

INTERACTIVE TACTILE DISPLAY FOR COMPUTER SCREEN

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to tactile displays.

[0003] 2. Description of the Related Art

[0004] As the computer industry moves towards user interfaces that are more and more graphically oriented, most users are noticing an improved ease of use. But visually impaired people find graphically oriented computers, automatic teller machines, public information kiosks and the like extremely difficult for them to use, if not outright impossible. This schism between sighted and visually impaired users is even wider with the ever increasing use of touch screen technology, since keyboards or other input devices are no longer required, and the only feedback given to a user is often exclusively visual. A visually impaired user cannot use a conventional touch screen display, since he has no idea where to touch the display to instruct the computer to do what he wants it to do, and cannot receive any sufficient feedback indicating what is happening. The frustration of not being able to perform the routine daily functions of their sighted friends, such as withdrawing money from an automatic teller machine, makes their disability even more unfortunate, both to them personally and to society as a whole.

[0005] In addition, there is an increasing number of computer devices designed for an increasing variety of applications. These devices may vary in their operating system, hardware types, storage and processing capacities, input/output interface standards, physical dimensions, and the like. Accordingly, it is exceedingly expensive to design and build tactile interfaces for each of the vast array of equipment that is on the market. This expense is difficult for manufacturers to justify or recoup in light of the small market for such tactile display devices.

[0006] Furthermore, many of the "Braille" interpreting devices or software are limited to identifying and translating text to provide the equivalent Braille text. Pictures, charts, formatting and other graphical or image information does not survive the translation and is typically not provided to the user.

[0007] Therefore, there is a need for a tactile display device with a functioning touch screen that does not require the user to see an image on the display. It would be desirable if the tactile display device could be used universally with all makes, models, types and sizes of touch screens, without relying upon a particular system or requiring customization from one system to the next. It would be further desirable if the tactile display device could provide a tactile image in addition to text.

SUMMARY OF THE INVENTION

[0008] The present invention provides an apparatus for converting a visual image into a tactile image. The apparatus comprises imaging means for converting incident light from a visual image into electrical signals that are proportional to the gray scale intensity of the incident light. The apparatus also comprises a tactile display device having a two-dimen-

sional array of variable height pixels, wherein the height of each pixel in the tactile display is dynamically variable in proportion to the electrical signals from the imaging means. Preferably, the height of each pixel is inversely proportional to the gray scale intensity of the incident light so that the maximum height of a pixel occurs when a corresponding pixel in the visual image is black. The density and resolution of the pixels in the tactile display device may vary, but the preferred ratio of tactile pixels to visual image pixels is one or less.

[0009] Preferably, the pixels of the tactile display device are pressure-sensitive for allowing touch-screen input. In one such embodiment, the tactile display means comprises: a plurality of individually controlled miniature motors oriented in a grid, wherein each motor is coupled to one of the electrical signals; a plurality of miniature rack and pinion gear assemblies, each of which is operatively connected to one of the miniature motors so that rotational motion of a pinion connected to a shaft of a miniature motor is converted into linear motion of a rack; and a plurality of rods, wherein each rod is connected to one of the racks so that the rods move linearly with the racks. Accordingly, the miniature motors move linearly in a Z dimension that is perpendicular to X and Y dimensions.

[0010] The apparatus of the invention are positioned or secured to a display screen or computer monitor using attachment means for attaching the imaging means in alignment with the display screen. Preferably, the imaging means is compatible with display screens of all many types, such as those displays selected from a cathode ray tube, liquid crystal display, array of light emitting diodes, laser images, projections, and combinations thereof. Most preferably, the display screen forms part of a portable or handheld computer, such as a personal digital assistant.

[0011] The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings wherein like reference numbers represent like parts of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 illustrates preferred system architecture for a computer system suitable for carrying out the present invention.

[0013] FIG. 2 is a block diagram of a portable handheld computing device.

[0014] FIG. 3 illustrates an alternate computer system suitable for carrying out the present invention.

[0015] FIG. 4 is a block diagram of a desktop computing device.

[0016] FIGS. 5A and 5B is a cross-sectional side view of a tactile display secured at a narrow gap from the surface of the touch screen.

[0017] FIGS. 6A-C are side views of a miniature actuator assembly in accordance with one embodiment comprising a rack and pinion gear assembly.

[0018] FIG. 7 illustrates a tactile display having built-in touch sensing means in some or all of the individual pixels