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(54) Title of the invention: DISPLAY SCROLLING SYSTEM

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SPECIFICATION

1. Title of the Invention

Display Scrolling System

2. Claims

A display scrolling system that calculates data indicating a movement amount and direction of a display image on the basis of data input by a pointing device and scrolls the display image on a display screen on the basis of the calculation results, wherein

image movement data having non-linear characteristics such that a difference relative to the amount of movement of a pointing section in the pointing device is greatest at the start of movement and gradually falls over time, and the display image is moved on the basis of the image movement data.

3. Detailed Description of the Invention

Summary

The present invention is a display scrolling system that scrolls a display image on the basis of input from a pointing device,

a movement speed of the display image is exponentially approximated to a movement speed of a pointing device such as a finger,

thereby performing naturally scrolling whereby the display image moves as though with an appropriate sensation of weight.

Industrial Field of Use

The present invention relates to display scrolling systems, and more particularly relates to display scrolling systems that move a display image by moving a pointing section of a pointing device.

Known devices to which a display scrolling system according to the present invention can be applied include the file searching device indicated by a block diagram in FIG. 3, for example. In the drawing, 1 is a central processing unit, (CPU) 2 is a random access memory (RAM), 3 is a read-only memory (ROM) that stores programs, etc., 4 is a display controller, and 5 is a cathode ray tube (CRT) or other type of display. A transparent touch

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panel 6 is provided in front of a display screen of the display 5.

The RAM 2 stores file data such as telephone books or employee rosters, and stored data is read out under control of the CPU 1 and displayed to the display 5 after being converted to predetermined image data in the display controller 4. A plurality of cards having indices A, B, C … are thus displayed in the display screen of the display 5 in a stacked state as shown in FIG. 4(A), for example.

When a person slides a finger or the like as indicated by 8 in FIG. 4(A) over the touch panel 6 in front of the display screen in which display is being performed, a coordinate position thereof is sent to the CPU 1 via an interface 7 as a change in resistance value or the like due to body capacitance, and a predetermined process is performed along with RAM 2 read control and display controller 4 control, etc., in accordance with input coordinate data thereof. A display image of the display 5, for example, is changed as shown in FIG. 4(B) by scrolling vertically.

the screen looks like it has moved by the amount (dx, dy). The minimum amount of movement for scrolling is one dot in the display 5.

The process in steps 11 to 13 is repeated until the finger is lifted off after inputting the scroll display coordinates (x_1, y_1). When it is detected that the finger has been lifted off, the display scroll operation is finished (steps 14 and 15 in FIG. 5).

Searching through the cards can thus be done easily with display scrolling.

Problems to be Solved by the Invention

In the aforementioned conventional display scrolling system, the scrolling movement amount dx, dy was calculated using $x_1 - x_0$, $y_1 - y_0$, which is the difference between the current input coordinates (x_1, y_1) and the touch-on coordinates (x_0, y_0). The movement speed of the finger therefore corresponded one-to-one with the movement speed of the display image being scrolled. Therefore, the movement speed of the display image being scrolled is done as if there were no sense of weight whatsoever in the display image, creating the problem of an unnatural feeling of movement therein.

The display scrolling done by this type of file searching device or the like requires more natural movement of the display image.

Prior Art

Conventional display scrolling systems have worked in accordance with a flowchart such as the one shown in FIG. 5 (last drawing) by means of the CPU 1. Namely, to start with, the CPU 1 reads coordinates of a point that is touched first (touch-on coordinates) indicated by (x_0, y_0) in FIG. 4(A) (step 10 in FIG. 5), then reads touch coordinates (x_1, y_1) input by movement of the finger thereafter (step 11), and on the basis of a difference between these coordinate values calculates an x-axis movement amount dx (= $x_1 - x_0$) and a y-axis movement amount dy (= $y_1 - y_0$) (step 12).

The CPU 1 controls the RAM 2 and the display controller 4 in order to scroll the display image by the movement amounts (dx, dy) thus calculated. Scrolling is done by changing the start address of the screen, for example, so that

The present invention was devised in light of these circumstances, and has as an object to provide a display scrolling system whereby a display image can be moved as though it had weight.

Means for Solving the Problems

A display scrolling system according to the present invention is such that image movement data having non-linear characteristics such that a difference relative to the amount of movement of a pointing section in the pointing device is greatest at the start of movement and gradually falls over time, and the display image is moved on the basis of the image movement data.

Operation

When data is input that causes a display image to move in any direction on a display screen by means of a pointing device, the movement amount of the display image is largest relative to a movement amount of the pointing

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section when movement starts and thereafter falls gradually over time.

