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(54) **SYSTEM AND METHOD FOR SHAPE DEFORMATION AND FORCE DISPLAY OF DEVICES**

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G09G 5/00 (2006.01)

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USPC **345/156**; 434/114

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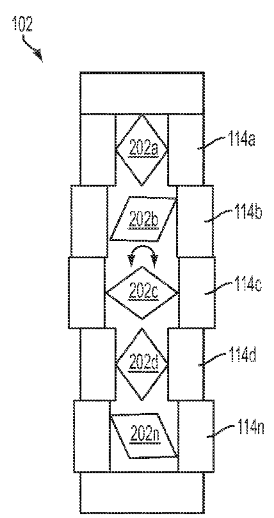
(57) **ABSTRACT**

Various systems, devices, and methods for shape deformation of a haptic deformation display device are provided. For example, the haptic deformation display device may receive an input signal when the shape of the haptic deformation display device is in a first shape configuration. In response to the input signal, the haptic deformation display device may activate an actuator of the haptic deformation display device. The actuator may move a deformation component of the haptic deformation display device. The deformation component may at least partially defining a shape of the haptic deformation display device, thereby causing the shape of the haptic deformation display device to deform into a second shape configuration different from the first shape configuration. The second shape configuration may be substantially maintained.

28 Claims, 5 Drawing Sheets



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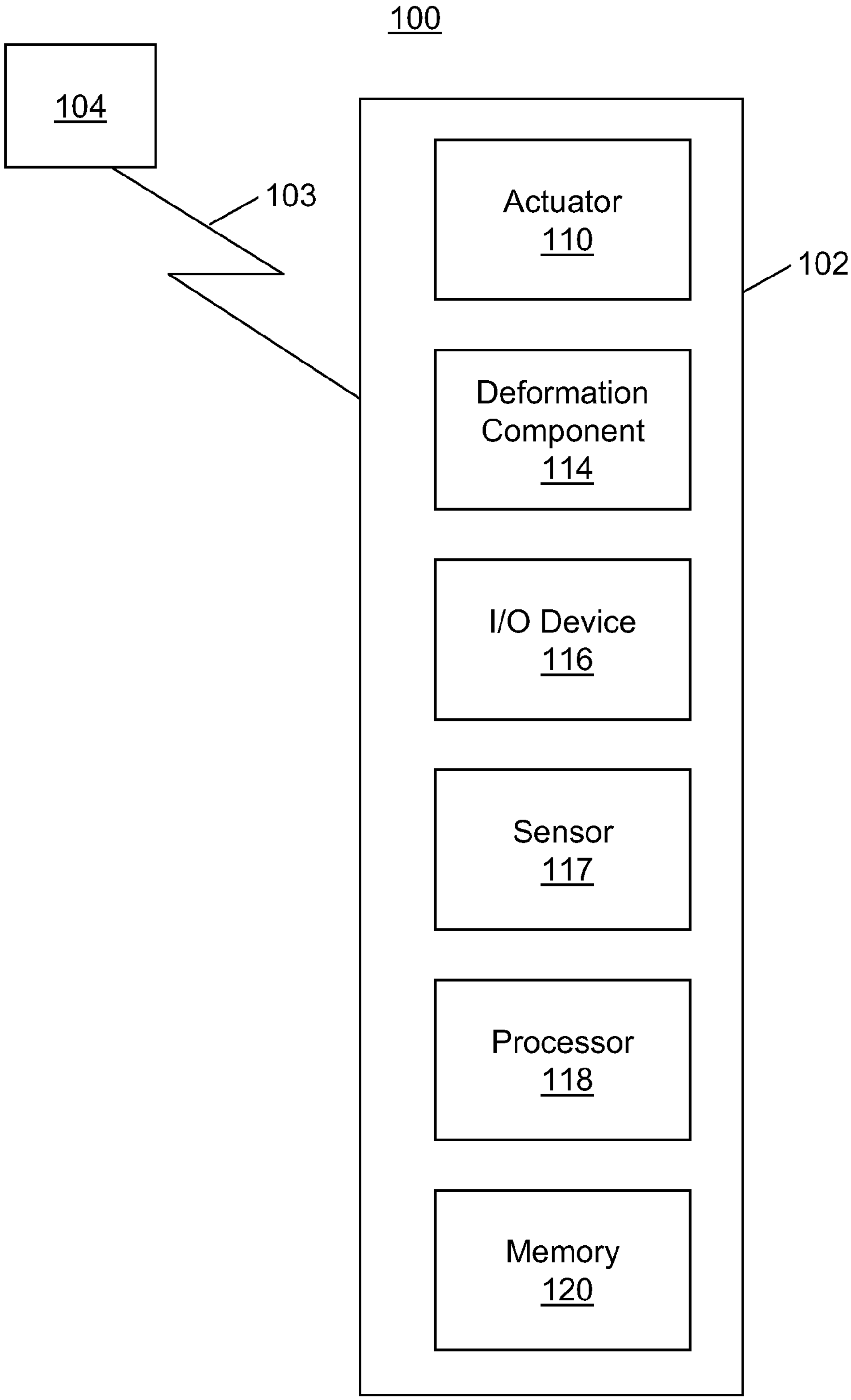
100
104
103
Actuator
110
102
Deformation
Component
114
I/O Device
116
Sensor
117
Processor
118
Memory
120

