

TOUCH PANEL INPUT DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a touch panel input device for vibrating a movable plate which is pressed, or a support substrate for supporting the movable plate, and generating an input operation feeling for an operator when the operator presses the movable plate. More specifically, the present invention relates to a touch panel input device for using a piezoelectric substrate to vibrate the movable plate or the support substrate.

[0003] 2. Description of the Related Art

[0004] A touch panel input device includes a movable plate and a support substrate which are laminated with a slight gap between them to separate conductor layers on the opposing surfaces of the movable plate and the support substrate. The input device electrically detects a contact between the conductor layers at a pressed position when the movable plate is pressed, and provides information to a processing device such as a personal computer about the pressed position.

[0005] When the movable plate, the support substrate, the conductor layers, and the like are formed of a transparent material, and the touch panel input device is overlaid on a display screen such as a liquid crystal panel or a CRT, a user can press an input operation surface of the touch panel input device while seeing the display through the touch panel input device. The touch panel input device detects the pressed position and provides a processing device such as a personal computer with data on the location of the pressed part corresponding to the display.

[0006] Because the movable plate and the support substrate are laminated with a very small insulation gap between them in this type of a touch panel input device as described above, the stroke for pressing the movable plate is 0.1 to 0.5 mm, which is extremely small. An operator who presses the movable plate has difficulty knowing whether or not an input operation is completed.

[0007] A force feedback type touch panel is known to solve this problem. Such a force feedback type touch panel vibrates the movable plate or the support substrate to generate a tactile feedback to the finger of the operator when the input operation on the touch panel input device is successful.

[0008] Referring to FIG. 8, a conventional touch panel input device 100 includes a movable plate 101 and a support substrate 103. The movable plate 101 is a flexible transparent plastic sheet. The support substrate 103 is made of glass, with a transparent plastic sheet 102 attached on a surface opposing to the movable plate 101. A large number of insulating protrusions 104 hold the movable plate 101 separated from the plastic sheet 102. Together, these elements constitute the touch panel 100A.

[0009] Conductor layers (not shown), made of a uniform resistive coating, cover opposing surfaces of the movable plate 101 and the plastic sheet 102. The conductor layers come in contact with each other, and conduct at a pressed position when a conductive sheet on the movable plate 101 is pressed into contact with the conductive sheet on the support substrate 103. The contact is position is detected

based on voltages between leader electrodes (not shown) electrically connected to peripheral edges of the conductor layers. The voltages provide information about the x and y position of the position that is pressed.

[0010] The support substrate 103 is supported on a plurality of cylindrical cushion pillars 106 affixed to a bottom surface of a housing 105. The cushion pillars 106 are a rubber material on which the entire touch panel 100A is supported. A rubber with a hardness of 50 to 60 is used because the use of a rubber material that is too soft would absorb the pressure on the movable plate 103.

[0011] A display panel 107 is placed in a space formed by the cushion pillars 106 between the support substrate 103 and the housing 105. Parts formed on the support substrate 103 are made of a transparent material to permit display of the display panel 107 seen from above the movable plate 101.

[0012] A piezoelectric actuator 108, formed by laminating multiple piezoelectric substrates made of piezoelectric ceramic or the like, is disposed at one end of the rear side of the support substrate 103. The piezoelectric actuator 108 uses an electrostriction effect to vibrate itself. The piezoelectric actuator 108 serves as a vibration generating source when a drive voltage is applied thereto.

[0013] The piezoelectric actuator 108 has its base end fixed on a support stand 109 and its center rotatably supported by a support shaft 110. A contactor 111 is fixed to the outer end of the piezoelectric actuator 108 in contact with a rear surface of the support substrate 103.

[0014] When a position on the movable plate 101 is pressed for an input operation, the conductor layers come into contact with each other at the pressed position. A pressure detecting means (not shown) detects the pressure and the pressed position, and provides a processing device such as a personal computer with pressed position data.

[0015] When a pressure is detected, a drive voltage is impressed on drive electrodes of the piezoelectric actuator 108. This causes the piezoelectric actuator 108 to vibrate. The vibration is transmitted to the support substrate 103 through the contactor 111 at the end of the piezoelectric actuator 108. A fingertip pressing the movable plate 101 feels the vibration.

[0016] Thus, when an operator who presses the touch panel input device presses the movable plate 101, the operator feels the vibration at the fingertip to confirm that the input operation is conducted.

[0017] While the conventional touch panel input device uses a vibrator such as a piezoelectric actuator or a vibrating motor as a source for generating vibration to vibrate the movable plate 101 and/or the support substrate 103, because the vibration generating source is provided in a space independent to the movable plate 101 or the support substrate 103 constituting the touch panel, the thickness and the size of the housing 105 and thus the size of the entire input device increases. The design of the exterior of the device is also restricted.

[0018] Because the piezoelectric actuator 108 as the vibration generating source has to transmit sensitive vibrations to the touch panel 100A in contact with the piezoelectric actuator 108, the piezoelectric actuator 108 must generate a