When the pointing section of the pointing device (e.g., a finger or stylus on a touch panel, etc.) is moved at a fixed speed as indicated by I in FIG. 2, image movement data generated on the basis of input data from this pointing device causes the display image to move at a speed that shows the changes indicated by curve II in the same drawing. Accordingly, the display image is scrolled in such a manner that the speed of movement thereof approximates the movement of speed of the pointing section of the pointing device in a non-linear manner (i.e., the difference grows smaller). This is the same when the moving pointing section stops—after the pointing section stops moving, scrolling of the display image which is being scrolled stops not immediately but with a slight lag.

Embodiments

FIG. 1 shows a flowchart for one embodiment of the system of the present invention. Operation according to this flowchart is realized by the CPU 1 when applied to the file searching device shown in FIG. 3. Namely, in the first step 20 in FIG. 1, the CPU 1 initializes to zero x-axis (horizontal) movement data x_s and y-axis (vertical) movement data y_s of the display screen, and then reads coordinate data (touch-on coordinates) indicating a movement start location that is input by the touch panel 6 via the interface 7 (step 21). The touch-on coordinates (x_0, y_0) indicate the first location on the touch panel 6 touched by the finger.

To scroll the display, the user moves his or her finger at an undefined speed in a fixed direction while maintaining contact with the touch panel 6, as indicated by 8 in FIG. 4(A). The touch panel 6 detects positional coordinates (touch coordinates) of the finger on the touch panel 6 in a fixed sampling cycle t_s and inputs coordinate data thereof to the CPU 1 via the interface 7.

The CPU 1 reads the touch coordinates (x_1, y_1) after the first sampling cycle t_s (step 22 in FIG. 1) and then calculates x- and y-axis image movement data dx_s, dy_s (step 23 in FIG. 1). The image movement data dx_s is calculated according to the formula $k((x_1 - x_0) - dx_s) + dx_s$, and the image movement data dy_s is calculated according to the formula $k((y_1 - y_0) - dy_s) + dy_s$, where the values of dx_s and dy_s are the previous values of dx_s and dy_s, which are zero at first because of step 20, and k is a coefficient that determines a rate of change of scrolling speed, selected so as to be an appropriate value such that $0 < k < 1$.

After calculating the image movement data dx_s and dy_s, the CPU 1 controls reading from the RAM 2 and the display controller 4 in order to move the display image inside the screen by an amount equal to the coordinates (dx_s, dy_s) (step 24 in FIG. 1). Next, the CPU 1 detects whether or not the finger has been lifted off the touch panel 6 on the basis of a signal from the touch panel 6 (step 25 in FIG. 1) and, if the finger has not been lifted off, returns the process to step 22.

In this manner the CPU 1 repeats the process in steps 22 to 25 for every one of the fixed sampling cycles t_s, and the display image is scrolled by being redrawn every one of the fixed sampling cycles t_s.

The image movement data dx_s, dy_s is calculated such that the difference between the position indicated by the touch coordinates (x_1, y_1) and the position of the display image which has been moved by an amount corresponding to the image movement data dx_s, dy_s is largest immediately after the finger starts moving and gradually falls, and therefore the display is scrolled so as to move as if it had an appropriate amount of weight.

Note that a movement speed v_s of (scrolling speed) of the display image and a speed v_f at which the finger moves are expressed in the following equations.

$$v_s = d_s / t_s$$

$$v_f = d_f / t_s$$

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where $d_s = \sqrt{(dx_s)^2 + (dy_s)^2}$ and $d_f = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}$. Because the sampling cycle t_s of the touch panel 6 is normally fixed, the scroll speed v_s changes in accordance with the movement amount describes of the display image, and approaches the speed of movement v_f of the finger over time.

Operation in a cases where the finger stops moving and is lifted off of the touch panel 6 is described next. When the finger is removed from the touch panel 6, the CPU 1 detects an off-touch by means of a signal from the touch panel 6 input via the interface 7 (step 25 in FIG. 1) and on the basis thereof calculates the image movement data dx_s, dy_s following the equation $(1 - k) \cdot dx_s$ and $(1 - k) \cdot dy_s$ (step 26 in FIG. 1).

Next, the CPU 1 determines whether or not the amount of movement corresponding to the image movement data dx_s, dy_s thus calculated is smaller than a size D_{th} of a single dot in the display 5 (steps 27 and 28 in FIG. 1). If the image movement data dx_s, dy_s is larger than D_{th}, the process returns to step 26 and calculates dx_s, dy_s. The amount of movement yielded by the formulas equation $(1 - k) \cdot dx_s$ and $(1 - k) \cdot dy_s$ is largest at the beginning but gradually falls, and by the end is smaller than the size D_{th} of one dot, at which point the scrolling ends (step 29 in FIG. 1).

