METHODS AND SYSTEMS FOR PROVIDING HAPTIC CONTROL

[0001] The present disclosure is directed towards haptic controls. More particularly, the present disclosure is directed, in some embodiments, towards multi-tiered haptic controls.

BACKGROUND

[0002] Tactile feedback systems provide a user with the ability to interact with a subsystem through touch or contact. Haptic systems facilitate these tactile interactions by using actuators, sensors, or both. Haptic systems are commonly used in robotics, video games (e.g., "rumbling" as used in some video game controllers), and other interactive systems which allow interaction via touch. An array of haptic elements is commonly used to provide touchscreen technology to users.

[0003] The scale of the haptic elements used affects tactile feedback. Large elements may be capable of achieving larger displacements and forces relative to smaller elements while sacrificing resolution. Small elements may be able to provide finer resolution for haptic response, relative to larger elements, but may sacrifice displacement and force. It would be desirable to provide a haptic system that is capable of providing sufficient displacements and forces at acceptable resolutions for haptic response.

SUMMARY

[0004] This disclosure relates to systems and methods for providing haptic response. The disclosed haptic response approaches may be implemented using any suitable software, hardware, or both. In some embodiments, the disclosed haptic response approach may use one or more arrays of shape change elements to provide a wide range of tactile feedback. Each shape change element, in each array, may be coupled to a control circuit, which may use any suitable type of control signal for actuation, sensing, feedback, or suitable combinations thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a diagram of illustrative shape change elements in accordance with some embodiments of the present disclosure;

[0006] FIG. **2** is a diagram of an illustrative un-activated shape change element in accordance with some embodiments of the present disclosure;

[0007] FIG. **3** is a diagram of an illustrative activated shape change element in accordance with some embodiments of the present disclosure;

[0008] FIG. **4** is a diagram of an illustrative shape change element affixed at each end in accordance with some embodiments of the present disclosure;

[0009] FIG. **5** is a diagram of an illustrative activated shape change element in a bending mode in accordance with some embodiments of the present disclosure;

[0010] FIG. **6** is a schematic diagram of illustrative shape change elements and a control system in accordance with some embodiments of the present disclosure;

[0011] FIG. **7** is a diagram of an illustrative elastic sheet in accordance with some embodiments of the present disclosure;

[0012] FIG. **8** is a schematic diagram of an illustrative user device in accordance with some embodiments of the present disclosure;

[0013] FIG. **9** is a diagram of an illustrative portable user device in accordance with some embodiments of the present disclosure;

[0014] FIG. **10** shows an illustrative top plan view of a tiered haptic system in accordance with some embodiments of the present disclosure;

[0015] FIG. **11** shows an illustrative cross-sectional view of the elements of FIG. **10**, taken from line XI-XI, in accordance with some embodiments of the present disclosure;

[0016] FIG. **12** shows an illustrative cross-sectional view of a tiered haptic system with similar arrays in accordance with some embodiments of the present disclosure;

[0017] FIG. **13** shows an illustrative cross-sectional view of a tiered haptic system with varied haptic element orientation in accordance with some embodiments of the present disclosure;

[0018] FIG. **14** shows an illustrative cross-sectional view of a tiered haptic system with multiple arrays in accordance with some embodiments of the present disclosure;

[0019] FIG. **15** shows an illustrative cross-sectional view of a tiered haptic system with a contoured display in accordance with some embodiments of the present disclosure;

[0020] FIG. **16** shows an illustrative cross-sectional view of a tiered haptic system with a flat display receiving tactile stimuli in accordance with some embodiments of the present disclosure;

[0021] FIG. **17** shows an illustrative cross-sectional view of a tiered haptic system with contoured display receiving tactile stimuli in accordance with some embodiments of the present disclosure;

[0022] FIG. **18** shows an illustrative cross-sectional view of an embedded haptic system with a flat display in accordance with some embodiments of the present disclosure;

[0023] FIG. **19** shows an illustrative cross-sectional view of an embedded haptic system with a contoured display in accordance with some embodiments of the present disclosure;

[0024] FIG. **20** shows an illustrative cross-sectional view of an embedded-tiered haptic system with a flat display in accordance with some embodiments of the present disclosure;

[0025] FIG. **21** shows an illustrative cross-sectional view of an embedded-tiered haptic system with a contoured display in accordance with some embodiments of the present disclosure;

[0026] FIG. **22** is a flow diagram of illustrative steps for providing haptic feedback in accordance with some embodiments of the present disclosure; and

[0027] FIG. **23** is a flow diagram of illustrative steps for altering displayed content in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0028] The present disclosure is directed to systems and methods for providing layered haptic controls. Haptic systems may be used for actuation such as vibration, shape change (e.g., contouring a flat surface), or other suitable actuations or combination of actuations which may provide tactile feedback to a user. Haptic systems may also be used for sensing stimuli such as, for example, contact on a display screen, patterns of contact on a screen, shape changes, physical changes of a system or component, or other suitable stimuli or combinations of stimuli which may be received.