FIG. 1

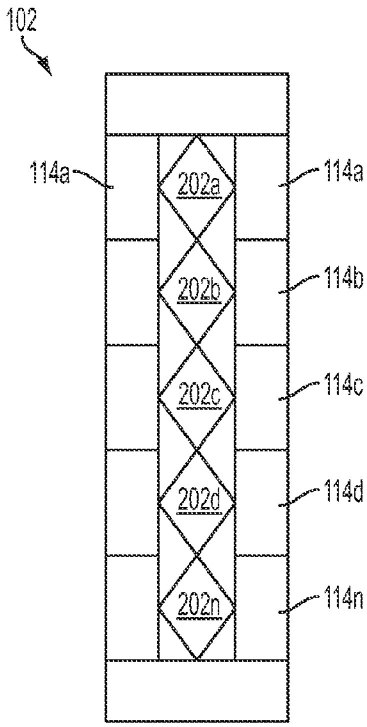

FIG. 2a

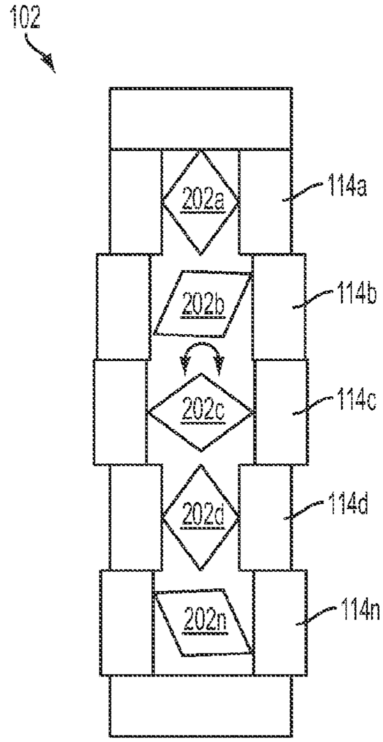

FIG. 2b

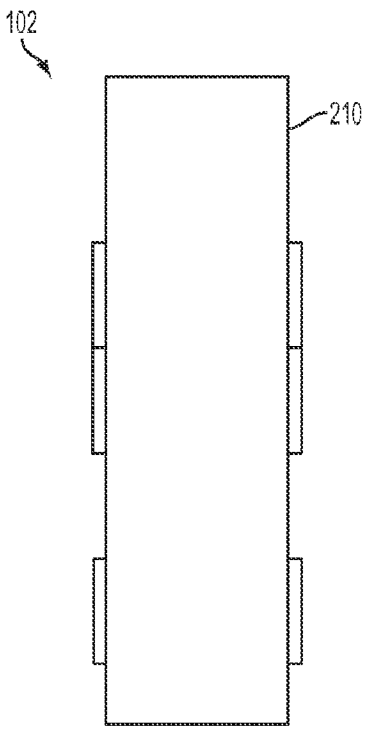

FIG. 2c

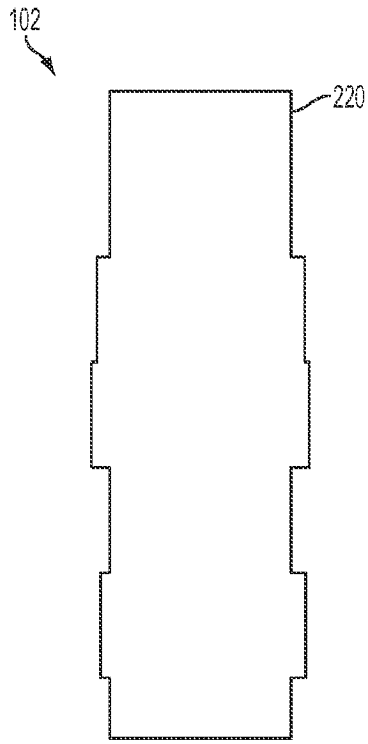

FIG. 2d

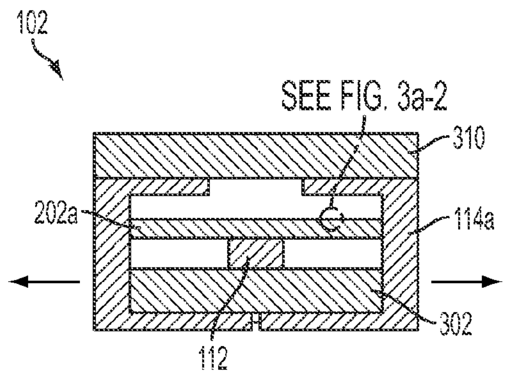

FIG. 3a-1

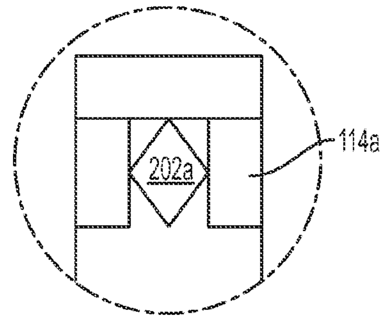

FIG. 3a-2

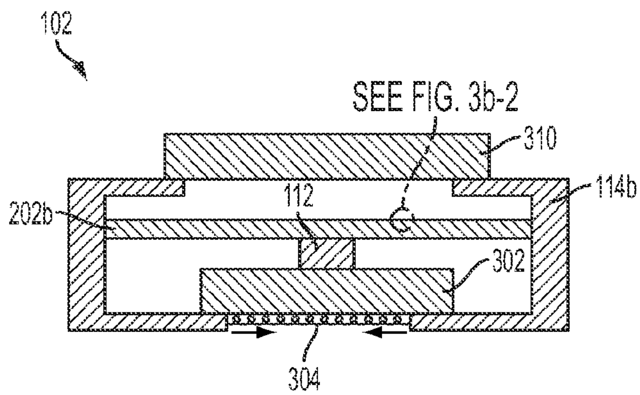

FIG. 3b-1

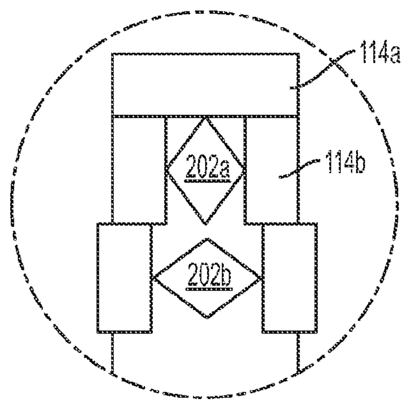

FIG. 3b-2

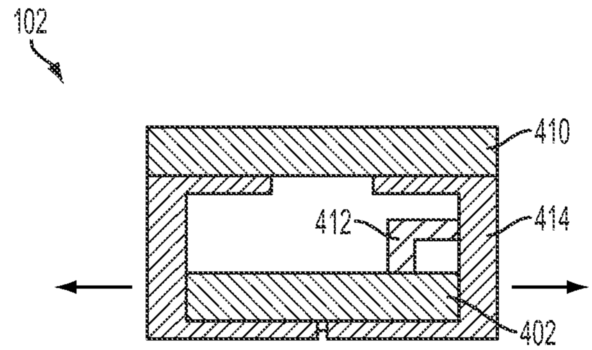

FIG. 4

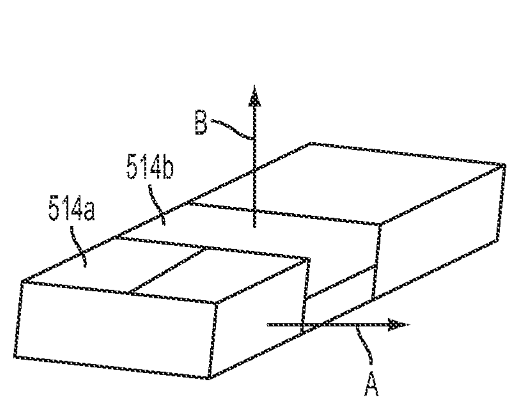

FIG. 5

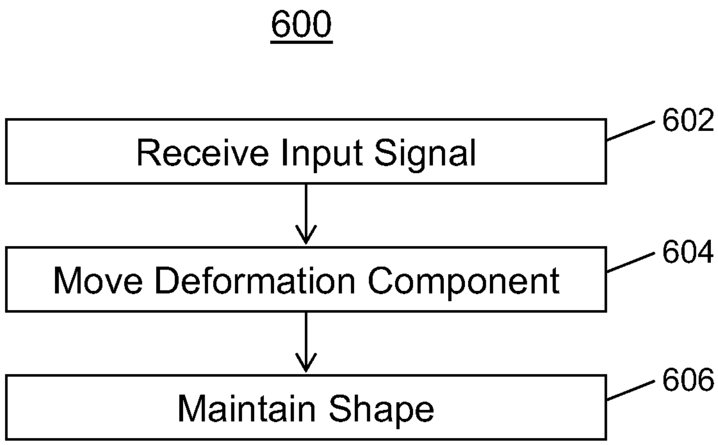
600
Receive Input Signal
602
Move Deformation Component
604
Maintain Shape
606

FIG. 6

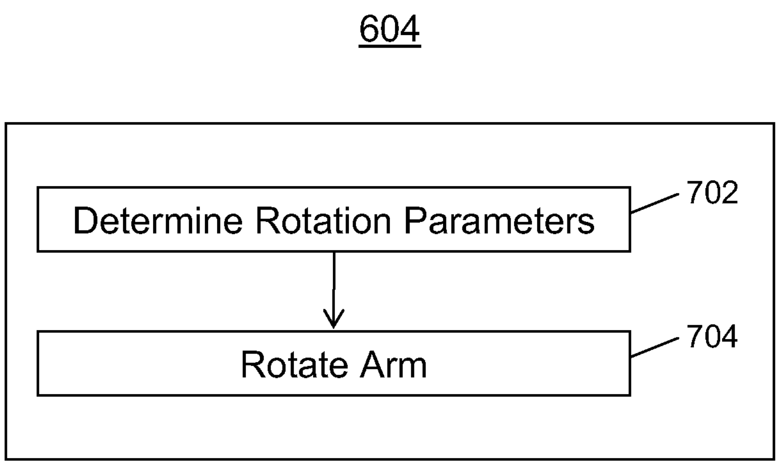
604
Determine Rotation Parameters
702
Rotate Arm
704

FIG. 7

SYSTEM AND METHOD FOR SHAPE DEFORMATION AND FORCE DISPLAY OF DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. provisional patent application Ser. No. 61/176,431, filed May 7, 2009, which is hereby incorporated by reference in its entirety.

FIELD

The disclosure relates to systems, devices, and methods for haptic interface devices and more particularly to shape deformation of devices.

BACKGROUND

Devices increasingly employ haptic actuators to generate haptic feedback in order to enrich the user interface experience. For example, cell phones, game controllers, automotive controls, and other devices use haptic feedback to convey information to a user. In some existing systems, different haptic feedback parameters such as frequency, magnitude, and/or other parameters may be used to communicate different information. Thus, the user may receive different information via haptic feedback in addition to or instead of audio/visual feedback.

SUMMARY

In one embodiment, a haptic deformation display device may receive an input signal when the shape of the haptic deformation display device is in a first shape configuration. In response to the input signal, the haptic deformation display device may activate an actuator of the haptic deformation display device. The actuator may move a deformation component of the haptic deformation display device. The deformation component may at least partially define a shape of the haptic deformation display device, thereby causing the shape of the haptic deformation display device to deform into a second shape configuration different from the first shape configuration. The second shape configuration may be substantially maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system for shape deformation, according to various embodiments of the invention.

