently than the magnetic field generated by the second electromagnet.

47. The method of claim 35, wherein the communication module comprises the optical sensor.

48. The method of claim 35, further comprising a plurality of additional optical sensors.

49. A non-transitory computer-readable storage medium storing computer-executable code for using an interactive device with a touch-based electronic display, that when executed by a processor causes the processor to perform the steps comprising:

configuring a rules engine to receive data from a magnetometer;

determining, by the rules engine, at least one of a position and an identity of the interactive device based on at least a portion of the magnetometer data;

configuring the display to present content based on at least one of the position and the identity of the interactive device; and

using the displayed content to generate an optical signal to the interactive device and wherein the interactive device is configured to provide a modulated magnetic field to the magnetometer.

50. The storage medium of claim 49, wherein the magnetometer data includes at least one of the following: a position of the interactive device relative to the display, an orientation of the interactive device relative to the display, a state of the interactive device, a type of the interactive device, a make or model of the interactive device, an interactive device feature, an interactive device memory capacity, an interface type, an interactive device capability, a revision number, an identity of the interactive device's owner, a transaction, and an external input to the interactive device.

51. The storage medium of claim 49, wherein the magnetometer data corresponds to a modulated magnetic field generated in the device, and the modulated magnetic field is modulated by at least one of frequency, amplitude, position, orientation, and an additional magnetic field.

52. The storage medium of claim 51, wherein the additional magnetic field is generated by at least one electromagnet.

53. The storage medium of claim 49, wherein the interactive device has at least one of an electromagnet and a permanent magnet.

54. The storage medium of claim 49, wherein the interactive device has a first and second magnet, the first and second magnets comprising at least one of an electromagnet and a permanent magnet.

