MOBILE APPARATUS HAVING TACTILE FEEDBACK FUNCTION

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] The present document is based on Japanese Priority Documents JP2002-018228 and JP2002-209232 filed in the Japanese Patent Office on Jan. 28, 2002 and Jul. 18, 2002, respectively, the entire contents of which being incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an information processing apparatus having user interface, and in particular to a mobile or handheld type apparatus such as PDA (Personal Digital Assistant), mobile phone, remote controls, and etc. More specifically, the present invention relates to a mobile apparatus that can give user tactile feedback through the user interaction, and particularly pertains to a mobile apparatus that can create a variety of tactile patterns without latency and arbitrary shapes.

[0004] The present invention also relates to information processing apparatus that uses pen for data input, such as tablets computers, touch screens and pen input screens.

[0005] 2. Description of the Related Art

[0006] In accordance with recent technological development, various types of computers, such as personal computers (PCs) and personal digital assistants (PDAs) have been developed and are being widely sold and used.

[0007] In general, computers have user input device such as keyboard and mouse, and also include output device such as display, speaker and printer. Through output device, computer can give user sensible feedback so as to guide him to a correct operation.

[0008] However, user may not be aware of visible feedback by display if he does not look at display screen. Phonetic feedback also may be suppressed by noise.

[0009] As computing devices are decreased in size while accommodating more functionality, visual displays are also becoming smaller and using them becomes even more difficult.

[0010] Therefore, as a robust feedback means in any working environment, torque based tactile feedback devices have been proposed. Most of the conventional tactile feedback devices use rotating motors with cams. The tactile feedback is generated from the torque when the motor starts and stops. ((1) Yoshie, M., Yano, H., Iwata., Development of non-grounded force display using gyro moments.(Proceedings of Human Interface Society Meeting. 2001. pp.25-30); (2) Fukui, Y., Nishihara, S., Nakata, K., Nakamura, N., Yamashita, J., Hand-held torque feedback display. (Proceedings of SIGGRAPH01 Abstracts and Applications. 2001. ACM. pp. 192))

[0011] The shortcomings of such feedback device is that:

[0012] 1) They cannot be used into small handheld devices because they require a large mass attached to them.

[0013] 2) They can create only limited variety of the tactile patterns.

[0014] 3) Because of the motor inertia, the tactile bandwidth is slow and that is why they have been mostly used as force back device rather than tactile feedback.

[0015] The conventional vibration motors, which are widely used into many mobile phones, comprise asymmetric shafts or cams that start vibrating after certain delay time. These actuators have very large latency so that they cannot be used in interactive applications. Only sinusoidal patterns of vibration can be generated using the conventional actuators. In other words, they cannot generate arbitrary pattern.

[0016] US published patent application U.S. No. 2002-0149561 discloses various application examples of the tactile feedback using vibration actuators that utilize magnetic or electrostatic force to cause reciprocal movement of weight.

[0017] On the other hand, piezoelectric actuators have been used to directly stimulate the target such as user's hand. However, they generate only local stimulation in a small area of skin, or they use matrix of the piezoelectric actuators (Cholewiak, R. W. and Sherrick, C. E., 1981 A computer-controlled matrix system for presentation to the skin of complex spatiotemproal patterns. Behavioral Research Methods and Instrumentation, 13, 667-673).

[0018] Japanese published patent Application JP 11-212725 discloses examples of the tactile feedback method using piezoelectric elements. The piezoelectric elements are formed in a block shape and placed to directly support a surface member of operation unit by which a user input is accepted. The tactile feedback is presented by feeding a high frequency current to each of the piezoelectric elements.

[0019] Voice coils have also been used to provide tactile feedback. But they also provide only local vibration, they are relatively large and usually allow for vibrations only within the natural resonant frequency of actuator. In other words, they allow only limited signal shapes. (Fukumoto, M., Toshiaki, S., ActiveClick: Tactile Feedback for Touch Panels. (Proceedings of CHI'2001, Extended Abstracts. 2001. ACM. pp. 121-122.))

[0020] There have been a number of matrix based tactile displays that include pins moving and affecting the user hand. Because of the size of such actuators and complexity, they can not be allowed being used into mobile apparatuses (Cholewiak, R. W. and Sherrick, C. E., 1981 A computer-controlled matrix system for presentation to the skin of complex spatiotemproal patterns. Behavioral Research Methods and Instrumentation, 13, 667-673).

[0021] Most of the interaction techniques do not allow for effective tactile to control of a particular portion or single part of the mobile apparatus.

[0022] There were several attempts to develop haptic apparatus for pen-style devices. However, most of these interfaces were based on using external force-producing mechanisms (usually motors) attached to pen. The motion of the pen would be restricted by the motors so when the user was operating the pen he would feel pen resisting user motion. An example is a Phantom haptic device produced by Sensible Technologies or other pen style force feedback