FIG. **2***a* is a block diagram of a cutaway view of a haptic deformation device in a non-deformed shape configuration, according to various embodiments of the invention.

FIG. **2***b* is a block diagram of a cutaway view of a haptic deformation device in a deformed shape configuration, according to various embodiments of the invention.

FIG. **2***c* is a block diagram of a haptic deformation device with a top plate in a deformed shape configuration, according to various embodiments of the invention.

FIG. **2***d* is a block diagram of a haptic deformation device with a flexible housing in a deformed shape configuration, according to various embodiments of the invention.

FIG. **3***a* is a cross-sectional view of a haptic deformation device in a non-deformed shape configuration with a superimposed partial view of the non-deformed shape as illustrated in FIG. **2***a*, according to various embodiments of the invention.

FIG. **3***b* is a cross-sectional view of a haptic deformation device in a deformed shape configuration with a super-imposed partial view of the deformed shape as illustrated in FIG. **2***b*, according to various embodiments of the invention.

FIG. **4** is a cross-sectional view of a haptic deformation device, according to various embodiments of the invention.

FIG. **5** is a perspective view of a block diagram of a haptic deformation device, according to various embodiments of the invention.

FIG. **6** is a flow diagram of a process for shape deformation, according to various embodiments of the invention.

FIG. **7** is a flow diagram of a process for moving a deformation component, according to various embodiments of the invention.

DETAILED DESCRIPTION

Various embodiments of the invention relate to systems, devices and methods for shape deformation of a haptic deformation device. For example, the system may include a haptic deformation device that receives a shape input signal when the haptic deformation device is in a first shape configuration. The haptic deformation device may include an actuator that moves a deformation component of the haptic deformation device in response to the shape input signal. The deformation component at least partially defines the shape of the haptic deformation device, thereby causing the shape of the haptic deformation device to deform into a second shape configuration different from the first shape configuration when the deformation component is moved by the actuator. The haptic deformation device may include a game controller that is coupled to a game console or other host computer, a communication device such as a cellular telephone, a computer peripheral such as a mouse, a gaming device that changes shape based on events in a game being run on the gaming device, or other device that includes an actuator configured to move a deformation component in response to a shape input signal.

FIG. **1** is a block diagram of a system **100** for shape deformation, according to various embodiments of the invention. System **100** may include a haptic deformation display device **102** coupled to a remote device **104** via link **103**. Link **103** may be a wireless link, a wired link, and/or other link between haptic deformation display device **102** and remote device **104**. Haptic deformation display device **102** may include a game controller, a communication device, a computer peripheral such as a mouse, and/or other device that is configured to deform its shape configuration in response to a shape input signal. "Shape configuration" refers to a shape of haptic deformation display device **102** as felt by a user. "Deforming" a shape from a first shape configuration to a second shape configuration refers to a macro change in the shape such that a user is able to perceive a change in the shape by touch and/or sight. A macro change may differ from a vibration in that the change occurs in a single cycle or in a small number of cycles instead of a high number of cycles per second of change on a periodic basis (e.g., 25-100 Hz) as occurs with a typical vibration. Remote device **104** may include a game console or other computing device, another haptic deformation device, a cellular tower, and/or other device coupled to haptic deformation display device **102**. Although illustrated in FIG. **1** as being coupled to remote device **104**, in some embodiments, haptic deformation display device **102** may be a standalone device such as, for example, a handheld gaming device.

Through various modules and components, haptic deformation display device **102** may deform its outer shape in response to the shape input signal. For example, haptic deformation display device **102** may include an actuator **110**, a deformation component **114**, an input/output device **116** ("IO device **116**"), a sensor **117**, a processor **118**, a memory **120**, and/or other components.

Actuator **110** may be coupled to and move deformation component **114** in response to the shape input signal. Actuator **110** may include a piezo-electric actuator, rotating/linear actuator, a solenoid, an electroactive polymer actuator, shape memory alloy, and/or other actuator. In some embodiments, deformation component **114** at least partially defines a shape of haptic deformation display device **102**. In some embodiments, deformation component **114** may form at least a portion of a housing of haptic deformation display device **102**. In some embodiments, deformation component **114** may be housed inside a flexible housing that deforms according to movement of deformation component **114**. Thus, movement of deformation component **114** may deform the outer shape of haptic deformation display device

In some embodiments, actuator **110** may generate one or more haptic effects in addition to or instead of moving deformation component **114**. In this manner, for example, a user may receive the haptic effect in addition to or instead of a shape deformation of haptic deformation display device **102**.

IO device **116** may include, among other things, one or more of a display, a touch screen, a light, a speaker, a button, and/or other user interface component for input and output.

According to various embodiments of the invention, sensor **117** may include sensors and/or encoders such as a force sensor, a torque sensor, a pressure sensor, or other sensor configured to sense an input. Sensor **117** may be disposed on an outer surface of haptic deformation display device **102** (such as on a housing of haptic deformation display device **102**), disposed inside the housing, and/or be included as part of actuator **110**. In some embodiments, for example, actuator **110** may include an actuator configured to both actuate and sense inputs such as electroactive polymer actuators.

In some embodiments, sensor **117** may sense input such as a force, a shaking, a gesture, or other input from a user to a housing or other component of haptic deformation display device **102**.

In some embodiments, sensor **117** may generate sensory input representative of the sensed input. The sensory input may be used to cause deformation demands such as shape configurations to haptic deformation display device **102** and vice versa. In other words, in some embodiments, sensor **117** generates sensory input and causes haptic deformation display device **102** to deform its shape in response to the sensory input.

