TOUCH-SENSITIVE DISPLAY WITH TACTILE FEEDBACK

BACKGROUND OF THE INVENTION

Touch-sensitive displays, or "touchscreens," are used predominantly in so-called touchscreen terminals which can be operated by a user touching the screen with a finger, whereby the keyboard and mouse known from the PC are generally dispensed with.

A confirmation that an input effected by a user has actually taken place is, in general, obtained by means of audiovisual feedback; for example, by means of a beep sound or a change of color of the display area when the display is touched.

Touchscreen terminals are set up at trade fairs, presentations or in the reception areas of companies in order to enable dialog with customers. Touchscreen terminals also can be found at airports and in city centers as information terminals for tourists, and in manufacturing facilities for data entry and control purposes in production processes.

One disadvantage experienced with the above mentioned applications are loud and irregularly occurring ambient noises which occur at airports and in streets and production facilities, with the result that there is a danger of audible feedback being masked by the ambient noises and going unnoticed by the user.

Visual feedback is similarly dependent on ambient influences. For example, direct or reflected sunlight can cause irritation, with the result that the visual feedback does not achieve the desired effect. In addition, situations also occur whereby users obscure areas of the display intended for the visual feedback with their hand.

Furthermore, a touch-sensitive monitor is known from U.S. Pat. No. 4,885,565, in which tactile feedback is initiated when an input is made by a user touching the screen. To this end an oscillating coil is driven in such a way by a microprocessor that it triggers a mechanical stimulus which causes the housing of the monitor to vibrate so that the user can also feel that his/her input has been detected in addition to receiving the audiovisual feedback.

The disadvantage of this solution is that regardless of which input has been made by the user touching the screen, the same tactile feedback always occurs and a differentiation is only possible when taken in conjunction with the audiovisual feedback which is still present as before.

An object to which the present invention is directed is, therefore, to set down a touch-sensitive display with tactile feedback which resolves the disadvantages of the prior art.

SUMMARY OF THE INVENTION

According to the present invention, a touch-sensitive display with tactile feedback has a first mechanically flexible layer which is designed such that it functions as a display, such as, a membrane known as electronic paper, a second layer having at least one receptor, a third layer having at least one controllable actuator, whereby the second layer is disposed in such a way that the receptor detects a contact in at least one section of the first layer and generates at least one first signal, and whereby the third layer is disposed in such a way that the controllable actuator mechanically manipulates the first layer at least in some points of the section, and also a control device which is designed and contacted with the second layer and the third layer in such a way that, in an initial state, at least one second signal for controlling the actuator is generated, whereby at least one modified second signal is generated on the basis of the first signal.

The display according to the present invention enables the detection of a contact with the display via the receptor, whereby a tactile feedback is given directly at the location of the contact, at which (for example, in the case of a virtual keypad represented on the display which can be operated by pressing on the corresponding position of the display), for each of the keys represented in the keypad a tactile delimitation and/or a keyboard label is implemented via an actuator, which is also useful, in particular, with regard to the implementation of a terminal for visually impaired or blind persons. It is conceivable, for example, that the keyboard and labels are displayed for sighted persons while at the same time an output is generated in Braille for blind persons via the actuator beneath the displayed key.

By exercising appropriate control (software), in order to get closer to the impression of a real keyboard it is possible to generate the feeling of the virtual key yielding or locking and it is even possible to simulate a slider control in that a virtual key representing a slider control follows the key being touched or dragged, whereby the surface of a slider control of this type could be generated, in particular, to be rough so as to give a good grip. As a result of the display according to the present invention, the user receives an intuitive level of feedback which offers the user a greater degree of confidence when handling a touch-sensitive display and minimizes or neutralizes the influence of disruptive noise and lighting conditions.

Particularly suitable for use as the first layer are display media which are designed in accordance with the "electronic paper," "microencapsulated electrophoretic display" or "organic electro-luminescence" technologies since these are very thin and, designed as a flexible membrane, yield to mechanical forces, such as are generated by the actuator which, in particular, act in localized fashion on the membrane surface. In this situation, the membrane is designed to be elastic in such a way that it returns to the initial state prior to the effect of the mechanical force as soon as the force effect is removed.

An embodiment of the receptor as a light grid enables the indirect detection of contacts since such a light grid situated just above the first layer simply detects the location at which a user interrupts the light of the grid, with his/her finger for example, in order to touch a virtual key. Furthermore, this embodiment offers the advantage that the second layer is formed by the air, which is limited only by the facilities used to implement the light grid, with the result that the actuator experiences no additional resistance when performing mechanical manipulation in localized fashion and requires little drive energy.

The embodiment of the actuator as a matrix arrangement of electrically and/or magnetically driven pins permits the generation of a roughness and good grip characteristic for the virtual keys, and is particularly suitable for implementation of the output of a text display for blind persons.

A matrix of movable pins lying perpendicular to the display as a receptor is suitable for simulating the locking or yielding to a key depression. The detection of a virtual slider control is also simple to implement with this embodiment since only the state of adjacent pins needs to be checked in order to determine the direction of slider movement.

Arranging pins of the actuator matrix and the receptor matrix in alternation beside one another on the same level (layer) saves space.