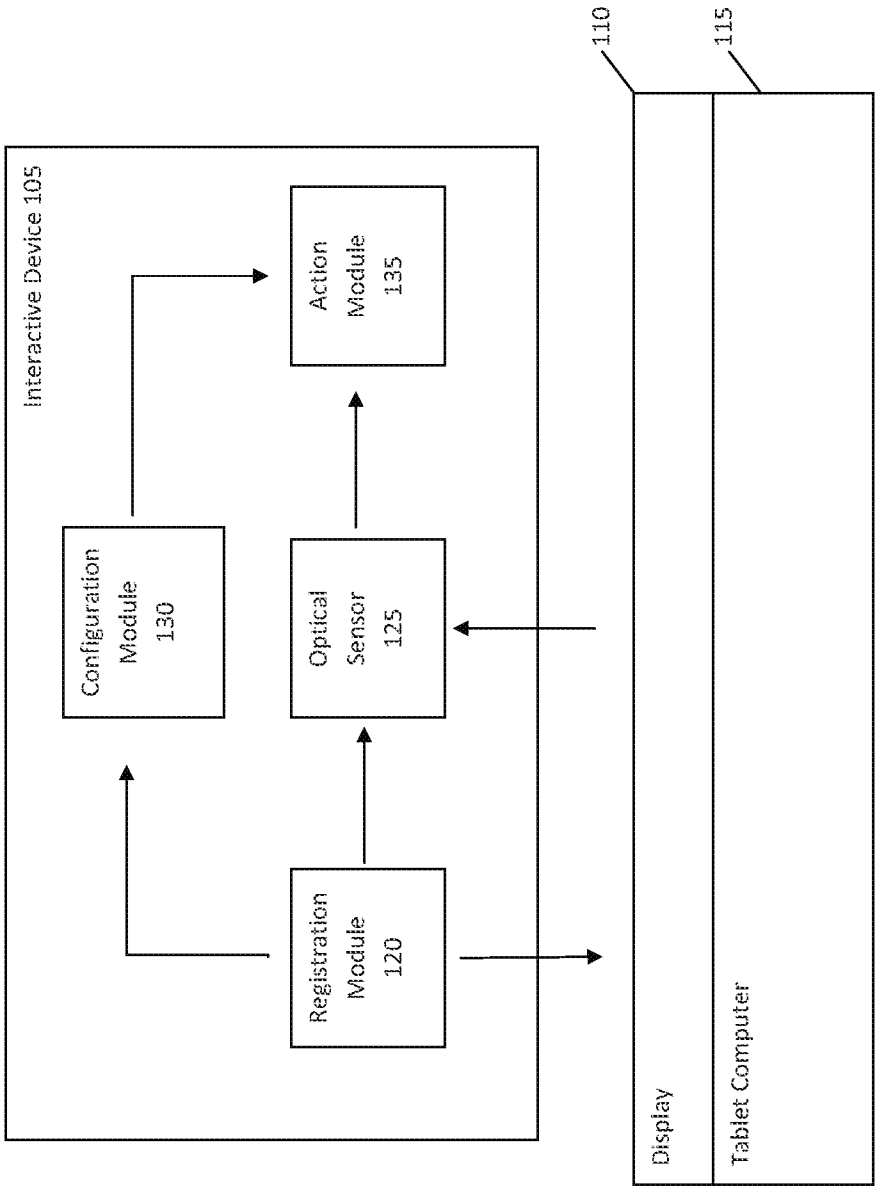

110
115
Interactive Device 105
Action Module 135
Configuration Module 130
Optical Sensor 125
Registration Module 120
Display
Tablet Computer

Figure 1

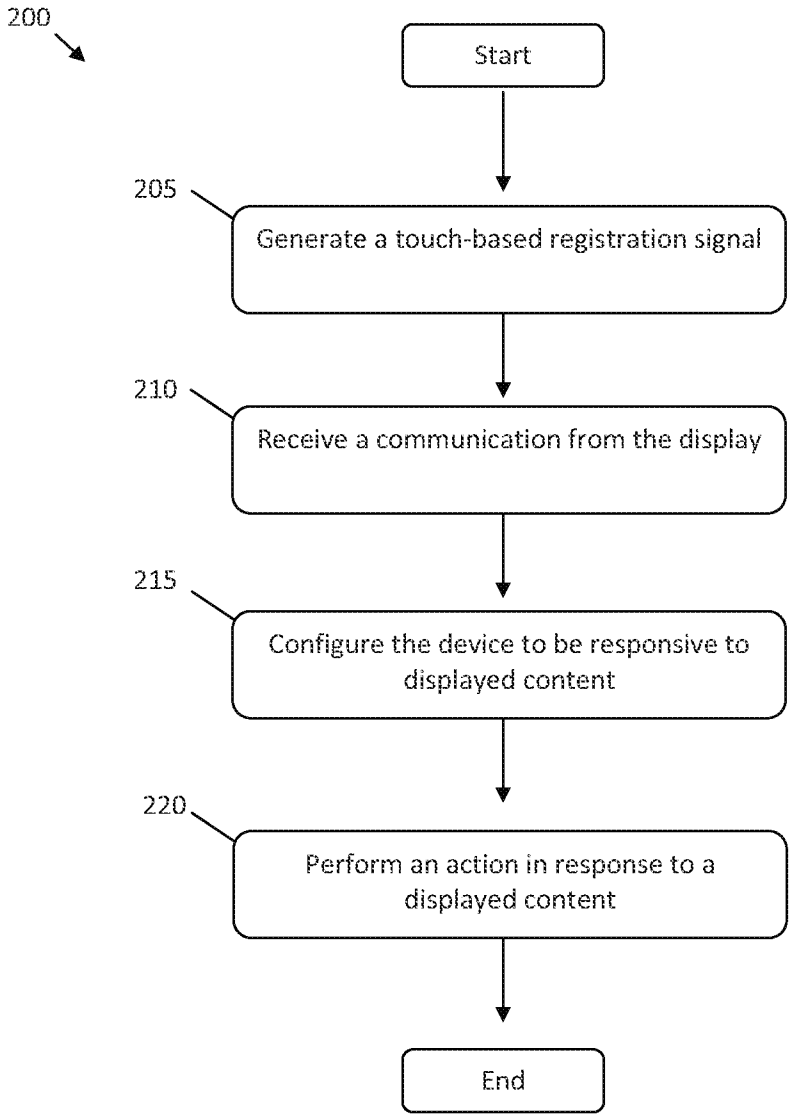

200
Start
205
Generate a touch-based registration signal
210
Receive a communication from the display
215
Configure the device to be responsive to displayed content
220
Perform an action in response to a displayed content
End