In some embodiments, sensor **117** may be used to communicate inputs to and/or from remote device **104**. For example, sensor **117** may receive input signals from remote device **104** and/or cause sensory input to be transmitted to remote device **104**. In this manner, remote device **104** may receive and respond to sensory input from haptic deformation display device **102** and/or haptic deformation display device **102** may deform its shape in response to input from remote device **104**.

Thus, in some embodiments, haptic deformation display device **102** may be configured to deform its shape, sense inputs (such as force from a user) imparted to a housing or other component of haptic deformation display device **102**, and/or communicate (transmit and/or receive) signals with remote device **104**.

Processor **118** may be configured to perform various functions of haptic deformation display device **102** such as, for example, communicating information to and from a user, causing actuator **110** to move deformation component **114**, and/or other functions.

Memory **120** may store instructions for configuring processor **118** to perform the various functions of haptic deformation display device **102** and/or store other information related to haptic deformation display device **102**. For example, memory **120** may include shape instructions for associating a shape input signal with a particular haptic response to be output by actuators **110** that causes a particular shape configuration of haptic deformation display device **102**. In some embodiments, memory **120** associates different shape input signals with different forces to be output by actuator **110** in a lookup table. This association may be used to cause different shape deformations based on the different shape input signals. In this manner, processor **118** may perform a lookup of the shape input signal to cause actuator **110** to deform the shape of haptic deformation display device **102**.

In some embodiments, haptic deformation display device **102** may receive the shape input signal from remote device **104**. For example, remote device **104** may include a gaming console that runs a game application and communicates the shape input signal to haptic deformation display device **102**. The shape input signal may be related to or otherwise correspond with game events. The game events may be user-driven events or user-independent events. User-driven events include events that respond to user actions such as, for example, when a user manipulates an object such as a tennis ball in a tennis gaming application. User-independent events include events that occur independent of user actions such as events occurring in the game beyond the control of the user. In some embodiments, sensor **117** may transmit sensory input to remote device **104**. In response to the sensory input, remote device **104** may cause haptic deformation display device **102** to deform its shape configuration. In some embodiments, remote device **104** may be another haptic deformation display device. Thus, haptic deformation display device **102** may communicate with various remote devices and receive and/or transmit signals such as a shape input signal that cause shape deformation of haptic deformation display device **102** and/or remote device **104**. In this manner, a user of remote device **104** may communicate a shape input signal that cause haptic deformation display device **102** to deform its shape configuration.

In some embodiments, haptic deformation display device **102** may locally determine the shape input signal (thus, receiving the shape input signal from itself). In some embodiments, processor **118** may locally generate the shape input signal in response to a manipulation of IO device **116**. For example, IO device **116** may include one or more user inputs that when manipulated causes processor **118** to generate the shape input signal. In some embodiments, IO device **116** includes one or more buttons that when pressed cause haptic deformation display device **102** to deform into one or more shapes corresponding to the pressed button. For example, a user may press a first button that causes haptic deformation display device **102** to deform into a first shape such as a ball, press a second button that causes haptic deformation display device **102** to deform into a second shape such as a bat, press a third button that causes haptic deformation display device **102** to deform into a dynamically moving wave, and/or manipulate other IO device **116** inputs that causes haptic deformation display device **102** to deform into one or more shapes. In some embodiments, processor **118** may locally generate the shape input signal based sensory input from sensor **117**.

In some embodiments, processor **118** may locally generate the shape input signal in response to information from remote device **104**. For example, haptic deformation display device **102** may receive event information related to an event occurring at remote device **104**. In response to the event information, haptic deformation display device **102** may generate the shape input signal, thereby locally determining the shape input signal based on information received from remote device **104**.

In an operation according to various embodiments of the invention, shape deformation device **102** may receive a shape input signal. The shape input signal may be received from a remote source such as remote device **104** or a local source such as processor **118**. For example, when running a tennis game application, remote device **104** may communicate a shape input signal that causes haptic deformation display device **102** to form the shape of a tennis racket handle. When a game character is holding a tennis ball, the shape input signal may cause haptic deformation display device **102** to approximate the shape of a ball. Regardless of the source of the shape input signal, haptic deformation display device **102** causes actuator **110** to move deformation component **114** in response to the shape input signal. Movement of deformation component **114** causes an outer shape of haptic deformation display device **102** to deform from a first shape configuration to a different shape configuration.

FIG. **1** and other drawing figures are illustrative only and not intended to be limiting. Those having skill in the art will appreciate that various configurations, additions, and/or omissions may be used. For example, although illustrated as having a single actuator **110**, a single deformation component **114**, and a single IO device **116**, various numbers and configurations of either of these and other components may be used according to particular needs.

FIG. **2***a* is a block diagram of a cutaway view of haptic deformation display device **102** in a non-deformed shape configuration, according to various embodiments of the invention. According to various embodiments, haptic deformation display device **102** includes arms **202***a*, **202***b*, **202***c*, **202***d*, **202***n* ("arm **202**" for convenience) each coupled to one or more actuators (not illustrated in FIG. **2***a*). In some embodiments, each arm **202** may be coupled to its own actuator. In some embodiments, two or more arms **202** may share a single actuator using various linkages (not illustrated in FIG. **2***a*). In some embodiments, arm **202** may form at least a portion of actuator **110**, thereby at least partially forming a moving portion of actuator **110**.

