[0043] Handle **504** may also include a shape changing haptic mechanism **510**. Depending on the application, shape changing haptic mechanism **510** can macroscopically change its physical dimension to fit with a user's hand or to simulate a different type of racket. In other embodiments, device **500** can be configured to one of various types of gaming apparatus capable of emulating one of various types of ball games, such as a tennis match, a racquetball match, a table tennis match, a hockey game, a lacrosse game, and other types of ball games.

[0044] FIG. **6** is a logic block diagram illustrating an example of control structure **610** for a shape changing device in accordance with embodiments of the present invention. In one example, an operating mode detector **612** receives various operating mode signals or other indicators from various modules in, or associated with, the device. A processor or controller **614** can receive indications of a detected mode from a communication module or detector **612**, as well as information from predetermined states and patterns **618**.

[0045] Such predetermined states can include any device operating mode, application, and/or condition, in which a kinesthetic, shape change, and/or haptic effect is to be enacted in response thereto. Such effects or shape changes have corresponding patterns associated therewith, and an associated pattern can be recalled from storage (e.g., using any suitable memory device or elements). Activated control signals can then be supplied to haptic substrate **616** such that the appropriate pattern can be formed and enacted in a housing or flexible surface **620**, as discussed above.

[0046] FIG. **7** is a flow diagram showing an example method **100** of controlling a deformable surface for a device in accordance with embodiments of the present invention. A device operating mode can be detected (**104**). A comparison can be made to determine if the device operating mode matches any predetermined states (**106**). When the detected operating mode or application matches a predetermined device state (**108**), appropriate activation control signals can be asserted in a haptic mechanism (**110**). In response, a flexible surface can be changed to enact a predetermined kinesthetic effect (**112**).

[0047] FIG. **8** illustrates a handheld device **800** capable of providing haptic effects in accordance with various embodiments of the present invention. In particular, handheld device **800** is capable of providing vibrotactile effects, kinesthetic effects, and/or force effects. As illustrated, handheld device **800** provides a deformation **830** or stretch effect in a middle portion **810** of handheld device **800** which may be used to provide various kinesthetic effects and/or deformation effects. Further, force effects or vibrotactile effects **820**, **822** may be provided at a rear portion **812** of handheld device **800** and/or at a front portion **814** of handheld device **800**. Other effects and arrangements may be used. In some embodiments of the invention, handheld device **800** is a gaming controller. Handheld device **800** in one embodiment further includes a sensing mechanism (not shown) that in one embodiment provides six degrees of freedom sensing.

[0048] FIG. **9** illustrates various haptic effects that may be provided in, for example, a gaming environment, via handheld device **800** of FIG. **8** in accordance with various embodiments of the present invention. As illustrated, handheld device **800** uses various haptic effects to simulate a gaming object **910** (e.g., a ball) impacting a gaming surface **920** (e.g., a string or an elastic band) during various impact regions **900**. As illustrated, impact regions **900** include a pre-impact region **900**A, an impact region **900**B, an initial deformation or stretch region **900**C, a maximum deformation region **900**D, a final deformation region **900**E, and a release region **900**F.

[0049] For example, as illustrated in FIG. **9**, a ball falls during pre-impact region **900**A and lands on an elastic band during impact region **900**B. During deformation regions **900**C-E, the elastic band stretches to a maximum at which point the ball changes direction and is bounced back up. The ball is released from the elastic band during release region **900**F and then moves upwardly away from the elastic band. Other impact regions may be included. Further, other deformation profiles may be used to simulate different gaming surfaces **920** (e.g., rackets, bats, golf clubs, etc.).

[0050] In the example of FIG. **9**, the user experiences the initial contact of the ball with the elastic band via a force effect, the catch and stretch via a deformation effect, and the release with another force effect. A sensing device in the handle of device **800** can be synchronized with the force and deformation haptic effects so that they are generated when the user is swinging the device, or crossing a plane, for example. In pre-impact region **900**A, no force effects or deformation effects are used. In impact region **900**B, one or more force effects **820**, **822** are used to simulate the impact of gaming object **910** with gaming surface **920**. In initial deformation region **900**C, an initial deformation effect **830** may be used to simulate an initial stretch or pulse associated with the impact of gaming object **910** by gaming surface **920**. In maximum deformation region **900**D, a maximum deformation effect may be used to simulate a maximum stretch or pulse associated with the impact of gaming object **910** by gaming surface **920**. In final deformation region **900**E, a final deformation effect may be used to simulate a final stretch or pulse associated with the impact of gaming object **910** by gaming surface **920**. In release region **900**F, one or more force effects **820**, **822** may be used to simulate a release of gaming object **910** from gaming surface **920**. In a post-impact region, no force effects or deformation effects are used. Various combinations of force effects and/or deformation effects, as well as vibrotactile effects or other haptic effects, may be used.

[0051] As illustrated in FIG. **9**, deformation effects correspond to haptic effects having predominately low frequency components in the range of less than 5 Hz. In contrast, force effects correspond to haptic effects having predominately medium frequency components in the range of approximately 30 Hz while frequencies in the range of 15 Hz to 80 Hz may be used.

[0052] A combination force and deformation effects may be used in various forms of gaming. For example, when swinging a device that simulates a tennis racket or baseball bat, force is felt on the grip, and a slight deformation can be felt as part of the return force. For a boxing game, force and deformation can be felt when colliding with an opponent. For catching a ball, deformation can be used to simulate the feeling of catching or releasing a ball in the user's hands.

[0053] FIG. **10** illustrates an example input signal **1010** and a haptic output **1020** that may be used to simulate a force effect **820**, **822** in accordance with various embodiments of the present invention. Input signal **1010** is provided to drive a haptic actuator which in turn responds by providing haptic output **1020**. More particularly, input signal **1010** may include a pulse **1012** having a magnitude, M (which depends on a variety of factors as would be apparent), and a duration or pulse width, d (e.g., 70 ms). Input signal **1010** may include a square wave pulse, a sawtooth pulse, a semi-sinusoidal pulse, or other type of pulse. Pulse **1012** drives the haptic actuator