Figure 2

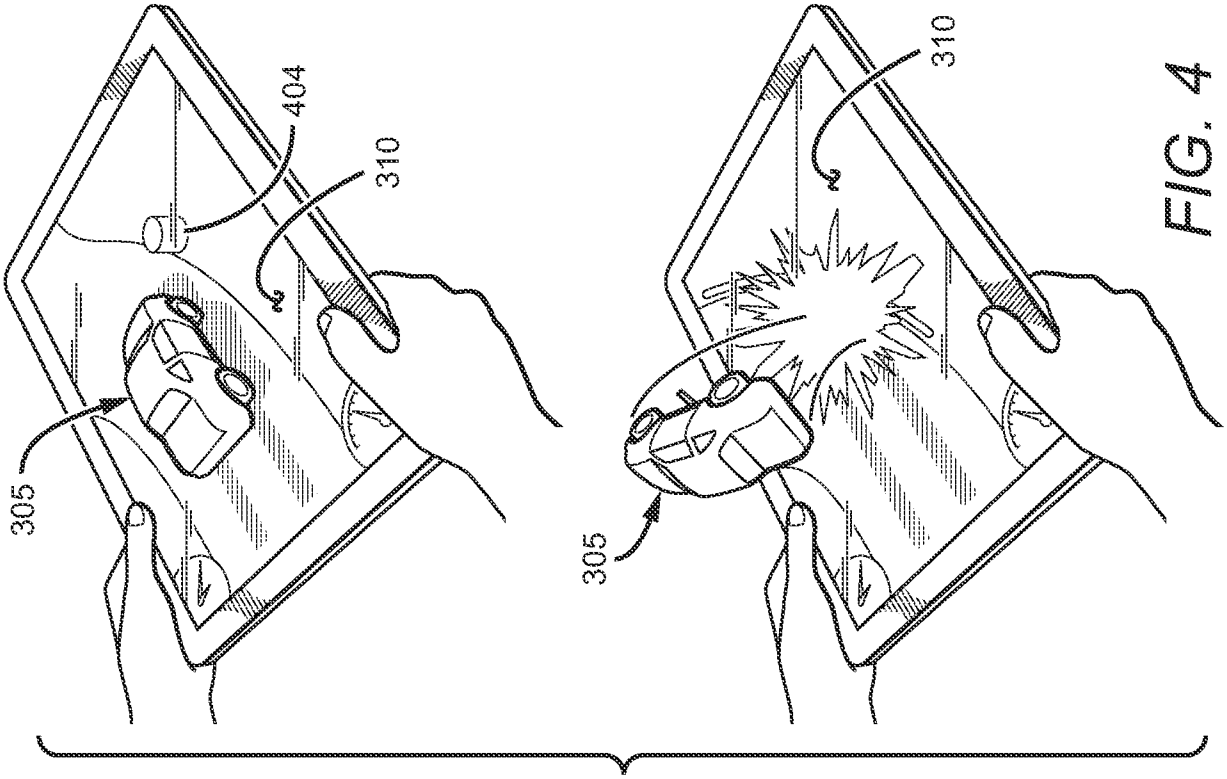


FIG. 4

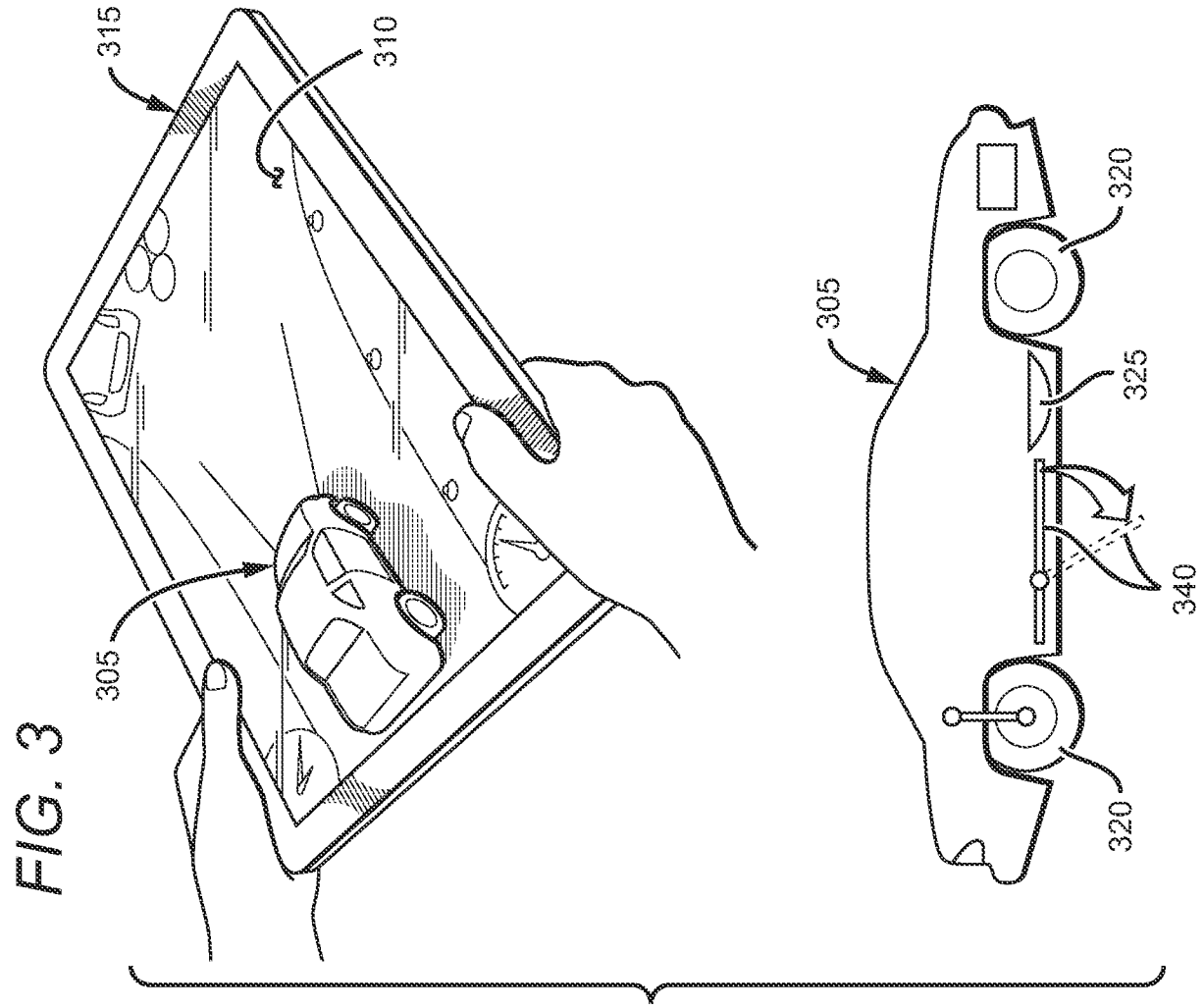