In some embodiments, an arm **202** includes a shape that is oblong. In other words, arm **202** may include a first dimension such as a length along a plane that is longer than a second dimension such as a width along the plane. Thus, rotation of arm **202** (illustrated by arrows described in FIG. **2***b* below) about an axis perpendicular to the plane causes arm **202** to contact any objects along a rotation path of arm **202**, causing arm **202** to contact objects in the rotation path as arm **202** rotates.

In some embodiments, each arm **202** may be coupled to one or more respective deformation components **114***a*, **114***b*, **114***c*, **114***d*, **114***n* ("deformation component **114**" for convenience). Deformation component **114** may be positioned along the rotation path of arm **202**, thereby being moved as arm **202** is rotated. Deformation component **114** at least partially defines the shape of haptic deformation display device **102**. Thus, the shape of haptic deformation display device **102** may deform into a second shape configuration different from the first shape configuration when deformation component **114** is moved. In some embodiments, deformation component **114** forms at least a portion of a housing of haptic deformation display device **102**. In some embodiments, deformation component **114** is enclosed within a flexible housing such that movement of deformation component **114** moves the flexible housing. In either implementation, movement of deformation component **114** causes haptic deformation display device **102** to deform into the second shape configuration.

In operation, an actuator causes arm **202** to rotate based on a shape input signal. Deformation component **114** is positioned along the rotation path of arm **202** such that deformation component **114** is moved as arm **202** is rotated, thereby causing the shape of haptic deformation display device **102** to deform.

FIG. **2***b* is a block diagram of a cutaway view of a device in a deformed shape configuration, according to various embodiments of the invention. As illustrated in FIG. **2***b*, arm **202***a* and arm **202***d* are in an original position, which may correspond to a non-deformed shape configuration of deformation component **114**. Arms **202***b*, **202***c*, and **202***n* are rotated with respect to the original position.

In some embodiments, arm **202** may be rotated according to one or more rotation parameters. The rotation parameters may include, for example, a rotational angle, magnitude (such as torque), and/or other parameters used to activate the actuator.

In some embodiments, each arm may be rotated according to a rotational angle by which arms **202***b*, **202***c*, and **202***n* are rotated. Different rotational angles may result in different amounts by which deformation components **114***b*, **114***c*, and **114***n* are moved. In other words, different rotation angles in which arm **104** is rotated causes a different deformation effect on deformation component **114**.

In some embodiments, each arm **202** may be rotated at different speeds and/or different angles relative to a neighboring arm. For example, arm **202***a* may be rotated at a different speed than arm **202***b*, which may be accomplished by applying more torque to arm **202***a* than to arm **202***b*. Thus, different haptic effects and/or shape configurations may be caused by different rotational speeds.

In some embodiments, movement of arms **202** may be coordinated to create a "waveform effect." The waveform effect may be accomplished by rotating arms **202** at different rotation angles relative to one another to move deformation components **114** in a manner that simulates a wave shape. The wave shape may be defined by one or more apexes, where an apex occurs when a deformation component **114** is maximally extended, which may occur when an arm **202** is rotated substantially at 90 degrees in either direction with respect to the original position, thereby maximally extending deformation component **114**.

In some embodiments, the waveform effect may be substantially continuously updated such that the one or more apexes move from a first location of haptic deformation display device **102** to a second location of haptic deformation display device **102**. This may be accomplished, for example, by causing arms **202** to rotate at substantially 90 degrees relative to the original position at different times such that an apex moves from the first location to the second location. An arm **202** adjacent to the apex may be rotated from zero to approximately 90 degrees with respect to the original position, where rotational angles closer to zero degrees result in deformation components **114** further from the apex while rotational angles closer to 90 degrees result in deformation components closer to the apex.

FIG. **2***c* is a block diagram of haptic deformation display device **102** with a top plate **210** in a deformed shape configuration, according to various embodiments of the invention. In some embodiments of the invention, top plate **210** may protect an inner portion of haptic deformation display device **102** upon deformation. In these embodiments, haptic deformation component **114** forms at least a portion of a housing of haptic deformation display device **102**.

FIG. **2***d* is a block diagram of haptic deformation display device **102** with a flexible housing **220** in a deformed shape configuration, according to various embodiments of the invention. In some embodiments of the invention, deformation component **114** is disposed inside deformable housing **220**. In these embodiments, deformable housing **220** may be formed using flexible material, such as rubber or other flexible material, that may deform based on movement of deformation component **114**.

In FIGS. **2***a*, **2***b*, **2***c*, and **2***d*, while five deformation components are illustrated, in some embodiments, various shapes, sizes, and number of components may be used to achieve greater or lesser granularity of shape profile in a dynamic manner. For instance, water wave forms can be realistically generated on this device using a much larger number of deformation components in one embodiment.

FIG. **3***a* is a cross-sectional view of haptic deformation display device **102** in a non-deformed shape configuration with a super-imposed partial view of the non-deformed shape as illustrated in FIG. **2***a*, according to various embodiments of the invention. In some embodiments of the invention, haptic deformation display device **102** includes a top plate **310** and a bottom plate **302** coupled to deformation component **114** (illustrated as deformation component **114***a*). Arm **202***a* is coupled to actuator **112**, which may be coupled to bottom plate **302** for support. When activated, actuator **112** rotates arm **202***a*, thereby causing arm **202***a* to move deformation component **114***a* in a direction indicated by arrows. Although shown as being centered, actuator **112** may be position offset from the center.

