

A METHOD AND APPARATUS FOR PROVIDING INFORMATION FOR DISPLAY

Field of the Invention

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This invention relates to a method and apparatus for providing information for display and more particularly, though not exclusively, to controlling the information for display in one or more windows on a display.

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Background of the Invention

As is known, microcontrollers are used in portable electronic equipment having a display, such as note book computers and
15 organisers. In these portable applications, the microcontroller has to operate with limited resources, such as power and memory, and provide maximum functionality.

Conventionally, such a microcontroller is an integrated semiconductor package made up of a core microprocessor module, a
20 system memory, a display controller and a variety of other modules. The core microprocessor module, the system memory, the display controller and the other modules are linked via various communication links including an address bus and a data bus. One such microcontroller is the MC68328 manufactured by Motorola Inc. of the United States of America.

25 A dedicated part of the system memory in the microcontroller is used as a display memory. The display memory stores information for display on a display, such as a liquid crystal display (LCD). A LCD has a predetermined number of picture elements or pixels and the entire contents of the display memory is used to represent the predetermined
30 number of pixels on the display.

During normal operation, the entire contents of the display memory is repeatedly provided from the display memory to the display by the display controller in order to maintain a display of the information stored in the display memory. The display controller performs this
35 function independently and without intervention by the microprocessor.



In order to simultaneously view several documents or applications on a display it is common for information for each document or application to be displayed in a window on the display.

However, whenever displayed information is updated i.e. for example when a window on the display is moved, or when a new window is added to the display, the microprocessor, under program control, clears the display memory, organises the updated information for display and loads the organised information into the display memory.

Communicating the entire contents of the display memory between the microprocessor and the display memory in this way puts a considerable load on the limited resources available to the microcontroller, particularly on the limited power, memory, and the bandwidth of the address bus and data buses.

Brief Summary of the Invention

The present invention therefore seeks to provide a method and apparatus for providing information for display which reduces the use of the limited resources available in the microcontroller, particularly the power, memory, and the bandwidth of the address and data buses.

Accordingly, in one aspect, the invention provides an apparatus for providing a first and second data for display, wherein the first data is for displaying at a first display location on a display having a first set of coordinates associated therewith, and wherein the second data is for displaying at a second display location on the display having a second set of display coordinates associated therewith, the apparatus comprising: a display memory having an input for receiving the first and second data and first and second addresses, for storing the first data in a first storage location having the first address associated therewith and for storing the second data in a second storage location having the second address associated therewith, and the display memory having an output for providing the first data when the first address is received and for providing the second data when the second address is received; and a controller coupled to the input and the output of the display memory, the controller having an output for coupling to the display, an input for receiving the first and second sets of display coordinates, and having a memory for storing the first and second addresses and the first and

second sets of coordinates, wherein the controller is arranged to provide the first address to the display memory if the first set of coordinates is received, to receive the first data from the display memory, and to provide the first data to the output for display at the first display location, and to
5 provide the second address to the display memory if the second set of coordinates is received, to receive the second data from the display memory, and to provide the second data to the output for display at the second display location.

Another aspect of the invention provides a method for providing
10 first and second data for display, wherein the first data is to be displayed at a first display location on a display having a first set of display coordinates associated therewith, and wherein the second data is to be displayed at a second display location on the display having a second set of display coordinates associated therewith, the method comprising
15 the steps of: providing the first and second data; storing the first data in a first portion of a display memory wherein the first portion of the display memory has a first address associated therewith and storing the second data in a second portion of the display memory wherein the second portion has a second address associated therewith; receiving the first or
20 second set of display coordinates; and providing the first data to the display if the first set of display coordinates is received, and providing the second data to the display if the second set of display coordinates is received.

25 Brief Description of the Drawings

An embodiment of the invention will now be more fully described, by way of example, with reference to the drawing which shows a schematic of a portion of a microcontroller and a display.

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Detailed Description of the Drawings

The figure shows a system memory 5 and a liquid crystal display controller (LCDC) 20 in the microcontroller 10, where the system memory
35 5 and the LCDC 20 are each coupled to a bi-directional address bus 2 and a bi-directional data bus 3. In addition, the LCDC 20 has an input 28

coupled to a graphical user interface (GUI) 40, and an output 27 coupled to a liquid crystal display (LCD) 30.

The microcontroller 10 is a high speed complimentary metal oxide semiconductor (HCMOS) static core and the system memory 5 is a random access memory (RAM). A portion of the system memory 5 is dedicated for use as a display memory 13 where information for display is stored.

Information 4 for display in a first display window 35 on the display 30, which will be described later, is represented by an A string stored in a first portion 14 of the display memory 13. The first portion 14 of the display memory 13 begins at address P1 as indicated by a pointer 11.