FIG. 3

FIG. 5

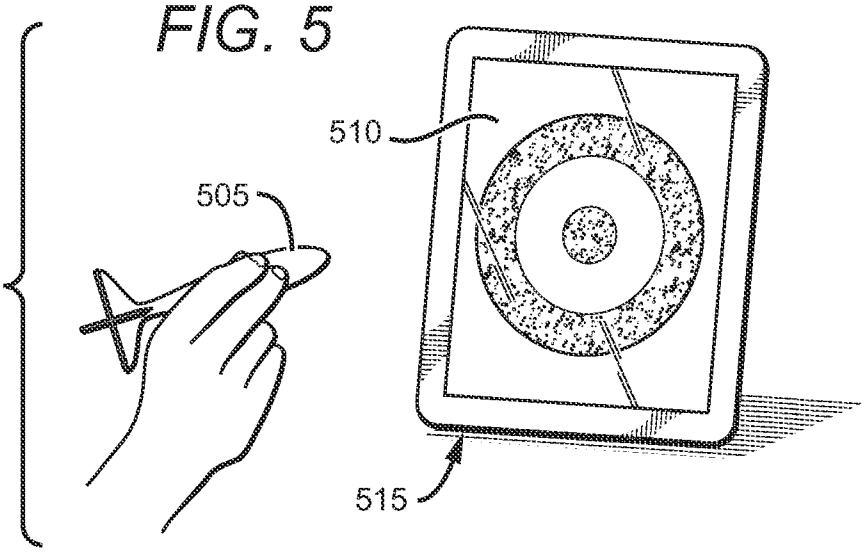
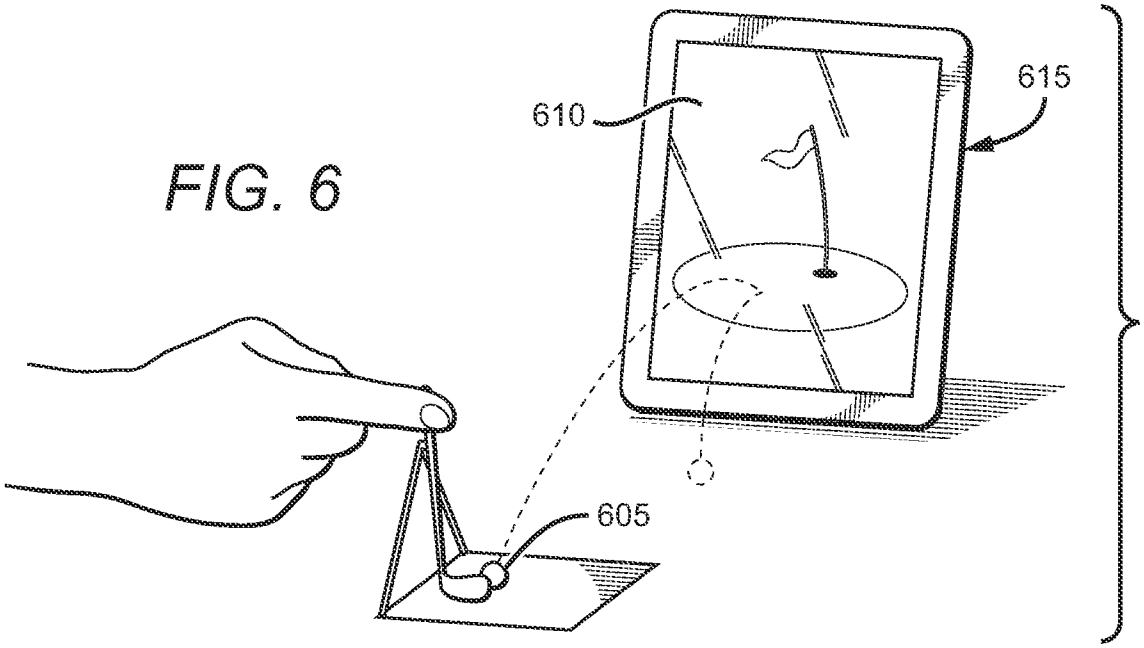