FIG. **3***b* is a cross-sectional view of haptic deformation display device **102** in a deformed shape configuration with a super-imposed partial view of the deformed shape as illustrated in FIG. **2***b*, according to various embodiments of the invention. In some embodiments of the invention, haptic deformation display device **102** includes a top plate **310** and a bottom plate **302** coupled to deformation component **114** (illustrated as deformation component **114***b*). Arm **202***b* is coupled to actuator **112**, which may be coupled to bottom plate **302** for support. As illustrated, arm **202***b* is rotated by actuator **112** such that deformation component **114***b* is extended, thereby deforming the shape of haptic deformation display device **102**. In some embodiments, haptic deformation display device **102** includes a returning force component **304** such as a spring or other component that causes a returning force in a direction indicated by arrows. Thus, when arm **202***b* is rotated from the original position to a rotational angle of 90 degrees relative to the original position, deformation component **114** may be moved against the returning force. When arm **202***b* is rotated from a rotational angle of 90 degrees to 180 degrees (or back to the original position), the returning force may cause deformation component **114** to move in the direction indicated by arrows.

FIG. **4** is a cross-sectional view of haptic deformation display device **102**, according to various embodiments of the invention. In some embodiments of the invention, haptic deformation display device **102** includes a bottom plate **402**, a top plate **410**, an actuator **412**, and a deformation component **414**. Deformation component **414** may be movably coupled to bottom plate **402** and top plate **410**. Actuator **412** may be grounded to bottom **402** or other component of haptic deformation display device **102** and may directly cause deformation component **414** to move in a direction indicated by the arrow illustrated in FIG. **4**. Thus, in some embodiments, actuator **412** may directly move deformation component **414**, thereby deforming the shape configuration of haptic deformation display device **102**.

FIG. **5** is a perspective view of a block diagram of haptic deformation display device **102**, according to various embodiments of the invention. In some embodiments of the invention, haptic deformation display device **102** includes a deformation component **514***a* and a deformation component **514***b*. As illustrated in FIG. **5**, deformation component **514***a* may be moved in a first direction indicated by the arrow labeled "A" while deformation component **514***b* may be moved in a second direction indicated by the arrow labeled "B." As would be appreciated by those having skill in the art, other numbers and configurations of deformation component **514***a* and deformation component **515***b* may be used as appropriate. Thus, in some embodiments, haptic deformation display device **102** may include deformation components that are moved in different directions, thereby allowing deformation of the shape configuration in three dimensional space.

FIG. **6** is a flow diagram of a process **600** for shape deformation, according to various embodiments of the invention. FIG. **6** is a flow diagram of an example process **600** for shape deformation, according to various embodiments of the invention. The various processing operations depicted in the flow diagram of FIG. **6** (and in the other drawing figures) are described in greater detail herein. The described operations for a flow diagram may be accomplished using some or all of the system components described in detail above and, in some embodiments, various operations may be performed in different sequences. According to various embodiments of the invention, additional operations may be performed along with some or all of the operations shown in the depicted flow diagrams. In yet other embodiments, one or more operations may be performed simultaneously. Accordingly, the operations as illustrated (and described in greater detail below) are examples by nature and, as such, should not be viewed as limiting.

In an operation **602**, an input signal may be received. In some embodiments, the input signal may include a haptic shape input signal that causes a device to deform its shape configuration into, for example, a shape of a ball. In some embodiments, the input signal may include information that describes one or more events, such as a tennis serve, occurring at a remote device such as a gaming console. In these embodiments, the haptic shape input signal may be determined locally based on the one or more events. For example, an input signal indicating a tennis serve is occurring at a remote device may be received by the device. In response, the device may determine a haptic shape input signal that causes the device to deform its shape configuration into a ball.

In an operation **604**, a deformation component may be moved in response to the received input signal. The deformation component defines at least a portion of the shape configuration of the device. Thus, movement of the deformation component deforms the shape configuration. In some embodiments, an actuator may move the deformation component directly or indirectly in response to the input signal.

In an operation **606**, the deformed shape configuration may be substantially maintained until another input signal is received and/or the received input signal causes continuous shape deformation. In other words, in some embodiments, the input signal causes the deformed shape configuration to be substantially maintained until further instructed. In some embodiments, the input signal causes the deformed shape configuration to be changed after an interval of time, thereby causing the device to deform the shape configuration at intervals.

FIG. **7** is a flow diagram of a process **604** for moving a deformation component, according to various embodiments of the invention. In an operation **702**, one or more rotation parameters may be determined based on the received input signal. The rotation parameters may describe parameters used to rotate an arm coupled to an actuator, wherein a rotation of the arm causes the deformation component to move. In an operation **704**, the actuator may rotate the arm based on the determined rotation parameters, thereby moving the deformation component.

Embodiments of the invention may be made in hardware, firmware, software, or any suitable combination thereof. Embodiments of the invention may also be implemented as instructions stored on a machine-readable medium, which may be read and executed by one or more processors. A tangible machine-readable medium may include any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computing device). For example, a tangible machine-readable storage medium may include read only memory, random access memory, magnetic disk storage media, optical storage media, flash memory devices, and other tangible storage media. Intangible machine-readable transmission media may include intangible forms of propagated signals, such as carrier waves, infrared signals, digital signals, and other intangible transmission media. Further, firmware, software, routines, or instructions may be described in the above disclosure in terms of specific exemplary embodiments of the invention, and performing certain actions. However, it will be apparent that such descriptions are merely for convenience and that such actions in fact result from computing devices, processors, controllers, or other devices executing the firmware, software, routines, or instructions.

Embodiments of the invention may be described as including a particular feature, structure, or characteristic, but every aspect or implementation may not necessarily include the particular feature, structure, or characteristic. Further, when a particular feature, structure, or characteristic is described in connection with an aspect or implementation, it will be understood that such feature, structure, or characteristic may be included in connection with other embodiments, whether or not explicitly described. Thus, various changes and modifications may be made to the provided description without departing from the scope or spirit of the invention. As such, the specification and drawings should be regarded as exemplary only, and the scope of the invention to be determined solely by the appended claims.

