[0148] FIG. **24** illustrates a side view of an exemplary user interface that can change topography using shape changeable nodes according to embodiments of the invention. In the example of FIG. **24**, user interface **240** can include a plurality of selectable shape changeable nodes **248** spread about a surface **241**. The surface **241** can be made of a membrane of flexible or deformable material, e.g., elastic, silicone, soft plastic, or materials that can temporarily deform into a discrete shape or form before returning to its original shape or form, with a front side that can receive a touch and a back side opposite the front side that can receive change from the nodes **248**. The nodes **248** can be disposed adjacent to the back side of the surface **241**, where each node **248** can be proximate to a particular deformable region of the surface. In some cases, the nodes **248** can be coupled, while in other cases they can be separate from the membrane.

[0149] In one example, the change in the surface **241** can be driven by shape changeable actuators that form the shape changeable nodes **248**.

[0150] In some embodiments, the actuators can be made up of shape changeable material (symbolically illustrated by the circles in FIG. **24**), such as nitinol, piezocrystals, and other suitable such material, that can elongate, shrink, or rotate to change shape. Generally speaking, shape changeable materials change their shape upon a stimulus. The stimulus can be electrical current, heat, magnetic, light, pressure, and the like. In one example, the shape changeable material can have a transformation temperature at which the material can transform from a predetermined original shape into a predetermined new shape. The transformation temperature can generally be above room temperature such that, upon heating, the material can transform into the new shape. Heating can be supplied by electrical current. When the electrical current passes through the material, the current can generate enough heat to heat the material to the transformation temperature, thereby causing the transformation. Conversely, when the electrical current is terminated, the material can cool to room temperature and transform back to its original shape. Alternative stimuli, e.g., magnetic energy, light, heat, etc., can also be used to heat the shape changeable material. This stimuli can also be used directly instead of heating.

[0151] FIG. **28** illustrates an exemplary shape changeable node that can be used as a shape changeable actuator for changing topography of a user interface according to embodiments of the invention. In the example of FIG. **28**, actuator **288** (or shape changeable node) can have an initial unstimulated shape. In a stimulated state, the actuator **288** can elongate, stretch, raise, extend, or the like (see actuator **288**-*a*) to push against the corresponding deformable region of the surface **241** of FIG. **24** to deform that region into a discrete shape or form above the initial surface (e.g., stretches the surface). Here, the shape changeable material of the actuators can be formulated to have two shapes—an initial shape and an elongated shape. During stimulation, an electrical current, heat or other stimulus can be applied to the actuator such that the actuator elongates to form the actuator **288**-*a* in an elongated shape. Similarly, in a stimulated state, the actuator **288** can shorten, retract, lower, retreat, or the like (see actuator **288**-*b*) to pull away from the corresponding deformable region of the surface **241** of FIG. **24** to deform that region into a discrete shape or form below the initial surface. Here, the shape changeable material of the actuator **288** can be formulated to have two shapes—an initial shape and a shortened shape. During stimulation, an electrical current, heat or other stimuli can be applied to the actuator **288** such that the actuator shortens to form the actuator **288**-*b* in a shortened shape. In some embodiments where the shape changeable material of the actuator can be formulated to have three shapes—an initial shape, an elongated shape, and a shortened shape, the actuator can have different stimuli at which the respective transformations occur. Alternatively, the actuator can have the same stimulus applied in different amounts to produce the respective transformations.

[0152] FIG. **29** illustrates another exemplary shape changeable node that can be used as a shape changeable actuator for changing topography of a user interface according to embodiments of the invention. In the example of FIG. **29**, actuator **298** (or shape changeable node) can have an initial unstimulated shape. In a stimulated state, the actuator **298** can shift, rotate, tilt, or the like to push against the corresponding deformable region of the surface **241** of FIG. **24** to deform that region into a discrete shape or form above the initial surface. Here, the shape changeable material of the actuator **298** can be formulated to have two shapes—an initial shape and an upright shape. During stimulation, a stimulus can be applied to the actuator such that the actuator can shift, rotate, tilt, or the like to form state **298**-*a*. The amount that the actuator **298** changes shape can be controlled by the amount of stimulus, e.g., electrical current, applied to the actuator according to the user interface state.

[0153] Referring again to FIG. **24**, in some embodiments, each deformable region of the surface **241** can deform into a discrete shape or form above the initial surface when the region's corresponding actuator **248** is selected to provide a force to push against the back side of the region and can deform into a discrete shape or form below the initial surface when the actuator provides a force to pull away from the back side of the region. In some embodiments, where the actuators **248** have "push against" change, each deformable region can deform into a discrete shape or form above the initial surface **241** when the region's corresponding actuator pushes against the back side of the region and otherwise remain undeformed in the initial surface. In some embodiments, where the actuators **248** have "pull away" change, each deformable region can deform into a discrete shape or form below the initial surface **241** when the region's corresponding actuator pulls away from the back side of the region and otherwise remain undeformed in the initial surface.

[0154] In some embodiments (as shown), the alterable regions of the surface **241** can be configured to form a matrix grid of rows and columns. It is to be understood, however, that the surface configuration is not so limited, but can include other suitable configurations. Similarly, in some embodiments (as shown), the changeable actuators **248** can be configured to form a matrix of rows and columns corresponding to the matrix grid of the surface's alterable regions. It is to be understood, however, that the actuators' configuration is not so limited, but can include other suitable configurations, including other resolutions.

[0155] In some embodiments, the actuators **248** can additionally carry input signals between the surface **241** and other components of the user interface **240**. For example, the actuators **248** can carry touch signals from the surface **241** to the device processor to be processed and can carry display signals from the processor to the surface for display.

[0156] In alternate embodiments, the shape changeable actuators **248** can be electromechanical devices such as micro actuators, microelectromechanical (MEM) devices, piezo-