FIG. 6



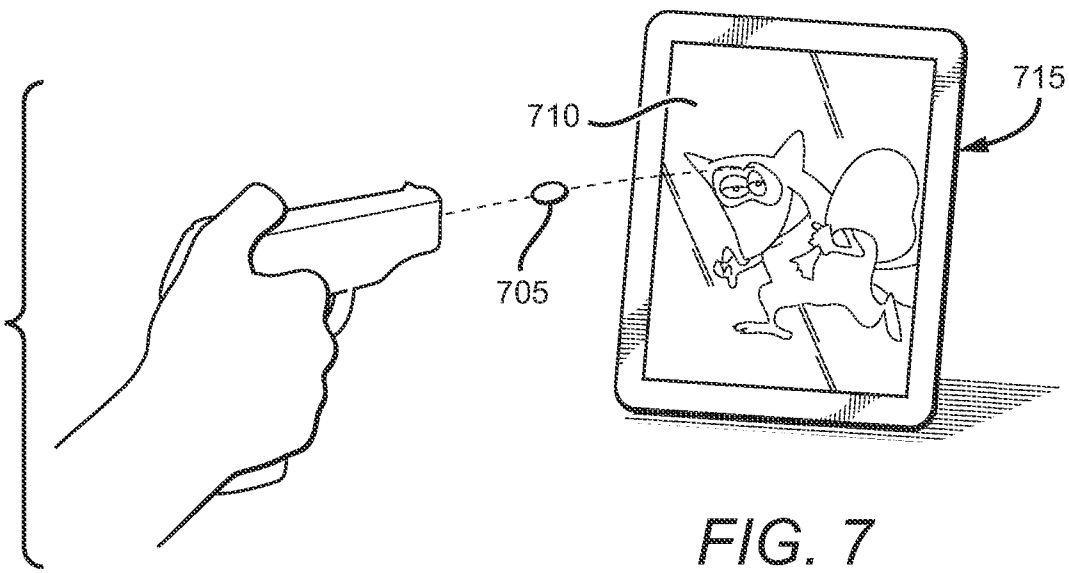
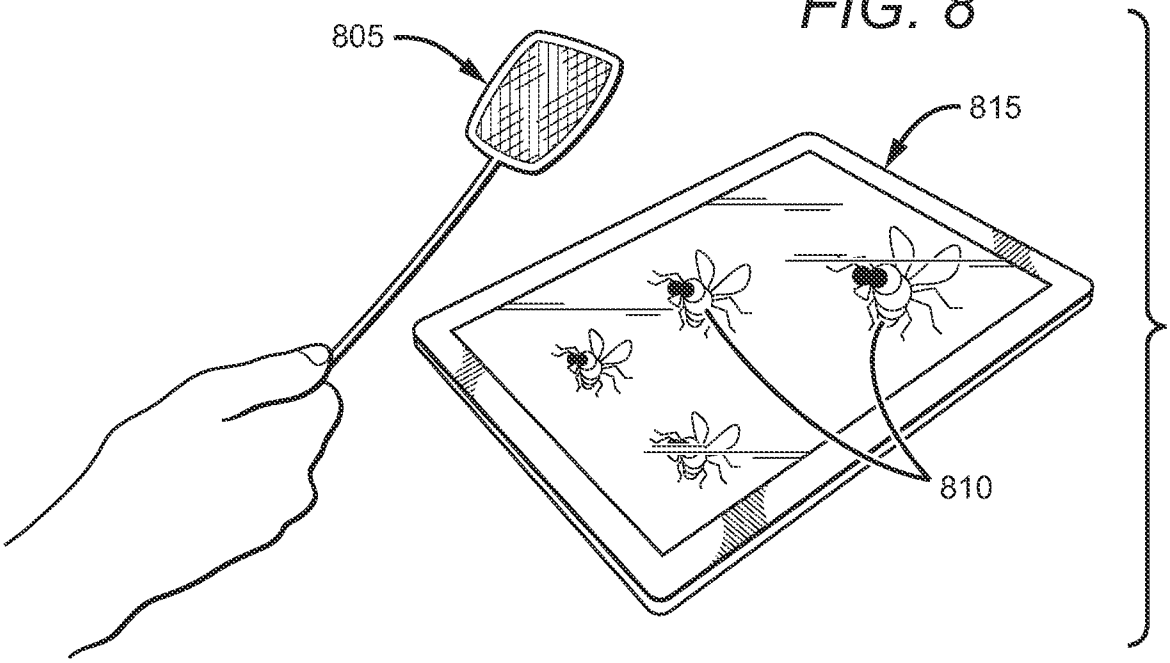