Information 6 for display in a second display window 36 on the display 30, which also will be described later, is represented by a B string stored in a second portion 15 of the display memory 13 of the display memory 13. The second portion 15 of the display memory 13 begins at address P2 as indicated by a pointer 12. Each of the first and second portions 14 and 15 of the display memory 13 include a group of storage locations in the display memory 13, and these storage locations may not be contiguous.

The display 30 displays the A string information 4 in a first window 35, and the B string information 6 in a second display window 36. The first window 35 is located at a first position defined by display coordinates X1, Y1 on the display 30, and the second display window 36 is located at a second position defined by display coordinates X2, Y2 on the display 30.

The LCDC 20 includes a digital signal processor (DSP) 21 having a number of registers 22 and a direct memory access (DMA) module. The DMA module enables the LCDC 20 to get information stored in the display memory 13 independent of the operation of the microprocessor in the microcontroller 10.

Information stored in the registers 22 is shown in tabular form. The information stored in the registers 22 represent a display list. Column 23 provides an address pointer to a portion of display memory containing information for display in a particular window on the display. Columns 24 and 25 indicate the X and Y coordinates respectively, of the position for displaying the particular window on the display. Column 26 indicates the overlap display priority allocated to the particular display window. Hence,

the window with the highest priority, i.e. 1, will be unobstructed by other windows while windows having a lower overlap display priority may be partially displayed, if obstructed by windows having a higher priority.

5 The entries in row 16 provide information for displaying the first window 35 including the address pointer P1 which addresses the first portion 14 of the display memory 13 where the information 4 is located; the coordinates X1, Y1 indicating the position that the first window 35 is to be displayed on the display 30; and a display priority 2 for the window 35.

10 Similarly, the entries in row 17 provide information for displaying the second window 36 including the address pointer P2 which addresses the second portion 15 of the display memory 13 where the information 6 is located; the coordinates X2, Y2 indicating the position that the second window 36 is to be displayed on the display 30; and a display priority 1
15 for the window 35.

When additional windows are to be displayed, additional rows of information are entered in the display list, one additional row for each additional window.

In operation, the contents of the registers 22 are accessed in order
20 to display the information 4 and 6 stored in the display memory 13 in windows 35 and 26 on the display 30. Each pointer address is provided to the display memory 13 by the LCDC 20, and the information for display 4 stored in the first location 14 is provided from the display memory 13 to the display 30 via the LCDC 20. The LCDC also provides the associated
25 window coordinates X1,Y1 and display priority 2 to the display 30. This process is then repeated for each of the rows of entries in the registers 22.

In addition, to maintain a display of the information stored in the display memory 13 on the display 30, the above process of transferring
30 information from the display memory 13 to the display is repeated continuously by the LCDC 20 independent of the operation of the microprocessor in the microcontroller 10.

When, for example, the first window 35 is moved to a new position on the screen by a user using the GUI 40, the GUI provides the
35 coordinates of the new position of the window to the LCDC 20, and the DSP 21 updates the coordinates X1,Y1 to that of the new position of the first window 35. Subsequently, when the display list i.e. the contents of

the registers 22 is next accessed to maintain the displayed information on the display the new coordinates will cause the first window 35 to be displayed at the new location.

When a new window is added to the display 30, the information for display in the new window is stored in a new location of the display memory 13 and a pointer to the new location is provided to the LCDC 20. Entries are then made to the display list by the microprocessor, under program control, to add the details of the new window. These entries include the pointer to the new location of the display memory 13, the X, Y co-ordinates of the new window on the display, and the display priority of the new window. Subsequently, when the display list is next accessed to maintain the displayed information on the display, the new entries in the display list will cause the new window to be displayed on the display 30.

The invention as described, advantageously enables the display controller to provide information from the display memory to the display with a substantially reduced dependence on the microprocessor thereby reducing the drain on limited resources available to the microcontroller.

Thus, in accordance with the described embodiment of the present invention, a display controller maintains a display list of windows for display and provides information from a display memory to the display in accordance with the display list. In addition, the list indicates the location and display priority of each window on the display.

In addition, the embodiment of the present invention can be conveniently implemented by enhancing an existing display controller to provide the additional functionality.

Hence, the described embodiment provides information for display in windows on a display which reduces the use of the limited resources available in the microcontroller, particularly the power, memory, and the bandwidth of the address and data buses.



