from a user, the bottom surface of insulated layer **806** is placed adjacent to the top surface of haptic layer **812**. The bottom surface of haptic layer **812** is, in one embodiment, placed adjacent to a display (not shown in FIG. **8**), wherein haptic layer **812** and insulated layer **806** may be substantially transparent thereby objects or images displayed in the display can be seen through haptic layer **812** and insulated layer **806**. It should be noted that insulated layer **806** may be flexible whereby it is capable of providing desirable relief information on its surface.

Haptic layer **812**, in one embodiment, includes a grid of haptic cells **802**, wherein each cell **802** further includes a permanent magnet **804**, an electro magnet **810**, and two springs **808**. Haptic layer **812** is similar to haptic layer **612** shown in FIG. **6**(*a*) except that haptic layer **812** employs resonant devices while haptic layer **612** uses MEMS pumps. Haptic cell **802**, in one embodiment, uses a resonant mechanical retractable device to generate haptic effects. The resonant mechanical retractable device vibrates in response to a unique frequency, which could be generated by a side mounted resonant stimulator **816** or a rear mounted resonant stimulator **814**. A resonant grid, in one embodiment, is used to form a haptic layer **812**. Each cell **802** is constructed using resonant mechanical elements such as linear resonant actuator or MEMS springs. Each cell **802**, however, is configured to have a slightly different resonant frequency and a high Q (high amplification at resonance and a narrow resonant frequency band). As such, each cell **802** can be stimulated using mechanical pressure waves originating at the edges of the sheet. The haptic effects can also be generated by a piezoelectric or other high bandwidth actuator.

Cell **802**, in another embodiment, includes one spring **808**. In yet another embodiment, cell **802** includes more than two springs **808**. Each spring **808** is configured to respond to a specific range of frequencies thereby each spring **808** can produce a unique haptic sensation. As such, a grid of haptic cells using various resonant devices may be used to control the surface texture of touch sensitive surface of the interface device. For example, if the displacement of haptic mechanism is sufficiently high such as 200 micrometers or greater, the movement (or tactile vibration) with low frequencies such as 50 Hz or less should sufficiently create desirable relief information.

The exemplary embodiment(s) of the present invention includes various processing steps which will be described below. The steps of the embodiments may be embodied in machine or computer executable instructions. The instructions can be used to cause a general purpose or special purpose system or controller, which is programmed with the instructions, to perform the steps of the embodiment(s) of the present invention.

FIG. **9** is a flowchart **900** illustrating a process of generating haptic feedback using multi-actuated waveform phasing in accordance with one embodiment of the present invention. At block **902**, the process monitors a flexible surface or touch surface in accordance with a set of predefined parameters or events. For example, the process is capable of sensing a contact, movement, predefined temperature, light, and/or a predefined audible sound.

At block **904**, the process detects an interaction on the flexible surface in response to an event. For example, the process is able to sense or detect a depression by a pointed object on the flexible surface. It should be noted that the pointed object can be a finger, a stylus, a pen, or the like.

At block **906**, the process is capable of determining a location of the contact on the flexible surface in response to the interaction. In one embodiment, the process is capable of identifying physical coordinates of a contact point with respect to the flexible or touch surface. For example, the process translates the location of contact point into a two-dimensional coordinating system such as x-axis and y-axis.

At block **908**, the process is able to calculate a first distance from a first haptic actuator to the location and a second distance from a second haptic actuator to the location. It should be noted that some distances are used for generating haptic feedback while other distances are utilized for reducing unwanted haptic effect.

At block **910**, the process activates the first haptic actuator in response to the first distance and the second haptic actuator in response to the second distance to generate haptic feedback at the location of the interaction. A haptic wave capable of traveling via a medium of a flexible surface is initiated to generate haptic feedback at the first location when the haptic wave reaches the location. In one aspect, upon calculating a third distance from a third haptic actuator to the location and a fourth distance from a fourth haptic actuator to the location, a third haptic actuator is activated in response to the third distance and a fourth haptic actuator is activated in response to the fourth distance. Note that the third and fourth actuators are used to cancel or reduce any unwanted haptic effect on the flexible surface. In another aspect, upon detecting a second interaction on the flexible surface, the process determines a second location of the second interaction on the flexible surface in response to the second interaction. After calculating a fifth distance from a fifth haptic actuator to the second location and a sixth distance from a sixth haptic actuator to the second location, the process activates the fifth haptic actuator in response to the fifth distance and the sixth haptic actuator in response to the sixth distance for providing haptic feedback at the second location. In another embodiment, after calculating a seventh distance from a seventh haptic actuator to the second location of the second interaction, the process is able to activate the seventh haptic actuator in response to the seventh distance for minimizing unwanted haptic effect on the flexible surface.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that, based upon the teachings herein, changes and modifications may be made without departing from this invention and its broader aspects. Therefore, the appended claims are intended to encompass within their scope of all such changes and modifications as are within the true spirit and scope of the exemplary embodiment(s) of the present invention.

What is claimed is:

**1**. A haptic device, comprising:

a touch surface configured to sense a first event;

a first plurality of haptic actuators coupled to the touch surface, each of the first plurality of haptic actuators configured to generate at least one haptic waveform pulse to provide haptic feedback to the touch surface in response to the first event; and

a second plurality of haptic actuators coupled to the touch surface, each of the second plurality of haptic actuators configured to generate at least one canceling haptic waveform pulse to minimize unwanted haptic effects on the touch surface in accordance with the first event.

**2**. The device of claim **1**, further comprising a haptic sensor coupled to the touch surface and configured to sense the first event, wherein the haptic sensor calculates a distance between at least one of the haptic actuators and a location of the first event.