FIG. 7

FIG. 8



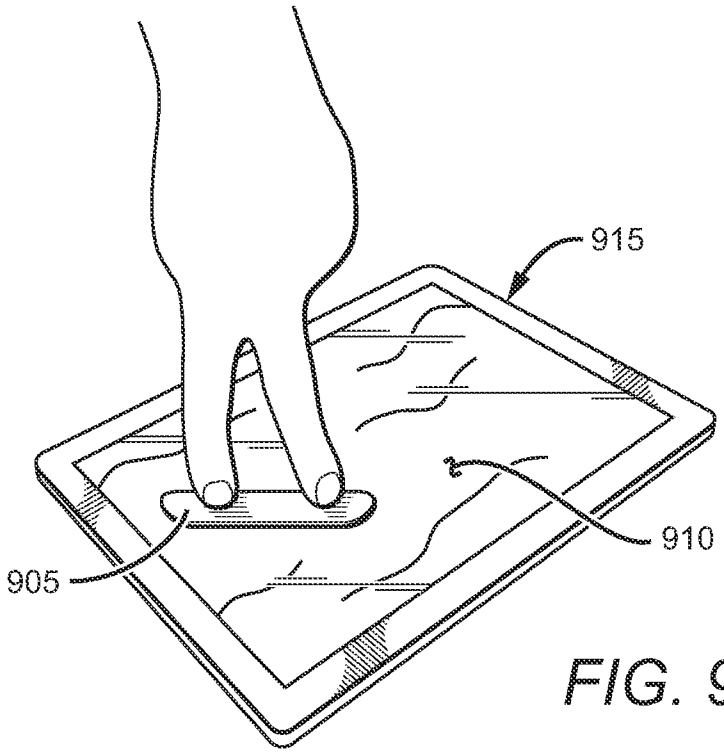


FIG. 9

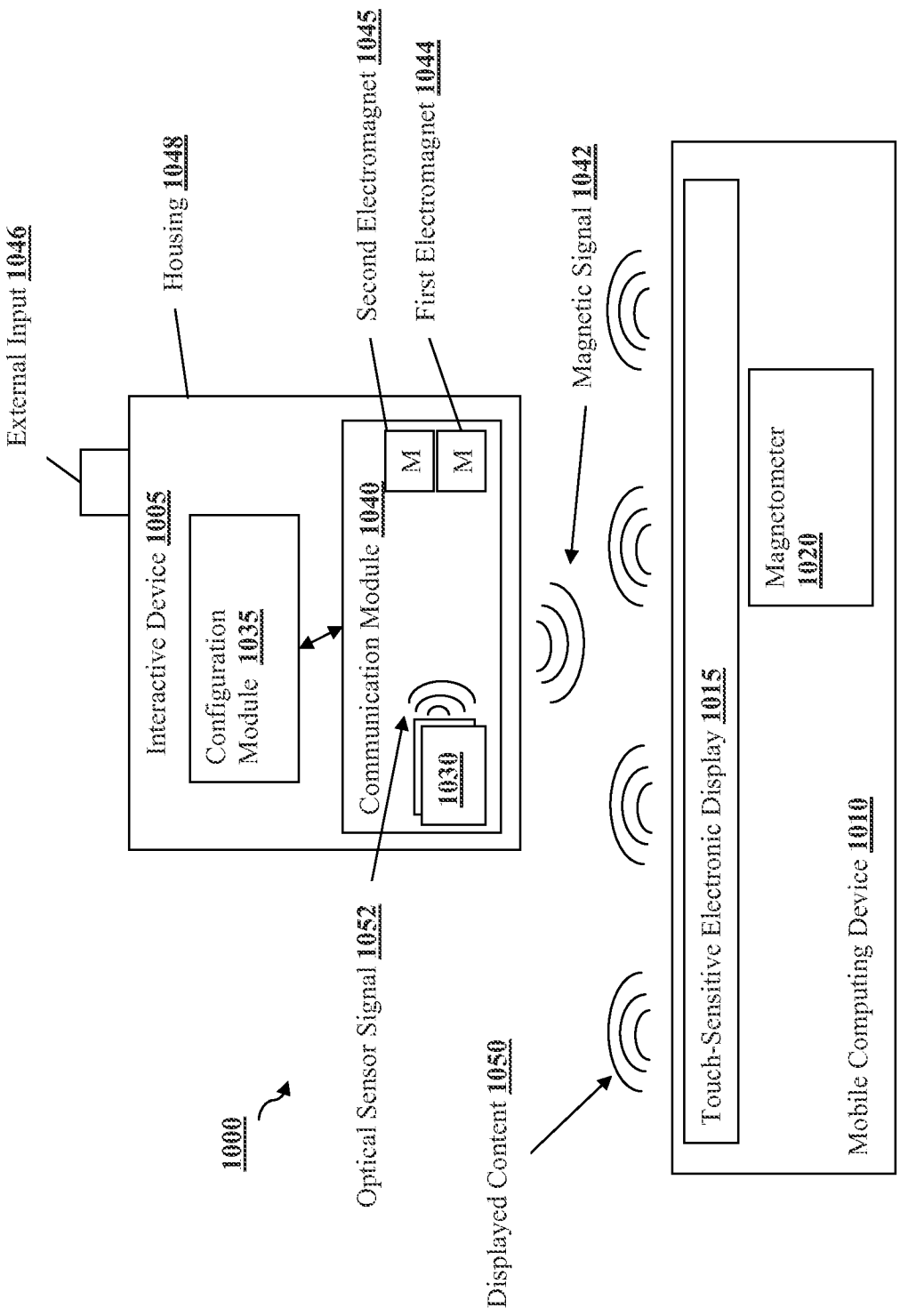

External Input 1046
Housing 1048
Second Electromagnet 1045
First Electromagnet 1044
Magnetic Signal 1042
Interactive Device 1005
Configuration Module 1035
Communication Module 1040
M
M
1030
1000
Optical Sensor Signal 1052
Displayed Content 1050
Touch-Sensitive Electronic Display 1015
Magnetometer 1020
Mobile Computing Device 1010

