ELECTRONIC APPARAUS WITH DISPLAY SHARED BY DIFFERENT ELECTRONIC MODULES

Field the Invention

The present invention relates to an electronic apparatus comprising display means and a screen controlled by the display means.

Background to the Invention

A typical portable electronic apparatus such a palmtop computer or a communicator, i.e. a computer/mobile telephone hybrid, is constructed around a microprocessor running an operating system program such as WindowsCE or EPOC. The functionality of the apparatus is provided by application programs run within the operating system environment and task specific hardware such as radio frequency circuitry.

One of the most important considerations for portable electronic apparatus is battery life. General purpose microprocessors are relatively power-hungry when compared with, for example, an ASIC (application specific integrated circuit) performing the same task.

However, power consumption is not the only consideration and in some applications the additional speed available from custom circuitry, when compared with a general purpose microprocessor, is desirable.

Notwithstanding the foregoing, the present invention is not restricted to portable electronic apparatus.

Summary of the Invention

An apparatus according to the present invention is characterised in that the display means is configured to be contemporaneously responsive to display control signals from a plurality of electronic modules so that the screen is shared by said modules. Thus, the modules are separately responsible for data/signal processing functions and the display means is provided so that the different data/signal processing functions of the modules can share the display. This is different from the case of a portable computer with an anciliary

card because, in the conventional portable computer, the computer's microprocessor generates the display control signals related to the operation of the anciliary card.

Preferably, at least one of the modules is readily disconnectable so that the functions performed by the apparatus can be changed. The or each readily disconnectable module may be received in a bay in a body that also houses the display means. There need not however be a physical connection between a disconnectable module and the display means. For instance, the connection could be provided by a wireless link, e.g. an IR link.

Preferably, the display means generates a respective window for each module. More preferably, the window of one module can wholly hide the window of another module. Still more preferably, an audio transducer, e.g. a microphone or a speaker, and switching means for selectively coupling the audio transducer to the modules are included and the switching means is responsive to the display means to couple the audio transducer to the module whose window has focus. Yet more preferably, pointing means is included for selecting a point on the screen and outputting an indication of the location of a selected point to the display means, and the display means is operable to send information, based on said indication, to the module whose window contained said location. The pointing means may comprise a touch sensitive element co-extensive with the screen.

An electronic apparatus according to the present invention preferably includes memory means comprising a memory and means for selectively transferring files from the modules to the memory for storage therein and selectively transferring files from the memory means to the modules. More preferably, the memory is nonvolatile solid state memory.

Preferably, the display means comprises a memory for storing bit map images, means for receiving display control signals from the modules and setting bits in the memory in dependence display control signals from the modules and means for driving the screen in dependence on the contents of the memory. More preferably, the means for receiving display control signals has a respective input for each module. However, a bus arrangement could be used. Still more preferably, the display means includes pointing means for generating screen location data in response to a user selecting a point on the screen, means for determining, with reference to the contents of the memory, to which

module, if any, said screen location data relates and sending the screen location to that module.

Brief Description of the Drawings

Figure 1 shows a first apparatus according to the present invention;
Figure 2 is a functional block diagram of the apparatus of Figure 1;
Figure 3 shows a second apparatus according to the present invention; and
Figure 4 is a functional block diagram of the apparatus of Figure 3.

Detailed Description of Preferred Embodiments

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings.

Referring to Figure 1, a portable electronic apparatus comprises a body 1 having a front face 1a, a rear face (not shown), a top end (not shown), a bottom end 1b, a first side 1c and a second side (not shown). A backlit LCD 2 is mounted to the front face 1a. A loudspeaker 3 is mounted behind the front face 1a between the LCD 2 and the top end of the body 1. A microphone 4 is mounted behind the front face between the LCD 2 and the bottom end 1b of the body 1. Microphone and earphone sockets (not shown) are also provided on the body 1.