Thus, the speed of movement of the display image according to the image movement data dx_s, dy_s is largest after the off-touch as well as immediately after the off-touch, but gradually approaches the speed of movement instructed by the touch panel 6 over time (i.e., zero in this case), eventually stopping. The display image therefore does not stop immediately after the off-touch, but rather scrolls and stops as though it had an appropriate amount of weight or inertia, moving a little before stopping. This gives a natural feel to the movement.

The present invention is not limited to the present embodiment, for example the device shown in FIG. 3 for organizing and searching through files in card format, as a device for performing display scrolling. The present invention may naturally be applied to various types of devices that can display other shapes. Moreover, the input device for giving instructions for display scrolling is not limited to touch panels. Stylus input devices may be used, as can mice and other types of pointing devices.

Effects of the Invention

As described above, the present invention can scroll a display that approaches a speed of movement of a pointing section on a pointing device in a non-linear manner over time, making it possible to scroll the display as though the display image has an appropriate weight and is being moved with a certain amount of friction and stops with inertia, and therefore has advantages in allowing extremely natural-feeling scrolling of displays.

4. Brief Description of the Drawings

FIG. 1 is a flowchart showing one embodiment of the present invention.

FIG. 2 is a descriptive view of a display scrolling speed in the present invention.

FIG. 3 is a block diagram of one example of a file searching device to which the present invention can be applied.

FIG. 4 is a view describing display scrolling in the device shown in FIG. 3.

FIG. 5 is a flowchart of one example of a conventional display scrolling system.

In the drawings:

1 is a central processing unit (CPU),

5 is a display,

6 is a touch panel, and

20 to 29 are steps.

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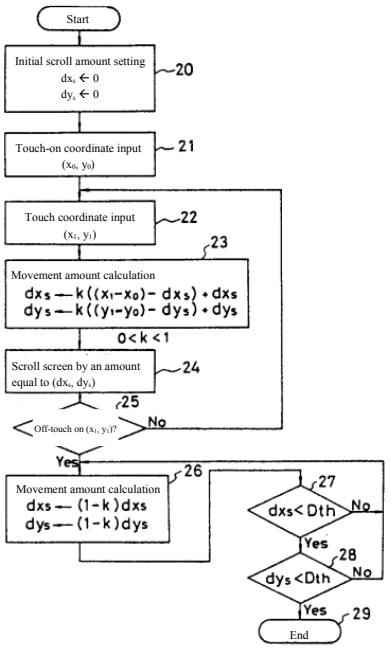
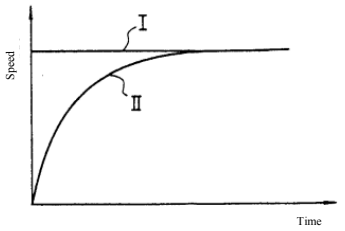


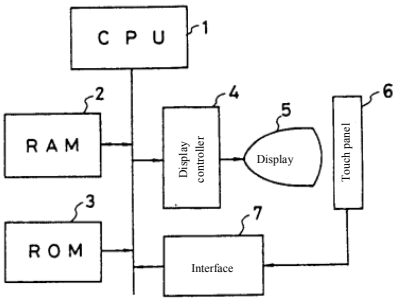
Flowchart of one embodiment of the present invention

FIG. 1



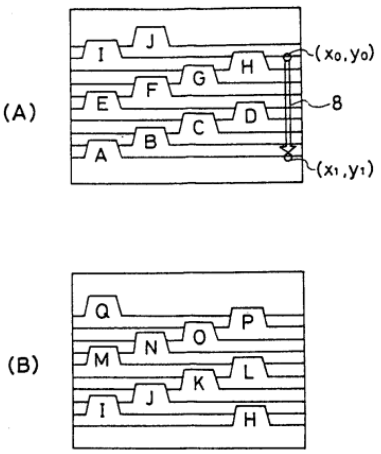
Descriptive view of display scrolling speed in the present invention

FIG. 2



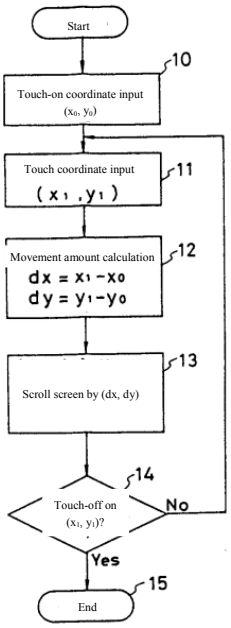
Block diagram of a file searching device to which the present invention can be applied

FIG. 3



Descriptive view of a display scrolling operation

FIG. 4



Flowchart of one example of a conventional system

FIG. 5

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