Figure 10

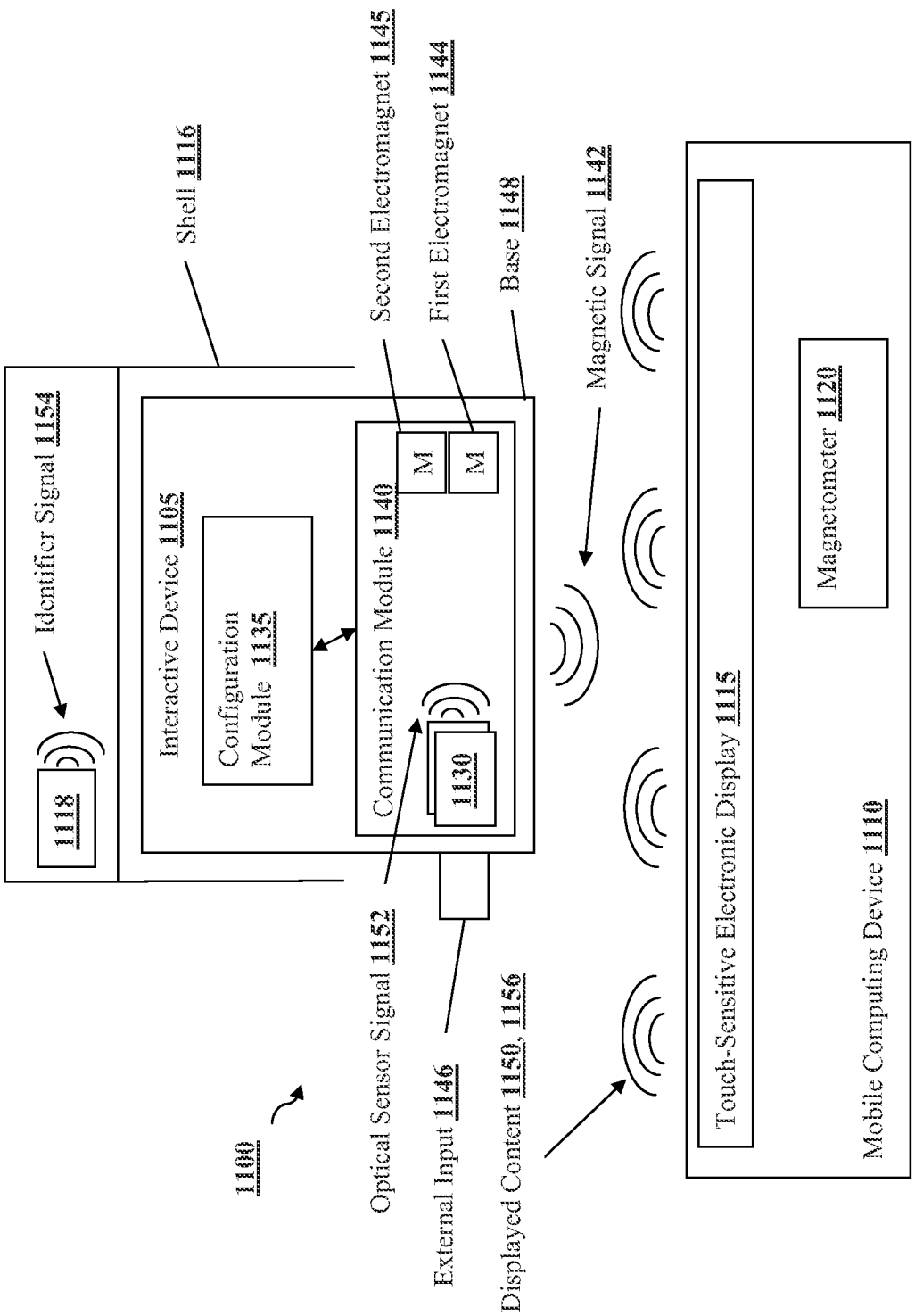

1100
Identifier Signal 1154
1118
Shell 1116
Interactive Device 1105
Configuration Module 1135
Communication Module 1140
Second Electromagnet 1145
First Electromagnet 1144
M
M
1130
Base 1148
Optical Sensor Signal 1152
External Input 1146
Displayed Content 1150, 1156
Magnetic Signal 1142
Touch-Sensitive Electronic Display 1115
Magnetometer 1120
Mobile Computing Device 1110

Figure 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/016599

A. CLASSIFICATION OF SUBJECT MATTER

G06F 3/01(2006.01)i, G06F 3/048(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F 3/01; G09B 1/36; A63F 3/00; G06F 3/041; A63F 13/00; G06F 3/048

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: touch screen, magnetic, communication, optical sensor, toy, and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0062490 A1 (CHRISTOPHER W. HEATHERLY et al.) 15 March 2012 See paragraphs 27-58; claim 16; and figures 1a-2.	1-30,32-34,49-54
Y		31,35-48
Y	US 2012-0212427 A1 (AN-KUO LI et al.) 23 August 2012 See paragraphs 5-14, 36; and figures 6-13.	31,35-48
A	US 2012-0049453 A1 (THEODORE MORICHAU-BEAUCHANT et al.) 01 March 2012 See paragraphs 6-9; and figures 2A-6C.	1-54
A	US 2007-0009866 A1 (BRIAN I. MARCUS et al.) 11 January 2007 See paragraphs 37-44; and figures 1-8.	1-54
A	US 2006-0175753 A1 (PETER MACIVER et al.) 10 August 2006 See paragraphs 4-8; and figures 3-5.	1-54

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2014 (10.07.2014)	**10 July 2014 (10.07.2014)**

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International application No.
PCT/US2014/016599

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