2174277

METHOD AND SYSTEM FOR DISPLAYING IMAGES ON A DISPLAY SCREEN

This invention relates to methods and systems for displaying an image on a display screen having a plurality of display rows and more particularly to a method and a system for displaying an image wherein a boundary in a row direction between each adjacent display area on such display screen can be variably set for each display row.

In known image display apparatus used for an information processing terminal, a plurality of display areas has been defined on the display screen, and an image has been displayed in each display area in order to utilize a limited display screen effectively.

For example, in JP-A-55-92937, a display screen is constituted by defining in a row direction and in parallel a plurality of display areas having display length of m characters per row, image information being stored in a screen memory having storage length of m characters per row in the order of display area and of row number, content of an address counter being transferred and stored into an auxiliary register when a character counter counts m, and content of the auxiliary register being set in the address counter to generate an address for reading the image information stored in the screen memory, thereby displaying an image in each display area.

In this conventional approach, the row display length of display area is fixed at predetermined m characters for all display rows, and it is required to use a special screen memory storing predetermined image information and having a fixed storage length of m characters.

Therefore, in the conventional approach, it is impossible to define at will a boundary in row direction between each adjacent display area, to change the boundary for each display row, and to display image information from a normal refresh buffer memory through windowing.

On the other hand, GB 2 144 952 discloses apparatus for providing a multiwindow display, which, in addition to a conventional address counter which systematically counts "the whole display" from a starting address to a finishing address and then wraps round again to the starting address, a picture information memory, a display timing circuit, a horizontal/vertical timing circuit and a display monitor, includes an address converter comprising horizontal and vertical window boundary memories, each with its own address counter, and a bias memory. These boundary memories are scanned by independent row and column address counters, the data accessed selecting bias values to be added to the current address value to modify the same so that, when the addresses on the counter fall within a window, the data displayed is retrieved from a portion of the picture information memory appropriate to that window. While this arrangement enables one to the limitation of having to start new windows only at preselected places on the screen, if one were to assume 80 columns and 25 rows in the display, these being typical figures and four windows as shown, the processor has to reload 105 storage locations sequentially merely to rearrange the existing windows which is a processing overhead on top of the hardware overhead involved.

In reducing this composite overhead, the present invention provides an arrangement in which the conventional address counter is replaced by a reloadable counter which is reloaded at the start of each row refresh and at an intermediate point, if necessary, doing away with the additional window selection circuit and multiplexer and reducing the storage location rewriting to a figure dependent on row only, and can reduce, in the above example, to 50 loads since the boundary information can be handled along with one of the sets of boundary addresses.

The present invention provides a method of displaying an image in each of a plurality of display areas adjacently defined in a row direction

on a display screen having a plurality of display rows selected in order comprising

a) storing multiple independent screen sized component images in a random access memory, accessible by row addressing via a reloadable row address counter and column indexing, so that the image data stored in each row belongs to one row of one component image, the column indexing order of the display data in each row corresponding to the raster order;

b) storing, for each row, in a first display area memory, the row address in the random access memory of the row data of the component image first to be encountered in the row direction in the image to be displayed;

c) storing, for each row, in a second display area memory, the row address in the random access memory of the row data of the component image, if any, next to be encountered in the row direction in the image to be displayed;

d) storing, for each row, in a display information memory, the column identity of the first to be encountered boundary between display areas in that row, if such exists; and

e) for each row of the display, accessing the corresponding entry in the display image information memory and, initially, the first display area memory, reloading the row address counter and, in response to the outputs thereof, indexing through the columns of the row of the random access memory identified by the first display area memory until the column index matches the entry in the display information memory and, thereafter, again reloading the row address counter and continuing to index through the columns of such other row of the random access memory as may be

identified by the corresponding row entry in the second display area memory.

The present invention equally provides a system for displaying an image in each of a plurality of display areas adjacently defined in a row direction on a display screen having a plurality of display rows selected in order comprising

a) a random access image information storage memory storing multiple independent screen sized component images in a random access memory, accessible by row addressing via a reloadable row address counter and column indexing, so that the image data stored in each row belongs to one row of one component image, the column indexing order of the display data in each row corresponding to the raster order;

b) a first display area memory, storing, for each row, the row address in the random access memory of the row data of the component image first to be encountered in the row direction in the image to be displayed;

c) a second display area memory, storing, for each row, the row address in the random access memory of the row data of the component image, if any, next to be encountered in the row direction in the image to be displayed;

d) a display information memory, storing, for each row, the column identity of the first to be encountered boundary between display areas in that row, if such exists; and

e) for each row of the display, accessing the corresponding entry in the display image information memory and, initially, the first display area memory, reloading the row address counter and, in

response to the outputs thereof, indexing through the columns of the row of the random access memory identified by the first display area memory until the column index matches the entry in the display information memory and, thereafter, again reloading the row address counter and continuing to index through the columns of such other row of the random access memory as may be identified by the corresponding row entry in the second display area memory.