First to fourth bays 5a, 5b, 5c, 5d are accessible through respective apertures in the first side 1c of the body. The bays 5a, 5b, 5c, 5d are rectangular in cross-section and are arranged in a line side-by-side. The closed end of each bay 5a, 5b, 5c, 5d is provided with the male part (not shown) of a respective multi-way connector.

The bays 5a, 5b, 5c, 5d can interchangeably accommodate plug-in modules 6, 7, 8. In this example, the first module 6 contains mobile telephone circuitry and sports an antenna 9. The second module 7 contains an ASIC implementing a clock. The third module 8 contains a low power microprocessor and ROM storing application programs, including a wordprocessor, spreadsheet and a drawing program.

Each of the modules 6, 7, 8 is provided with a female connector part for engaging the male connector parts at the ends of the bays 5a, 5b, 5c, 5d.

The modules 6, 7, 8 may be provided with small projections 8a to aid their removal from the body 1.

The first and second modules 6, 7 are plugged in and the LCD 2 shows a facsimile of a mobile telephone's user interface 10 and a clock face 11. The bottom righthand corner of the LCD 2 contains a region 12 showing an icon 13, 14 for each module 6, 7 plugged into the body 1.

The LCD 2 is overlaid with a touch sensitive layer and a stylus 15 is stored in a tube opening through the bottom end 1b of the body 1.

The modules 6, 7, 8 all fit substantially within the bays 5a, 5b, 5c, 5d. However, a module could comprise a plug for insertion in to a bay 5a, 5b, 5c, 5d connected by a lead to a body containing most or all of its electronics.

A power on/off switch 16 is mounted to the body 1.

Referring to Figure 2, the body 1 (Figure 1) houses a display driver circuit 21 and a touch position sensing circuit 22 for detecting the position of a point where the stylus 15 touches the LCD 2 and outputting the coordinates of that point. The display driver circuit 21 and the touch position sensing circuit 22 are coupled to the LCD 2 and to an interface controller 23. An interface switching unit 24 is interposed between the interface controller 23 and the modules 6, 7 and controls the routing of interface messages between the modules 6, 7 and the interface controller 23. The interface controller 23 is also coupled to an audio switching unit 25. The audio switching unit 25 links the microphone 4 and the loudspeaker 3 to the modules 6, 7.

A memory access switching unit 26 controls the access of the modules 6, 7 to a common non-volatile memory 27.

The interface controller 23 is also connected to a backlight control circuit 28 for controlling the illumination of the LCD 2.

A battery 30 and voltage regulator 31 provide power to the components in the body and to the modules 6, 7. It will be understood that solar cells could be used as a power source. The modules 6, 7 may also contain their own power sources, for instance for memory backup.

The production of images on the LCD 2 will now be described with reference to Figures 1 and 2.

The icon region 12 is reserved for the interface controller 23 and is always displayed when the apparatus is on.

The interface switching unit 24 receives display control messages from the modules 6, 7, caching them if necessary, and then feeds them on to the interface controller 23. These display control messages are accompanied by an ID code identifying the module 6, 7. The ID code may be unique to each module 6, 7 or merely identify the type of module 6, 7, in which case if two modules 6, 7 with the same ID were to be plugged in at the same time, an error message would be displayed. The interface switching unit 24 also receives stylus position messages from the interface controller 23 and routes them to the modules 6, 7.

When a module 6, 7 is first inserted into a slot 5a, 5b, 5c, 5d and is powered up, it sends a registration message to the interface controller 23 via the interface switching unit 24. The interface switching unit 24 adds the ID to the table mapping ID onto bay number. The bay number is known from the input on which the message is received. The message is passed on to the interface controller 23 with the module ID replaced by the bay number. The interface controller 23 then adds the bay number from the registration message to a list of active bays. After sending the registration message, the module 6, 7 sends a screen resource request message to the interface controller 23. This message defines the size of the region of the display

required by the module 6. 7. It can been seen from Figure 1 that the mobile phone module 6 requires a larger display region than the clock module 7. This and all subsequent messages are modified by replacing the module ID with the bay number from the table. After the screen resource request message, the module 6, 7 sends an icon message. The interface controller 23 responds to the icon message by displaying the icon defined thereby in the icon region 12.