What is claimed is:

1. A method for deforming a shape of a haptic deformation display device, comprising:

receiving an input signal when the shape of the haptic deformation display device is in a first shape configuration, wherein the haptic deformation display device comprises a top plate;

actuating an actuator in response to the input signal;

moving, by the actuator, an arm coupled to the actuator and a deformation component of the haptic deformation display device according to a first motion,

wherein the deformation component is positioned along a rotation path of the arm and is enclosed within a flexible housing,

wherein the arm moves the deformation component and the flexible housing, the deformation component at least partially defining a shape of the haptic deformation display device, thereby causing the shape of the haptic deformation display device to deform into a second shape configuration different from the first shape configuration;

moving, by the actuator or another actuator, at least one other arm and at least one other deformation component of the haptic deformation display device according to a second motion, the second motion being different from the first motion;

wherein the top plate is positioned above both the deformation component and the at least one other deformation component and protects an inner portion of the haptic deformation display device upon deformation; and

substantially maintaining the second shape configuration.

2. The method of claim **1**, wherein the arm is moved by rotating the arm, the rotation causing the arm to move the deformation component.

3. The method of claim **2**, wherein said rotating the arm is based on one or more rotation parameters that specify rotation of the arm.

4. The method of claim **3**, wherein the rotation parameters include one or more of: a speed, a magnitude, a torque, or a rotational angle.

5. The method of claim **1**, wherein a shape of the arm defines the movement of the deformation component.

6. The method of claim **1**, further comprising:

actuating the actuator at a plurality of intervals, thereby causing the shape of the haptic deformation display device to deform at each interval.

7. The method of claim **1**, wherein the first motion and the second motion are different based on a speed or an angle in which the deformation component and the at least one other deformation component are moved.

8. The method of claim **7**, wherein the first motion and the second motion at least partially generate a waveform effect.

9. The method of claim **8**, wherein the device is communicably coupled to at least one other device, and wherein the received input signal originates from the at least one other device such that the at least one other device causes the device to deform into the second shape configuration.

10. The method of claim **9**, wherein the at least one other device is at least one or more of: a computing device executing an application, a second haptic deformation display device, and a cellular device.

11. The method of claim **8**, wherein the device includes at least one sensor, the method further comprising:

receiving a sensory input from the at least one sensor, wherein the received input signal is based on the sensory input.

12. The method of claim **11**, wherein the sensory input originates from at least one of: a user of the haptic deformation display device and at least one other device.

13. The method of claim **11**, wherein the actuator includes the at least one sensor.

14. The method of claim **11**, further comprising:

transmitting the sensory input to at least one other device.

15. A haptic deformation display device, comprising:

an actuator;

a deformation component at least partially defining a shape of the haptic deformation device;

a top plate;

an arm coupled to the actuator and the deformation component, wherein the deformation component is positioned along a rotation path of the arm and is enclosed within a flexible housing; and

at least one processor configured to:

receive an input signal when the shape of the haptic deformation display device is in a first shape configuration; and

cause the actuator to actuate in response to the input signal,

wherein the actuator is configured to move the arm according to a first motion, wherein the movement of the arm is further configured to move the deformation component and the flexible housing to cause the shape of the haptic deformation display device to deform into a second shape configuration different from the first shape configuration,

wherein the actuator, or another actuator, is further configured to move at least one other arm according to a second motion, the second motion being different from the first motion, wherein the movement of the at least one other arm is further configured to move at least one other deformation component;

wherein the actuator substantially maintains the second shape configuration, and

wherein the top plate is positioned above both the deformation component and the at least one other deformation component and protects an inner portion of the haptic deformation display device upon deformation.

16. The haptic deformation display device of claim **15**, wherein the arm is moved by rotation of the arm, the rotation causing the arm to move the deformation component.

17. The haptic deformation display device of claim **16**, wherein said rotation of the arm is based on one or more rotation parameters that specify rotation of the arm.

18. The haptic deformation display device of claim **17**, wherein the rotation parameters include one or more of: a speed, a magnitude, a torque, or a rotational angle.

19. The haptic deformation display device of claim **15**, wherein a shape of the arm defines the movement of the deformation component.

20. The haptic deformation display device of claim **15**, the processor further configured to:

activate the actuator at a plurality of intervals, thereby causing the shape of the haptic deformation display device to deform at each interval.

21. The haptic deformation display device of claim **15**, wherein the first motion and the second motion are different based on a speed or an angle in which the deformation component and the at least one other deformation component are moved.

22. The haptic deformation display device of claim **21**, wherein the first motion and the second motion at least partially generate a waveform effect.

23. The haptic deformation display device of claim **22**, wherein the haptic deformation display device is communicably coupled to at least one other device, and wherein the received input signal originates from the at least one other device such that the at least one other device causes the device to deform into the second shape configuration.

24. The haptic deformation display device of claim **23**, wherein the at least one other device is at least one or more of: a computing device executing an application, a second haptic deformation display device, and a cellular device.

25. The haptic deformation display device of claim **22**, wherein the haptic deformation display device includes at least one sensor, the processor further configured to:

receive a sensory input from the at least one sensor, wherein the received input signal is based on the sensory input.

26. The haptic deformation display device of claim **25**, wherein the sensory input originates from at least one of: a user of the haptic deformation display device and at least one other device.

27. The haptic deformation display device of claim **25**, wherein the actuator includes the at least one sensor.

28. The haptic deformation display device of claim **25**, the at least one sensor further configured to:

cause the sensory input to be transmitted to at least one other device.

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