TOUCH SENSITIVE DEVICE EMPLOYING IMPULSE RECONSTRUCTION

FIELD OF THE INVENTION

[0001] The present invention relates to vibration sensing touch sensitive devices and, more particularly, to techniques for reconstructing an impulse originally generated by a contact or touch to a dispersive medium.

BACKGROUND

[0002] Interactive visual displays often include some form of touch sensitive screen. Integrating touch sensitive panels with visual displays is becoming more common with the emergence of next generation portable multimedia devices. One popular touch detection technology, referred to as Surface Acoustic Wave (SAW), uses high frequency waves propagating on the surface of a glass screen. Attenuation of the waves resulting from contact of a finger with the glass screen surface is used to detect touch location. SAW employs a "time-of-flight" technique, where the time for the disturbance to reach the pickup sensors is used to detect the touch location. Such an approach is possible when the medium behaves in a non-dispersive manner, such that the velocity of the waves does not vary significantly over the frequency range of interest.

SUMMARY OF THE INVENTION

[0003] The present invention is directed to apparatuses and methods for reconstructing an impulse generated by a contact or touch to a touch sensitive medium. The present invention is also directed to apparatuses and methods for confirming a location of a contact or touch to a touch sensitive medium. According to an embodiment of the present invention, a touch sensitive apparatus includes a touch plate and a number of sensors coupled to the touch plate. Each of the sensors is configured to sense bending waves in the touch plate and, in response to a touch to the touch plate, generate sensor signals. A controller is coupled to the sensors. The controller corrects for dispersion in the sensor signals and determines a location of the touch using the dispersion corrected signals. The controller performs impulse reconstruction, by which impulses representative of impulses generated by the touch to the touch sensitive device are produced. Using the reconstructed impulses, the controller confirms the location of the touch.

[0004] According to another embodiment, a method for use with a touch sensitive device involves generating, in response to a touch to the touch sensitive device, sensor signals that exhibit dispersion. The dispersion in the sensor signals is corrected to produce dispersion corrected signals, and a location of the touch is determined using the dispersion corrected signals. The method further involves reconstructing impulses representative of impulses generated by the touch to the touch sensitive device. Using the reconstructed impulses, the location of the touch may be confirmed. Confirming the location of the touch typically involves assessing similarity of one or more features of the reconstructed impulses. The touch location is considered valid if the reconstructed impulse similarity exceeds a preestablished threshold. The touch location is considered invalid if the reconstructed impulse similarity fails to exceed the preestablished threshold.

[0005] The above summary of the present invention is not intended to describe each embodiment or every implementation of the present invention. Advantages and attainments, together with a more complete understanding of the invention, will become apparent and appreciated by referring to the following detailed description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] **FIG. 1***a* graphically shows an impulse response in an ideal medium with a square root dispersion relation;

[0007] **FIG. 1***b* graphically shows the frequency response of the dispersive impulse response of **FIG. 1***a* obtained by taking the Fourier Transform of the impulse response of **FIG. 1***a;*

[0008] **FIG. 1***c* graphically shows a dispersion corrected transformation of the dispersive frequency response shown in **FIG. 1***b* obtained by warping the frequency axis with the inverse of the touch panel dispersion;

[0009] **FIG. 1***d* shows a non-dispersive impulse response produced by applying the inverse Fast Fourier Transform (FFT) to the trace of **FIG. 1***c*, which has been corrected for dispersion;

[0010] **FIG. 2** illustrates one configuration of a touch sensitive device that incorporates features and functionality for detecting bending wave vibrations in accordance with an embodiment of the present invention;

[0011] **FIG. 3** illustrates another configuration of a touch sensitive device that incorporates pickup sensors and an excitation transducer in accordance with an embodiment of the present invention;

[0012] **FIG. 4** shows a configuration of a touch sensitive device that incorporates an excitation transducer and pickup sensors coupled to buffer circuits in accordance with an embodiment of the present invention;

[0013] **FIG. 5** is a schematic of a buffer circuit configuration suitable for use in the device embodiment shown in **FIG. 4**;

[0014] **FIG. 6** is a sectional view of a touch sensitive device mounted to a display in accordance with an embodiment of the present invention;

[0015] **FIG. 7** is a depiction of a touch panel system that includes a touch sensitive device and a touch panel controller in accordance with an embodiment of the present invention;

[0016] **FIG. 8** illustrates an implementation for processing bending wave information obtained at each of a number of pickup sensors in accordance with an embodiment of the present invention;

[0017] **FIG. 9** illustrates a touch panel system that includes a touch sensitive device mounted to a display and coupled to a touch panel controller and host processor in accordance with an embodiment of the present invention;

[0018] **FIG. 10** shows an embodiment of a touch panel controller communicatively coupled to a touch sensitive device in accordance with the present invention;