The module 6, 7 then sends display control messages to set up its initial display configuration. These messages comprise combinations of the following:

the identity of a standard display element, e.g. a button or a square, and associated parameters, such as position and size;

text with associated font, size and position information; and

bit maps together with position, shape and size parameters;

When the interface controller 23 receives these messages, it determines to which area of an internal RAM they relate, on the basis of the received bay numbers. It then sets the states of RAM locations to generate bit map representations from the received messages. For instance, if the message indicates a button, a button draw process will be performed so that a bit map of the button is generated in the RAM at the appropriate location.

The interface controller 23 also refreshes the LCD 2 by reading the RAM and setting the pixels of the LCD 2 in accordance with the Z-order positions associated with the modules 6, 7. Z-order 0 being allocated to the focused-on module 6, 7.

As the modules 6, 7 perform their functions, they will send display control messages to the interface controller 23 to update their displays.

When a user touches the LCD 2 with the stylus 15, the co-ordinates of the point of contact are detected and sent to the interface controller 23. The interface controller 23 first determines whether the point of contact is in the icon region 12. If then the point of contact corresponds to one of the icons, the interface controller 23 sets the Z-order for the associated module 6, 7 to 0 and also informs the audio switching

unit 25 that that module 6, 7 is now the focused-on module. The audio switching unit 25 then connects the microphone 4 and the loudspeaker 3 to the focused-on module 6, 7.

The interface controller 23 also sends a loss of focus message to the previously focused-on module 6, 7 (assuming it is not the same as that identified by the touched icon). The module 6, 7 losing focus then has an opportunity of putting itself into an idle mode or sleep state so as to reduce power consumption.

If the point of contact is not in the icon region 12, the interface controller 23 determines which module's display is at the touched location using its knowledge of the module's display images and their Z-orders. If the region touched corresponds to an exposed part of a partially hidden window, the window is then moved to Z-order position 0 and the audio switching unit 25 is informed that the associated module 6, 7 is now the focused-on module and sends a loss of focus message to the formerly focused-on module 6, 7. In any event, the interface controller 23 converts the absolute co-ordinates from the touch position sensing circuit 22 into co-ordinates relative to the touched-on window. These co-ordinates are then sent to the interface switching unit 24 with the bay number for dispatch to the focused-on module 6, 7; no ID is required for messages from the interface switching unit and the modules 6, 7. The active module 6, 7 will respond according to its own internal logic.

When the interface controller 23 is not active handling display messages and generating stylus position messages, it periodically polls the modules 6, 7 to determine whether they are still present. If no reply is received from a module 6, 7, it is removed from the list of modules and the bit map of its window and its icon are cleared.

The interface controller 23 controls the backlight by means of the backlight controller 28, if the backlight is being used, so that only the windows of the focused-on module are illuminated. The backlight comprises an array of independently operable light sources.

The memory 27 is provided so that the modules 6, 7 can exchange data. The memory switching unit 26 maintains a directory of files in the memory 27.

When a module 6, 7 is to store a file in the memory 27, it sends a message to the memory switching unit 27 including the name and size of the file. The memory switching unit 26 then allocates space in the memory 27 for the file and invites the module to send the file. The module 6, 7 will respond by sending the file to the memory switching unit 26 which then stores it in the memory 7 and adds it to the directory.

A module 6, 7 may obtain a list of files in the memory 27 by sending a directory list request message to the memory switching unit 26.

When a module 6, 7 is to read a file, it sends a read file message, including the file's name, to the memory switching unit 26. If the file is present, the memory switching unit 26 reads the file from the memory 27 and sends it to the module 6, 7 that requested it, otherwise it returns an error message.

Files may also be deleted at the request of a module 6, 7.

