

other surface layers. The inclusion, omission, or nature of these additional layers and components is immaterial to the present invention.

[0041] Touch sensor 202 is connected to touch sensing controller 208. The nature of controller 208 depends on the design of touch sensor 202 and its details are immaterial to the present invention. Likewise, display 204 is connected to a suitable display controller 210, and backlight 206, if present, is connected to backlight controller 212. Each of controllers 208, 210, and 212 communicate with host computer 214. In an illustrative embodiment, controllers 208, 210, and 212 are connected to a central touch screen controller 216 that connects to host computer 214 by a single interface 218. Interface 218 may be a mouse interface such as PS/2, or a general purpose peripheral interface such as the Universal Serial Bus (USB). USB has the advantage of high bandwidth and wide availability. Any of controllers 208, 210, 212, and 216 may be implemented as chips or discrete components, combined onto fewer chips or one chip, integrated with assembly 200, or combined with other functions of host computer 214. Host computer 214 may be embodied in the central processing unit of computer system 100, a peripheral processor such as a USB host controller, or a combination thereof.

[0042] In an alternative illustrative embodiment, controllers 208, 210, and 212 may connect to host computer 214 through different interfaces. For example, touch screen controller 208 could connect as a conventional touch pad using a PS/2 interface, while display controller 210 and backlight controller 212 connect by USB or by a specialized display interface.

[0043] Because touch screen 106 of FIG. 1 replaces a conventional touch pad, touch screen 106 usually serves as a conventional pointing device for the computer. For this reason, the touch screen must be able to interface to the computer as a conventional mouse. This is a further reason for interface 218 to be either a mouse interface such as PS/2, or a general interface such as USB that includes support for conventional mice. Interface 218 may also provide for an alternate or extended interface protocol that allows for additional information about finger activity to be communicated to computer 214, and for computer 214 to control display 204 and backlight 206. This additional finger activity information may include the absolute location of the finger on the sensor surface. When appropriate driver software is loaded onto computer 214, the driver software can enable the alternate or extended interface protocol to support the user interface enhancements of the present invention. When other driver software, such as a conventional mouse or touch pad driver, is loaded instead, interface 218 can revert to mouse or touch pad compatibility using touch sensor 202 as a conventional touch pad, and controller 210 or 216 can operate the display autonomously, such as by furnishing a suitable default display image for display 204.

[0044] When the touch screen is used as a conventional touch pad, finger motions on the touch sensor (e.g., in a cursor positioning region, which could identify a starting position) will typically cause corresponding motions of a cursor on the main display, and clicks of "mouse" buttons (or action control icons) 108 will typically cause special actions, such as selections on the main display. Tapping gestures may be interpreted as "mouse" clicks or other

special actions, as disclosed in U.S. Pat. No. 5,543,591. Other gestures may also be recognized, such as scrolling motions as disclosed in U.S. Pat. No. 5,943,052. The default display image may include graphical icons to indicate special tapping or scrolling regions on the touch sensor surface or the default screen image may be a blank screen with only a manufacturer's logo.

[0045] In one embodiment, the cursor positioning region is denoted by the absence of icons for actions, other than cursor positioning. However, there are many different ways of identifying the cursor positioning region on the touch screen, such examples include, but are not limited to, a box could enclose the cursor positioning region, a shaded region or icon could cover the entire cursor positioning region, or an icon could be centered in an otherwise blank area, thus labeling the blank area as a cursor positioning region.

[0046] FIG. 3 illustrates an example default image for use when the touch screen is operating as a conventional touch pad. FIG. 3 depicts the image on the touch screen display as seen by the user. Image 300 includes arrow icons 302 and 304 indicating scrolling regions, an icon 306 indicating a corner tap region that simulates a right mouse button click, and an icon 308 which represents a logo for the computer vendor.

[0047] Alternatively, computer system 100 of FIG. 1 can include a secondary pointing device, such as an isometric joystick located in keyboard 104 or an external mouse, which relieves touch screen 106 from the responsibility of functioning as primary pointing device in addition to its role as an enhanced user interface device.

[0048] A conventional touch pad with default screen image is just one of several general modes of usage that are envisioned for the touch screen of the present invention. Subsequent drawing figures illustrate several other usage modes that employ the touch screen as a fully interactive input/output device to enhance the user interface of the computer system. These general usage modes include "iconic," "auxiliary," and "pop-up" touch screen modes, each with a variety of possible applications. The same touch screen can operate in each of these various modes, or other modes, at different times. The different modes can also appear on the screen at the same time; for example, icons can appear in an auxiliary or pop-up image, or an auxiliary or pop-up image could be overlaid in a window on the iconic mode image instead of fully replacing that image.

[0049] FIG. 4 illustrates an example of a first "iconic" usage mode of the touch screen. In the iconic mode, the screen displays an image that includes a number of small icons such as pictures or buttons. The touch sensor operates as a touch pad pointing device in iconic mode, in which finger motions and taps on the sensor are generally interpreted the same as when the touch screen operates as a conventional touch pad. The screen image in iconic mode may include elements in common with the default image of FIG. 3, as the two modes operate similarly. Iconic mode will generally display additional icons relating to software that is running on the computer and other aspects of the operation of the computer.

[0050] In the example image of FIG. 4, image 400 includes scroll arrow icons 402 and 404 and a touch region, such as illustrated by corner tap icon 406 in common with