The present invention will be described further by way of example with reference to an embodiment thereof as illustrated in the accompanying drawing, in which:-

Figure 1 is a diagram illustrating an image display method according to the invention;

Figure 2 is a block diagram of an embodiment of the image display system according to the invention; and

Figure 3 is a diagram illustrating various divisions of the display screen.

The image display method of the invention is applied to a display with a display screen 10 (Fig. 1) of 25 rows with 80 characters per row. A refresh buffer memory 20 has image information on images A, B, C and D, each of which has size of 25 rows with 80 characters per row. It is desired to select cross-hatched portions a, b, c and d from the image information in the memory 20 and to display them on the display screen 10.

In adjacent upper display areas I and II of the display screen 10, are displayed, respectively, the portion a of 15 rows with 50 characters each at upper left hand corner of the image A, and the portion b of 15 rows with 30 characters each at the upper right hand corner of the

image B. Similarly, in adjacent lower display areas III and IV on the display screen 10 are displayed, respectively, the portion c of 10 rows with 30 characters each at the upper left hand corner of the image C and the portion d of 10 rows with 50 characters each at the lower right hand corner of the image D.

The boundary data defining the boundary between adjacent display areas is stored in a boundary information storage means 30 for each display row.

The boundary data is information prescribing the number of displayed characters in each display row, 1 to 25, of the display areas I and III, and information on a display start location on each display row of the display areas II and IV or a location from which column of the display screen 10 the display is started. Thus, the boundary information storage means 30 is set with a value of 50 that defines the boundary between the adjacent display areas I and II for the display rows 1 to 15, and a value of 30 that defines the boundary between the adjacent display areas III and IV for the display rows 16 to 25. Thus, when any display row is to be displayed, the corresponding boundary data is fetched and image display is switched between the adjacent display areas I and II, or III and IV based on the boundary data fetched.

In addition, for the adjacent display areas I and III to be first displayed on each display row, a start address for each display row in the refresh buffer memory 20 for the portion a of the image A and the portion c of the image C is stored in a row table storage means 40 storing row information. Addresses 0000, 0080, ..., 1040, 1120 are set for the display rows 1 to 15 for sequentially displaying the portion a of the image A from the upper left hand corner, while addresses 4000, 4080, ..., 4640, 4720 are set for the display rows 16 to 25 for sequentially displaying the portion c of the image C from the upper left hand corner.

Similarly, for the adjacent display areas II and IV to be second displayed on each display row, a start address for each display row in the refresh buffer memory 20 for the portion b of image B and the portion d of the image D is stored in a row table storage means 50 storing row information. Addresses 2050, 2130, ..., 3090, 3170 are set for the display rows 1 to 15 for sequentially displaying the portion b of the image B from the upper right hand corner, while addresses 7230, 7310, ..., 7870, 7950 are set for the display rows 16 to 25 for sequentially displaying the portion d of the image D from the lower right hand corner.

It is possible to increase the display areas adjacently defined in a row direction by adding a further boundary information storage means and a

further row information storage means. Because the boundary information storage means is to store row information, it may be embodied similarly to the row table storage means. The content stored in the boundary information storage means and the row table storage means depends on software.

The boundary information storage means 30 is connected to a counter means 60 (Fig. 2) and the row table storage means 40 and 50 are connected to an address generation means 70, including a register means 72 and a counter means 74.

In this case, it is assumed that the portion b of the image B and the portion c of the image C in the refresh buffer memory 20 are to be displayed in adjacent display areas II and III below a display row n-1 on the display screen 10, that is from display row n.

In fly-back or retrace line after completion of the display row n-1, boundary data defining the boundary between the adjacent display areas II and III, for example 50, is set from the boundary information storage means 30 into the counter means 60. At the same time, the start address for the portion b of the image B for the display row n is read from the row table storage means 40 and loaded into the counter means 74. The start address for the portion c of the image C for the display row n is read from the row table storage means 50 and loaded into the register means 72. When display of the display row n is started, the counter means 60 is decremented. When the count reaches 0 from 50, a timing signal is output to switch the display from that for display area II to that for the display area III. The counter means 74 increments the value of the start address loaded therein, and generates sequential addresses following the start address in the portion b of the image B to be displayed on the row n. When timing signal is output from the counter means 60, the start address loaded in the register means 72 is transferred to the counter means 74, which generates sequential addresses following the start address in the portion c of the image C to be displayed on the row n.