The communication between the modules 6, 7 and the memory and interface switching units 24, 26 may be serial or parallel or a hybrid thereof. The choice of serial or parallel is a trade-off between speed and complexity of connections.

It will be appreciated that the internal organisations of the modules is largely irrelevant. The important consideration is their interfacing with the shared parts of the system. Physically, the modules of the above-described embodiment are provided with connector parts for interface messages and optionally file transfer and audio in and out. The behaviour of the modules 6, 7 must include the registration process described above and generation of standard interface messages recognised by the interface controller 23. Optionally, the modules can interact with

the memory switching unit 26 using messages it understands and perform power saving measures in response to a loss of focus message.

In an alternative embodiment, the icon region 12 is replaced by buttons, associated with respective bays, on the body 1.

Referring to Figure 3, a portable electronic apparatus comprises a body 101 having a front face 101a, a rear face (not shown), a top end (not shown), a bottom end 101b, a first side 101c and a second side (not shown). A backlit LCD 102 is mounted to the front face 101a. Microphone and earphone sockets 103, 104 are provided on the first side 101c of the body 101.

A bay 105 accessible through an aperture in the bottom end 101b of the body 101. The bay 105 is rectangular in cross-section. The closed end of the bay 105 is provided with the male part (not shown) of a multi-way connector.

The bay 105 can interchangeably accommodate plug-in modules 106. In this example, the module 6 contains an ASIC implementing a diary. An ASIC module implementing a clock is provided in the body 101.

The module 106 is provided with a female connector part for engaging the male connector parts at the ends of the bay 105.

The module 106 is provided with a small projections 106a to aid its removal from the body 101.

The LCD 2 shows a facsimile of a diary page 110 and a clock face 111.

The LCD 2 is overlaid with a touch sensitive layer and a stylus 115 is stored in a tube opening through the bottom end 101b of the body 101.

The module 106 fits substantially within the bay 105. However, a module could comprise a plug for insertion in to the bay 105 connected by a lead to a body containing most or all of its electronics.

A power on/off switch 116 is mounted to the body 1.

Referring to Figure 4, the body 101 (Figure 3) houses a display driver circuit 121 and a touch position sensing circuit 122 for detecting the position of a point where the stylus 115 touches the LCD 102 and outputting the coordinates of that point. The display driver circuit 121 and the touch position sensing circuit 122 are coupled to the LCD 102 and to an interface controller 123. An interface switching unit 124 is interposed between the interface controller 123 and the internal clock and plug-in diary modules 107, 106 and controls the routing of interface messages between the modules 106, 107 and the interface controller 123. The interface controller 123 is also coupled to an audio switching unit 125. The audio switching unit 125 links the microphone and loudspeaker sockets 103, 104 to the modules 106, 107.

A memory access switching unit 126 controls the access of the modules 106, 107 to a common non-volatile memory 127.

The interface controller 123 is also connected to a backlight control circuit 128 for controlling the illumination of the LCD 102.

A battery 130 and voltage regulator 131 provide power to the components in the body 101 and to the diary module 106. It will be understood that solar cells could be used as a power source. The diary module 106 may also contain its own power source, for instance for memory backup.

The production of images on the LCD 102 will now be described with reference to Figures 3 and 4.

The interface switching unit 124 receives display control messages from the modules 106, 107, caching them if necessary, and then feeds them on to the

interface controller 123. These display control messages are accompanied by an ID code identifying the module 106, 107. The interface switching unit 124 also receives stylus position messages from the interface controller 123 and routes them to the modules 106, 107.

When a plug-in module 106 is first inserted into the slot 105 and is powered up, it sends a registration message to the interface controller 123 via the interface switching unit 124. The internal module 107 sends a registration message each time the apparatus is powered up. The interface switching unit 24 adds the ID to a table mapping ID onto the bay 105 or the internal module 107. The fact that an ID is from the bay 105 is known from the input on which the message is received. The message is passed on to the interface controller 123 with the module ID replaced by the bay number (the internal module 107 is notionally considered to be bay "0" and the bay 105 is considered to be bay "1"). The interface controller 123 then adds the bay number from the registration message to a list of active bays. After sending the registration message, the module 106, 107 sends a screen resource request message to the interface controller 123. This message defines the size of the region of the display required by the module 106. 107. It can been seen from Figure 3 that the diary module 106 requires a larger display region than the clock module 107. This and all subsequent messages are modified by replacing the module ID with the bay number from the table.

