

[0019] FIG. 11 illustrates a method employing impulse reconstruction in accordance with an embodiment of the present invention;

[0020] FIG. 12 illustrates a method employing impulse reconstruction and touch location confirmation in accordance with an embodiment of the present invention;

[0021] FIG. 13 illustrates a method of performing impulse reconstruction in accordance with an embodiment of the present invention;

[0022] FIG. 14 illustrates a method of performing impulse reconstruction and touch location confirmation in accordance with an embodiment of the present invention;

[0023] FIG. 15 shows a touch sensitive device with which methodologies involving impulse reconstruction and touch location verification may be implemented in accordance with embodiments of the present invention;

[0024] FIG. 16 is a graphical representation of a touch sensitive plate with dimensions indicated and a marker indicating the location of contact to the plate by a finger;

[0025] FIG. 17 shows traces of pickup signals for four sensors responsive to the contact shown in FIG. 16;

[0026] FIG. 18 shows traces of impulse reconstructed data corresponding to the raw data shown in FIG. 17;

[0027] FIG. 19 shows the touch sensitive plate of FIG. 16 with the addition of a marker indicating a shifted contact location for purposes of simulating an error;

[0028] FIG. 20 shows traces of the four pickup signals implicated in FIG. 19 that have been subject to impulse reconstruction and touch location verification in accordance with the present invention, the reconstructed impulses verifying the error simulated in FIG. 19;

[0029] FIG. 21 shows a touch sensitive plate mounted to an LCD assembly, and a marker indicating a false point returned by the touch location determination algorithm resulting from a touch to the bezel of the LCD assembly;

[0030] FIGS. 22 and 23 show traces of pickup signals and reconstructed impulses, respectively, resulting from the bezel touch event depicted in FIG. 21;

[0031] FIGS. 24, 25, and 26 show contact location, pickup signals, and reconstructed impulses, respectively, resulting from a touch event with a stylus;

[0032] FIG. 27 illustrates a measurement of impulse synchronicity as applied to the data shown in FIG. 18 in accordance with an embodiment of the present invention;

[0033] FIG. 28 illustrates a measurement of impulse synchronicity as applied to the data shown in FIG. 20, when the reported touch is inaccurate, in accordance with an embodiment of the present invention;

[0034] FIG. 29 illustrates a measurement of impulse synchronicity as applied to the bezel touch data shown in FIG. 22 in accordance with an embodiment of the present invention;

[0035] FIG. 30 shows a touch sensitive plate and the location of two contacts of different strength;

[0036] FIG. 31 shows pickup signals corresponding to the two contacts depicted in FIG. 30; and

[0037] FIG. 32 shows impulse reconstructed signals corresponding to the two contacts depicted in FIG. 30.

[0038] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It is to be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[0039] In the following description of the illustrated embodiments, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration, various embodiments in which the invention may be practiced. It is to be understood that the embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

[0040] The present invention relates to touch activated and user interactive devices that sense vibrations that propagate along a touch substrate for sensing by a number of touch transducers. Embodiments of the present invention are directed to structures and techniques for reconstructing an impulse generated by a contact or touch to a touch sensitive medium, and, in particular, a dispersive medium. Embodiments of the present invention are also directed to structures and techniques for confirming a location of a contact or touch to a touch sensitive medium. Further embodiments of the present invention are directed to structures and techniques that provide for improved touch detection and location determination. Such enhancements include, but are not limited to, improved rejection of spurious touches to the casing or support structure of a touch sensitive device, improved z-axis or contact strength determinations, improved accuracy in determining touch location in the presence of ambiguity or noise, improved identification of contact implement type and related properties, and improved rejection of spurious contact data generated by background acoustic noise, either airborne or structural.

[0041] The impulse reconstruction techniques described herein are useful in touch sensing apparatuses of varying configurations. For example, the techniques involving impulse reconstruction of the present invention may be employed in touch sensitive apparatuses that employ as few as three pickup sensors. The impulse reconstruction techniques of the present invention may also be employed in touch sensitive apparatuses that employ four or more pickup sensors, such as a configuration in which a pickup sensor is positioned at each of the four corners of a rectangular-shaped touch sensitive plate, for example. The techniques involving impulse reconstruction of the present invention may further be employed in touch sensitive apparatuses that employ a number of pickup sensors and at least one excitation transducer.

[0042] It is noted that, in a configuration that incorporates an excitation transducer in addition to several pickup sensors, the excitation transducer may or may not directly participate in the processes of impulse reconstruction. For example, an excitation transducer according to one embodi-