Claims

1. An apparatus for providing a first and second data for display, wherein the first data is for displaying at a first display location on a display having a first set of coordinates associated therewith, and wherein the second data is for displaying at a second display location on the display having a second set of display coordinates associated therewith, the apparatus comprising:

 - a display memory having an input for receiving the first and second data and first and second addresses, for storing the first data in a first storage location having the first address associated therewith and for storing the second data in a second storage location having the second address associated therewith, and the display memory having an output for providing the first data when the first address is received and for providing the second data when the second address is received; and

a controller coupled to the input and the output of the display memory, the controller having an output for coupling to the display, an input for receiving the first and second sets of display coordinates, and having a memory for storing the first and second addresses and the first and second sets of coordinates, wherein the controller is arranged to provide the first address to the display memory if the first set of coordinates is received, to receive the first data from the display memory, and to provide the first data to the output for display at the first display location, and to provide the second address to the display memory if the second set of coordinates is received, to receive the second data from the display memory, and to provide the second data to the output for display at the second display location.
2. An apparatus in accordance with claim 1 wherein the memory in the controller includes storage locations for storing a first display priority indicator associated with the first display location and a second priority display indicator associated with the second display location, wherein the first and second priority indicators indicate the priority for displaying the first and second data at the first and second display locations on the display when the first and second display locations overlap.



3. An apparatus in accordance with any one of the preceding claims wherein the display memory comprises a dedicated part of a system memory in a microcontroller.
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4. An apparatus in accordance with any one of the preceding claims wherein the controller comprises a liquid crystal display controller (LCDC).
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5. An apparatus in accordance with any one of the preceding claims wherein the controller comprises a window processor having an input for receiving the first and second data for display and the first and second set of display coordinates, and the window processor having an output coupled to provide display information to the output of the controller,
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- wherein the display information causes a first window to be displayed on the display, the first window being positioned on the display in accordance with the first set of display coordinates, and the first window having the first data displayed therein, and wherein the display information causes a second window to be displayed on the display, the
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- second window being positioned on the display in accordance with the second set of display coordinates, and having the second data displayed therein.
6. An apparatus in accordance with claims 3 and 4 further
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- comprising a direct memory access (DMA) controller coupled to the microcontroller and the LCDC for communicating the first and second data from the system memory to the LCDC without intervention by the microcontroller.
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7. An apparatus in accordance with any one of claims 4 or 5 wherein the LCDC further comprises a digital signal processor.
8. An apparatus in accordance with claim 6 wherein the memory in the controller comprises registers in the digital signal processor.
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9. A method for providing first and second data for display, wherein the first data is to be displayed at a first display location on a display



having a first set of display coordinates associated therewith, and wherein the second data is to be displayed at a second display location on the display having a second set of display coordinates associated therewith,

5 the method comprising the steps of:

a) providing the first and second data;

b) storing the first data in a first portion of a display memory

wherein the first portion of the display memory has a first address associated therewith and storing the second data in a second portion of
10 the display memory wherein the second portion has a second address associated therewith;

c) receiving the first or second set of display coordinates; and

d) providing the first data to the display if the first set of display coordinates is received, and providing the second data to the display if

15 the second set of display coordinates is received.

10. A method in accordance with claim 8 further comprising the steps of assigning first and second display priority indicators to the first and second display locations respectively, wherein the first and second
20 display priority indicators indicate the priority for displaying the first and second data at the first and second display locations on the display when the first and second display locations overlap.

11. A method according to either claim 8 or 9 further comprising the
25 steps of:

storing the first and second sets of display coordinates;

providing an updated first set of display coordinates;

receiving an updated first set of display coordinates when the first data is displaced from the first display location to an updated first display
30 location on the display;

providing the first data to the display when the updated first set of display coordinates is received; and

displaying the first data at the updated first display location on the display indicated by the updated first set of display coordinates.

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12. A method according to claim 9 further comprising the steps of:



determining a first and second window are to be displayed on the display in response to receiving the first and second data and the first and second sets of coordinates;

5 determining a first position on the display for displaying the first window in accordance with the first set of display coordinates, and a second position on the display for displaying the second window in accordance with the second set of display coordinates;

10 determining a first display area on the display required for displaying the first data in the first window and a second display area on the display required for displaying the second data in the second window; and

15 providing display information to the display causing the first window to be displayed at the first position, having the first display area, and having the first data displayed therein, and causing the second window to be displayed at the second position, having the second display area, and having the second data displayed therein.

13. A method according to claim 12 wherein displaying a third window on the display comprises the steps of:

20 storing information for display in the third window in a third location of the display memory; and

storing a third address of the third location, a third set of display coordinates, and a display priority for the third window.

25 14. An apparatus for providing first and second data on a display substantially as described herein with reference to and as illustrated by the accompanying drawing.

30 15. A method for providing first and second data on a display substantially as described herein with reference to and as illustrated by the accompanying drawing.