

surface in order to create a shape change. In so doing, the topography of the user interface can be selectively changed.

**[0072]** In some embodiments, the user interface **10** can change topography in conjunction with a user interface state, thereby providing different physical layouts of the user interface. For example, the user interface can change its topography to have a certain physical layout when used for a phone mode and can change its topography to have another certain physical layout when used for a media player mode. As should be appreciated, many different physical layouts can be used for any number of modes of a device. In addition, a particular topography can remain static during a particular mode to provide a particular tactile feel. Alternatively, the topography can dynamically change during a particular mode to provide a variety of tactile feels.

**[0073]** In some embodiments, rather than change in conjunction with a user interface state, the user interface **10** can change topography in conjunction with a user input, such as a touch, near touch, or press event. For example, the location proximate to the touch can be altered, in some cases continuously, during a touch event. For example, as a user slides a finger across the surface or presses a finger down on the surface, the node closest to the finger can alter while the remaining nodes do not. This can be implemented with a touch sensing device. For example, a controller can monitor the touch sensing nodes and alter the shape changeable nodes based on the location of the nodes that detect a touch, near touch, or press.

**[0074]** Rows and columns or matrices of shape changeable nodes **12** can cooperate to change topography of a user interface. For example, individual nodes can be altered to create distinct pixel shape changes at the user interface surface. Alternatively, nodes can be altered together to form a larger area or a group of pixel shape changes at the user interface surface.

**[0075]** Various components, e.g., a changeable surface and/or a plurality of changeable parts, can comprise the shape changeable nodes of the user interface according to embodiments of the invention. For example, the surface of the shape changeable nodes can comprise individual nodes that can be altered individually by underlying movable or deformable parts. Alternatively, the surface of the shape changeable nodes can comprise a flexible membrane that can be stretched and retracted at designated node locations by underlying movable or deformable parts. This can keep the nodes hidden from view until they can be activated, for example, if the flexible membrane is substantially opaque. Alternatively, the surface of the shape changeable nodes can comprise a shape changeable membrane that can expand and contract when stimulated by an electrical or magnetic signal or by chemical stimulus.

**[0076]** Movable or deformable parts can underlie the node surface. For example, electromechanical devices, e.g., micro actuators, microelectromechanical devices, or piezoelectronics, can have movable physical components that move up and down when stimulated by a mechanical force or an electrical or magnetic signal, thereby moving the overlying surface. The electromechanical devices can be placed adjacent to individual nodes or to certain locations of the flexible membrane. Alternatively, shape changeable material, e.g., shape memory material, magnetic material, or electrostatic material, can expand or contract when stimulated by an electrical or magnetic signal or chemical stimulus, thereby moving the over-

lying surface. The shape changeable material can be placed adjacent to individual nodes or to certain locations of the flexible membrane.

**[0077]** The shape changeable nodes will be described in more detail herein later.

**[0078]** In the example of FIG. 2, user interface **20** can include shape changeable surface **21** having shape changeable nodes **22**. Shape changeable nodes **22-b** can be individually selectively altered to raise regions at the user interface surface **21**, while shape changeable nodes **22-a** can remain unaltered in the original surface. In the example of FIG. 3, user interface **30** can include shape changeable surface **31** having shape changeable nodes **32**. Inner shape changeable nodes **32-b** can be collectively selectively altered to raise regions at the user interface surface **31**, while outer shape changeable nodes **32-a** can remain unaltered in the original surface. In some embodiments, the altered state can be created by a moving element. In some embodiments, the altered state can be created by a deformable element. In some embodiments, the altered state can be created by a shape changeable element. All or portions of the surface can be selectively raised and/or lowered to change topography. In one embodiment, all or a portion of the surface can be raised. In another embodiment, all or a portion of the surface can be lowered. In yet another embodiment, some portions of the surface can be raised while other portions can be lowered. By way of example, individual button(s) can be formed and/or a wheel, e.g., a scroll wheel with an outer scroll ring and a central button, can be formed in the surface by selectively raising and/or lowering different portions of the surface.

**[0079]** Although the shape changeable nodes can be described herein in terms of an orthogonal array of nodes having rows and columns, it should be understood that embodiments of this invention are not limited to orthogonal arrays, but can be generally applicable to nodes arranged in any number of dimensions and orientations, including diagonal, concentric circle, three-dimensional, and random orientations.

**[0080]** Although FIGS. 1 through 3 show the user interface as a planar surface, it is to be understood that the surface can embody various forms, including three-dimensional forms. For example, the initial surface can be contoured to devices having various known shapes, such as a mouse and the like.

**[0081]** It should be further understood that the shape changeable nodes are not limited to rectangles, but can take various forms, such as circles, ovals, irregular shapes, and the like, and sizes and can work together to form different forms and contoured portions at the surface. The shapes can be somewhat dependent on the resolution. The nodes can be associated with points or pixels as well as areas or regions.

**[0082]** A user interface having changeable topography can be associated with a touch sensitive device, such as a touch pad or a touch screen. As such, each shape changeable node of the user interface can be associated with one or more touch sensing nodes of a touch surface of the touch sensitive device. In the case of the touch screen, each shape changeable node can also be associated with one or more display pixels of the touch screen display. The resolution of the shape changeable nodes, the touch sensing nodes, and the display pixels can be the same or different. In some embodiments, the nodes and pixels can have a 1:1:1 relationship in both size and placement. In other embodiments, the relationship can be something other than 1:1:1. For example, it can be such that the resolution of the shape changeable nodes can be large com-