frequency response for the non-dispersive case (**FIG. 1***c*) in which the frequency of excitation is proportional to the inverse of the wavelength. This simple relationship translates the periodic variation with decreasing wavelength to a periodic variation with increasing frequency as shown in **FIG. 1***c*.

[**0054**] Applying the inverse Fast Fourier Transform (FFT) to the trace of **FIG. 1***c* produces an impulse response shown in **FIG. 1***d*, which is corrected for dispersion and where the clear reflection is restored. As is shown in **FIG. 1***d*, any particular waveshape of an impulse is preserved in time since the waves travelling in a non-dispersive medium have a constant velocity of travel, independent of their frequency. Accordingly, the task of echo location is relatively straight forward. The outgoing wave **50** is evident at time t=1, together with a clear reflection **52** at 4 ms. The reflection **52** has a magnitude which is approximately one-quarter of the magnitude of the outgoing wave **50**.

[**0055**] It is noted that the procedure described above is not applicable if the impulse has occurred at an unknown time t_0 and the distance x from the response to an initial impulse may only be calculated if the impulse occurs at $t_0=0$. A dispersion corrected correlation function may be employed in situations where the precise time, t_0, at which a contact occurred is not known. According to one approach, a first sensor mounted on a structure capable of supporting bending waves measures a first measured bending wave signal. A second sensor is mounted on the structure to determine a second measured bending wave signal. The second measured bending wave signal is measured simultaneously with the first measured bending wave signal. A dispersion corrected function of the two measured bending wave signals is calculated, which may be a dispersion corrected correlation function, a dispersion corrected convolution function, a dispersion corrected coherence function or other phase equivalent function. The measured bending wave signals are processed to calculate information relating to the contact by applying the dispersion corrected function. Details concerning this approach are disclosed in previously incorporated PCT application 01/48684 and U.S. patent application Ser. No. 09/746,405.

[**0056**] Another approach to correcting for dispersion in bending wave sense signals involves use of an excitation transducer together with pickup sensors disposed at the corners of a touch sensitive plate. According to this approach, a transfer function of the input at the excitation transducer to the output at each of the pickup sensors is determined. This transfer function may be obtained using a number of standard methods. Such known methods include the following: stimulation by a maximum length sequence (MLS) signal and cross-correlation to obtain the impulse response; use of an adaptive filter with a noise-like signal; averaged ratio of complex frequency responses; direct input and measurement of an impulse; and measurement of a linear chirp signal with Time Delay Spectrometry (TDS), among others.

[**0057**] The measured transfer function may be presented in terms of an impulse response, which will generally show dispersion. Dispersion results from the dependence of the bending wave velocity on frequency, which for pure bending is a square root dependence. Previously incorporated U.S. Patent Application Ser. No. 09/746,405 describes a method by which the dispersion of a signal may be corrected by a transformation that interpolates the frequency axis of a transfer function onto a wave vector. Taking the inverse FFT then yields an impulse response as a function of distance, with all frequency components aligned to correct for the effects of dispersion.

[**0058**] If the absolute velocity as a function of frequency is known from knowledge of the material properties of the touch sensitive panel, then the dispersion corrected impulse response may be returned as a function of absolute distance. If, however, this relationship is not known, then an arbitrary scaling of the distance axis still allows useful information to be determined, such as the aspect ratio of the touch sensitive plate. Additional details of this technique are described in commonly owned co-pending U.S. patent application entitled "Touch Sensitive Device Employing Bending Wave Vibration Sensing and Excitation Transducers," filed concurrently herewith under Ser. No. ______ Attorney Docket 59372US002 and incorporated herein by reference.

[**0059**] Turning now to **FIG. 2**, there is illustrated one configuration of a touch sensitive device **10** that incorporates features and functionality for detecting bending wave vibrations. According to this embodiment, the touch sensitive device **10** includes a touch substrate **12** and vibration sensors **16** coupled to an upper surface of the touch substrate **12**. In this illustrative example, the upper surface of the touch substrate **12** defines a touch sensitive surface. Although sensors **16** are shown coupled to the upper surface of the touch substrate **12**, the sensors **16** can alternatively be coupled to the lower surface of the touch substrate **12**. In another embodiment, one or more sensors **16** may be coupled to the upper surface while one or more other sensors **16** may be coupled to the lower surface of the touch substrate **12**.

[**0060**] Touch substrate **12** may be any substrate that supports vibrations of interest, such as bending wave vibrations. Exemplary substrates **12** include plastics such as acrylics or polycarbonates, glass, or other suitable materials. Touch substrate **12** can be transparent or opaque, and can optionally include or incorporate other layers or support additional functionalities. For example, touch substrate **12** can provide scratch resistance, smudge resistance, glare reduction, anti-reflection properties, light control for directionality or privacy, filtering, polarization, optical compensation, frictional texturing, coloration, graphical images, and the like.

[**0061**] In general, the touch sensitive device **10** includes at least three sensors **16** to determine the position of a touch input in two dimensions, and four sensors **16** may be desirable in some embodiments, as discussed in International Publications WO 2003 005292 and WO 0148684, and in U.S. patent application Ser. No. 09/746,405. In the present invention, sensors **16** are preferably piezoelectric sensors that can sense vibrations indicative of a touch input to touch substrate **12**. Useful piezoelectric sensors include unimorph and bimorph piezoelectric sensors. Piezoelectric sensors offer a number of advantageous features, including, for example, good sensitivity, relative low cost, adequate robustness, potentially small form factor, adequate stability, and linearity of response. Other sensors that can be used in vibration sensing touch sensitive devices **10** include electrostrictive, magnetostrictive, piezoresistive, acoustic, and moving coil transducers/devices, among others.