US 20010036861A1

(54) **IMAGE DISPLAYING METHOD, GAME SYSTEM AND COMPUTER READABLE STORAGE MEDIUM STORING IMAGE DISPLAYING PROGRAM**

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(57) **ABSTRACT**

It is an object of the present invention to enable to provide with a image display method which displays a high-quality picture without making any disorder on the screen even when the processing load increases.

A required time for each unit processing within one flame is detected during the image display processing, and a cumulative processing time Ta which is a total of each unit processing time is calculated. Then it is judged weather the situation Ta<Tr is made for the predetermined reference value Tr. By the result of the above judgement, the first display mode in which the pixel position of an odd number flame and an even number flame are differently arranged, and the second display mode in which the pixel position of an odd number flame and an even number flame are identically arranged, are alternatively settled. Then the paint processing for the object flame is performed. The first display mode which has advantage in picture quality is settled if the processing load is light. The second display mode is settled if the processing load is heavy. Accordingly, the disorder on the screen caused by the delay of processing is prevented and the high quality image display is realized.

FIG. 1

FIG. 2

ODD NUMBER FLAME

EVEN NUMBER FLAME

F I G. 3

```
                        ┌─────────────┐
                        │    START    │
                        └──────┬──────┘
                               ▽
        ┌──────────────────────────────────┐
        │ DETECT RIQUIRED TIME             │  S1
        │ FOR EACH UNIT PROCESSING         │
        │ WITHIN ONE FLAME                 │
        └──────────────────┬───────────────┘
                           ▽
        ┌──────────────────────────────────┐
        │ CALCULATE  CUMULATIVE            │  S2
        │ PROCESSING TIME Ta               │
        │ IN ONE FLAME                     │
        └──────────────────┬───────────────┘
                           ▽
                                      S3
                          ◇                     NO