Thus, the display in the adjacent display areas II and III is performed on the display row n. Display is similarly performed for succeeding display rows to display the portion b of the image B in the display area II and the portion c of the image C in the display area III.

As thus far described, the invention allows the definition of the boundary in a row direction between the adjacent display areas to be varied for each display row. Therefore, while, in the conventional method mentioned earlier, the boundary in a row direction is fixed, for example, as shown in Figures 3 (1) and 3 (2), that is, the display screen can be divided into display areas horizontally only at a position of predetermined column, the invention allows the boundary to be freely defined in the row direction on the display screen, as shown in Figures 3 (3) and 3 (4), that is, the display screen can be divided into display areas horizontally at various column positions.

According to the invention, such image display method can be inexpensively embodied by an image display system with very simple configuration. In addition, since it is not required to prepare image information in a special screen memory as in the above-mentioned conventional method, handling of image information is simple and free, and thus high speed display can be attained with simple display operation and a windowing display.

41

CLAIMS

1. A method of displaying an image in each of a plurality of display areas adjacently defined in a row direction on a display screen having a plurality of display rows selected in order comprising

a) storing multiple independent screen sized component images in a random access memory (20), accessible by row addressing via a reloadable row address counter and column indexing, so that the image data stored in each row belongs to one row of one component image (A; B; C or D), the column indexing order of the display data in each row corresponding to the raster order;

b) storing, for each row, in a first display area memory (40), the row address in the random access memory of the row data of the component image (A or C) first to be encountered in the row direction in the image to be displayed;

c) storing, for each row, in a second display area memory (50), the row address in the random access memory of the row data of the component image (B or D), if any, next to be encountered in the row direction in the image to be displayed;

d) storing, for each row, in a display information memory (30), the column identity of the first to be encountered boundary between display areas (I and II or III and IV) in that row, if such exists; and

e) for each row of the display, accessing the corresponding entry in the display image information memory and, initially, the first display area memory, reloading the row address counter and, in

response to the outputs thereof, indexing through the columns of the row of the random access memory identified by the first display area memory until the column index matches the entry in the display information memory and, thereafter, again reloading the row address counter and continuing to index through the columns of such other row of the random access memory as may be identified by the corresponding row entry in the second display area memory.

2. A system for displaying an image in each of a plurality of display areas adjacently defined in a row direction on a display screen having a plurality of display rows selected in order comprising

a) a random access image information storage memory (20) storing multiple independent screen sized component images in a random access memory (20), accessible by row addressing via a reloadable row address counter (74) and column indexing, so that the image data stored in each row belongs to one row of one component image (A; B; C or D), the column indexing order of the display data in each row corresponding to the raster order;

b) a first display area memory (40), storing, for each row, the row address in the random access memory of the row data of the component image (A or C) first to be encountered in the row direction in the image to be displayed;

c) a second display area memory (50), storing, for each row, the row address in the random access memory of the row data of the component image (B or D), if any, next to be encountered in the row direction in the image to be displayed;

d) a display information memory (30), storing, for each row, the column identity of the first to be encountered boundary between

* C L M S *

display areas (I and II or III and IV) in that row, if such exists; and

e) for each row of the display, accessing the corresponding entry in the display image information memory and, initially, the first display area memory, reloading the row address counter and, in response to the outputs thereof, indexing through the columns of the row of the random access memory identified by the first display area memory until the column index matches the entry in the display information memory and, thereafter, again reloading the row address counter and continuing to index through the columns of such other row of the random access memory as may be identified by the corresponding row entry in the second display area memory.

3. A system as claimed in claim 2, wherein the boundary and row information memories are provided as row tables storage means.

4. A system as claimed in claim 2 or claim 3, wherein the reloadable row address counter is connected to the boundary and row information memories via a start address counter (60) and a register (72), the boundary column for each row being detected by the start address counter attaining the count supplied thereto from the boundary information memory and the register holding the boundary change address, if any, for reloading the row address counter, if and when the completed count is detected.

5. A system for displaying an image in each of a plurality of display areas adjacently defined in a row direction on a display screen having a plurality of display rows selected in order, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.