The module 106, 107 then sends display control messages to set up its initial display configuration. These messages comprise combinations of the following:

the identity of a standard display element, e.g. a button or a square, and associated parameters, such as position and size;

text with associated font, size and position information; and

bit maps together with position, shape and size parameters;

When the interface controller 123 receives these messages, it determines which area of an internal RAM they relate to, on the basis of the received bay numbers. It then sets the states of RAM locations to generate bit map representations from the received messages. For instance, if the message indicates a button, a button draw

process will be performed so that a bit map of the button is generated in the RAM at the appropriate location.

The interface controller 123 also refreshes the LCD 102 by reading the RAM and setting the pixels of the LCD 102.

As the modules 106, 107 perform their functions, they will send display control messages to the interface controller 123 to update their displays 110, 111.

When a user touches the LCD 102 with the stylus 115, the co-ordinates of the point of contact are detected and sent to the interface controller 123. The interface controller 123 determines which module's display is at the touched location using its knowledge of the module's display images. The module 106, 107 corresponding to the touched window is then the focused-on module and the audio switching unit 125 is informed that the associated module 106, 107 is now the focused-on module and sends a loss of focus message to the formerly focused-on module 106, 107. The audio switching unit 125 responds by connection the microphone and speaker sockets 103, 104 to the focused-on module 106, 107.

The interface controller 123 converts the absolute co-ordinates from the touch position sensing circuit 122 into co-ordinates relative to the touched-on window. These co-ordinates are then sent to the interface switching unit 124 with the bay number for dispatch to the focused-on module 106, 107; no ID is required for messages from the interface switching unit 124 and the modules 106, 107. The focused-on module 106, 107 will respond according to its own internal logic.

When the interface controller 123 is not active handling display messages and generating stylus position messages, it periodically polls the plug-in module 106 to determine whether it is still present. If no reply is received from the plug-in module 106, it is removed from the list of modules and the bit map of its window is cleared.

The interface controller 123 controls the backlight by means of the backlight controller 128, if the backlight is being used, so that only the windows of the

focused-on module are illuminated. The backlight comprises an array of independently operable light sources.

The memory 127 is provided so that modules 106, 107 can exchange data. The memory switching unit 126 maintains a directory of files in the memory 127.

When a module 106, 107 is to store a file in the memory 127, it sends a message to the memory switching unit 127 including the name and size of the file. The memory switching unit 126 then allocates space in the memory 127 for the file and invites the module 106, 107 to send the file. The module 106, 107 will respond by sending the file to the memory switching unit 126 which then stores it in the memory 107 and adds it to the directory.

A module 106, 107 may obtain a list of files in the memory 127 by sending a directory list request message to the memory switching unit 126.

When a module 106, 107 is to read a file, it sends a read file message, including the file's name, to the memory switching unit 126. If the file is present, the memory switching unit 126 reads the file from the memory 127 and sends it to the module 106, 107 that requested it, otherwise it returns an error message.

Files may also be deleted at the request of a module 106, 107.

The communication between the modules 106, 107 and the memory and interface switching units 124, 126 may be serial or parallel or a hybrid thereof. The choice of serial or parallel is a trade-off between speed and complexity of connections.

It will be appreciated that the internal organisations of the modules is largely irrelevant. The important consideration is their interfacing with the shared parts of the system. Physically, the plug-in module of the above-described embodiment are provided with connector parts for interface messages and optionally file transfer and audio in and out. The behaviour of the modules 106, 107 must include the registration process described above and generation of standard interface messages

recognised by the interface controller 123. Optionally, the modules can interact with the memory switching unit 126 using messages it understands and perform power saving measures in response to a loss of focus message.

From the foregoing, it will be apparent that the present invention provides for an apparatus in which display means interacts independently with a plurality of sources of display control signals.

Claims

1. An electronic apparatus comprising display means (23, 24; 123, 124) and a screen (2; 102) controlled by the display means, characterised in that the display means is configured to be contemporaneously responsive to display control signals from a plurality of electronic modules (6, 7, 8; 106, 107) so that the screen is shared by said modules.

2. An electronic apparatus according to claim 1, wherein the modules (6; 7; 8) are readily disconnectable from the display means (23, 24).

3. A electronic apparatus according to claim 1, wherein one module (107) is integrally housed with the display means (123, 124) and another module (106) is readily disconnectable from the display means (123, 124).

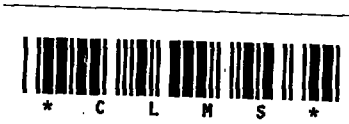
4. A electronic apparatus according to claim 1, 2 or 3, wherein the display means (23, 24; 123, 124) generates a respective window for each module (6, 7, 8; 106, 107).

5. A electronic apparatus according to claim 4, wherein the window of one module can wholly hide the window of another module.

6. A electronic apparatus according to any preceding claim, including memory means comprising a memory (27, 127) and means (26, 126) for selectively transferring files from the modules (6, 7, 8; 106, 107) to the memory for storage therein and selectively transferring files from the memory means to the modules (6, 7, 8; 106, 107).

7. A electronic apparatus according to claim 6, wherein the memory (127) is nonvolatile solid state memory.

8. A electronic apparatus according to claim 4 or 5, including an audio transducer (3, 4) and switching means (25; 125) for selectively coupling the audio transducer (3, 4) to the modules (6, 7, 8; 106, 107), wherein the switching means (25) is responsive to the display means (23, 24; 123,124) to couple the audio transducer (3, 4) to the module (6, 7, 8; 106, 107) whose window has focus.



9. A electronic apparatus according to claim 8, including a microphone (4) and a speaker (5), wherein the switching means (25) is operable in response to the display means (23, 24) for coupling the microphone (4) and the speaker (5) to the module (6, 7, 8) whose window has focus.

10. A electronic apparatus according to claim 4, including pointing means (15, 22; 115, 122) for selecting a point on the screen (2; 102) and outputting an indication of the location of a selected point to the display means (23, 24; 123, 124), wherein the display means (23, 24; 123, 124) is operable to send information, based on said indication, to the module (6, 7, 8; 106, 107) whose window contained said location.

11. A electronic apparatus according to claim 10, wherein the pointing means (15, 22; 115, 122) comprises a touch sensitive element co-extensive with the screen (2, 102).

12. A electronic apparatus according to 2 or 3, comprising a body housing (1; 101) the display means (23, 24; 123, 124) and having a bay (5a, 5b, 5c, 5d; 105) for receiving the or each readily disconnectable module (6, 7, 8; 106).

13. A electronic apparatus according to any preceding claim, wherein the display means (23, 24; 123, 124) comprises a memory for storing bit map images, means (24; 124) for receiving display control signals from the modules and setting bits in the memory in dependence display control signals from the modules (6, 7, 8; 106, 107) and means for driving the screen in dependence on the contents of the memory.

14. A electronic apparatus according to claim 13, wherein the means (24; 124) for receiving display control signals has a respective input for each module.

15. A electronic apparatus according to claim 13 or 14, wherein the display means (23, 24; 123, 124) includes pointing means (15, 22; 115, 122) for generating screen location data in response to a user selecting a point on the screen, means (23, 123) for determining, with reference to the contents of the memory, to which module (6, 7, 8; 106, 107), if any, said

screen location data relates and sending the screen location to that module (6, 7, 8; 106, 107).

16. A portable electronic apparatus according to any preceding claim.