                     Ta<Tr ? ───────────────────────────────┐
                          ◇                                  │
                          │                                  ▽       S5
                        YES                                        NO
                          ▽       S4              SET THE SECOND ──────────┐
                                                  DISPLAY MODE?            │
              SET THE FIRST      NO                    ◇                   │
              DISPLAY MODE? ──────────┐              YES                   │
                    ◇                 │               │                    │
                  YES                 ▽    S6         │                    │
                    │        Ta<Tr WAS MADE           │                    │
                    │   NO   IN CONTINUOUS M          │                    │
                    │ ◁───── FLAMES ?                 │                    │
                    │            ◇                    │                    │
                    │          YES   S7               │                    │
                    │            ▽                    │           S8       ▽
                    │   ┌──────────────────┐          │   ┌──────────────────┐
                    │   │ SWITCH TO THE    │          │   │ SWITCH TO THE    │
                    │   │ FIRST DISPLAY MODE│         │   │ SECOND DISPLAY MODE│
                    │   └────────┬─────────┘          │   └────────┬─────────┘
                    ▽            ▽                    ▽            │
        ┌──────────────────────────────────┐
        │ PAINT PROCESSING FOR             │  S9
        │ THE OBJECT FLAME                 │
        └──────────────────┬───────────────┘
                           ▽
                                      S10
                          ◇
            NO        FINISH THE DISPLAY
        ┌─────────── PROCESSING ?
        │                 ◇
        │               YES
        │                 ▽
        │         ┌─────────────┐
        │         │     END     │
        │         └─────────────┘
        └──────────────────────────────
```
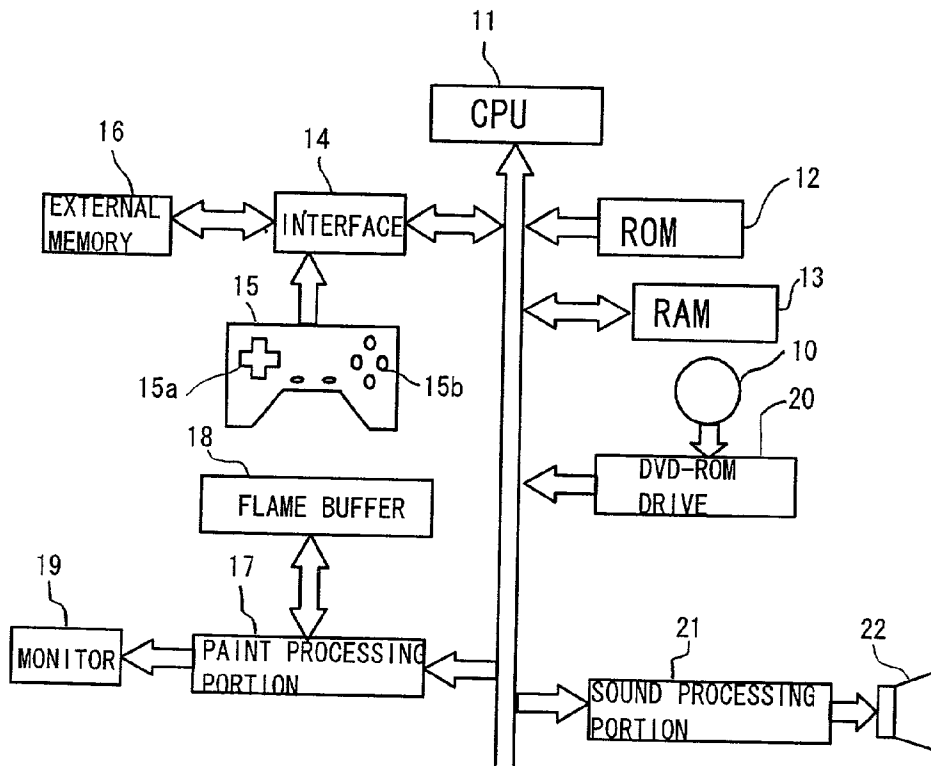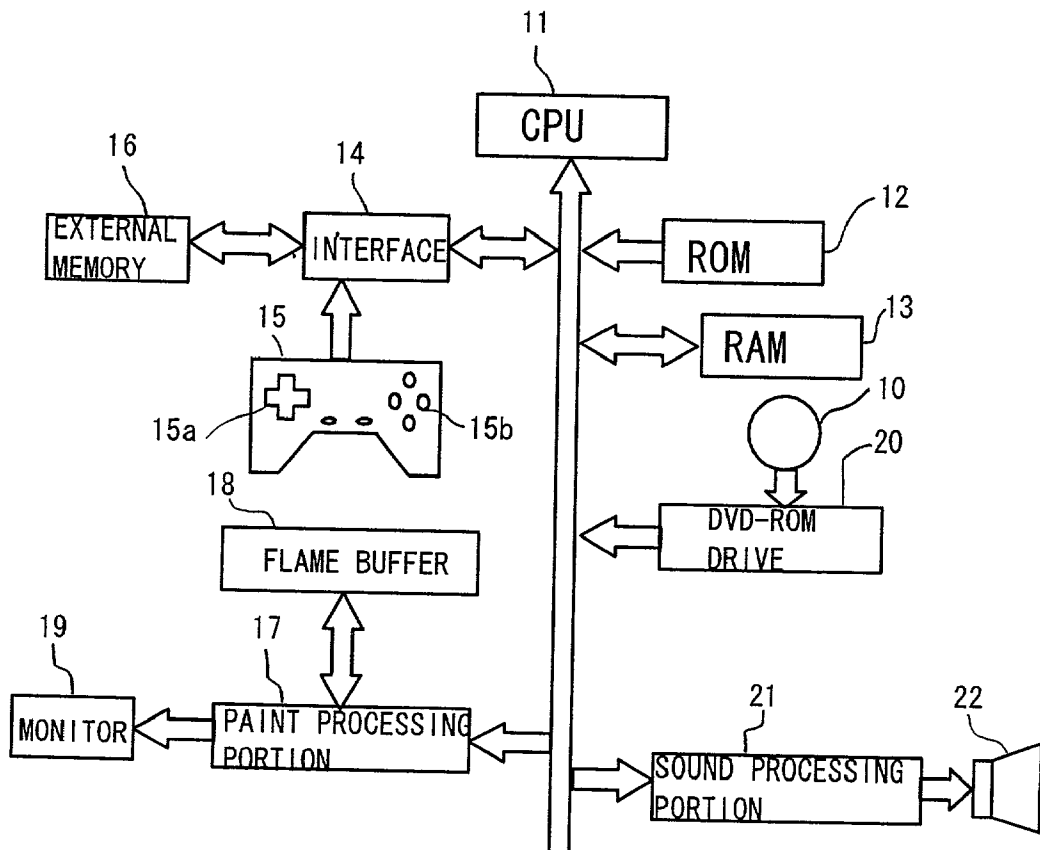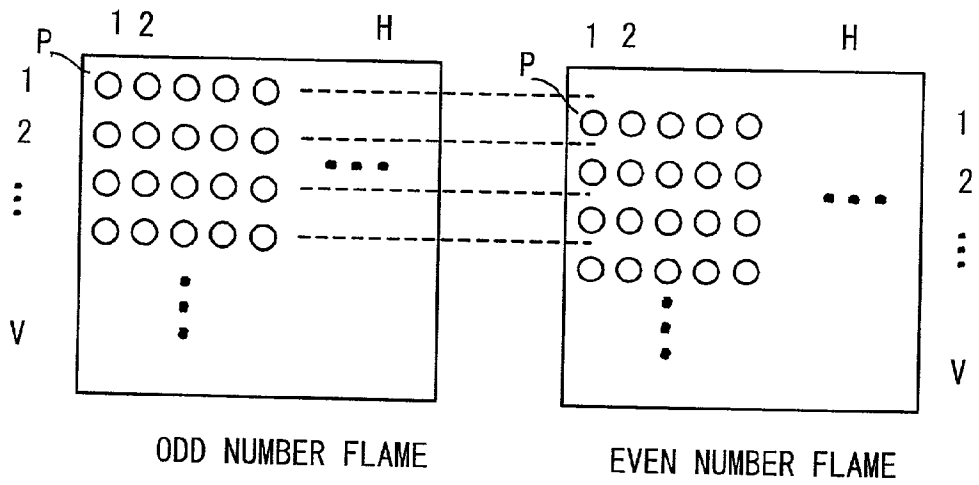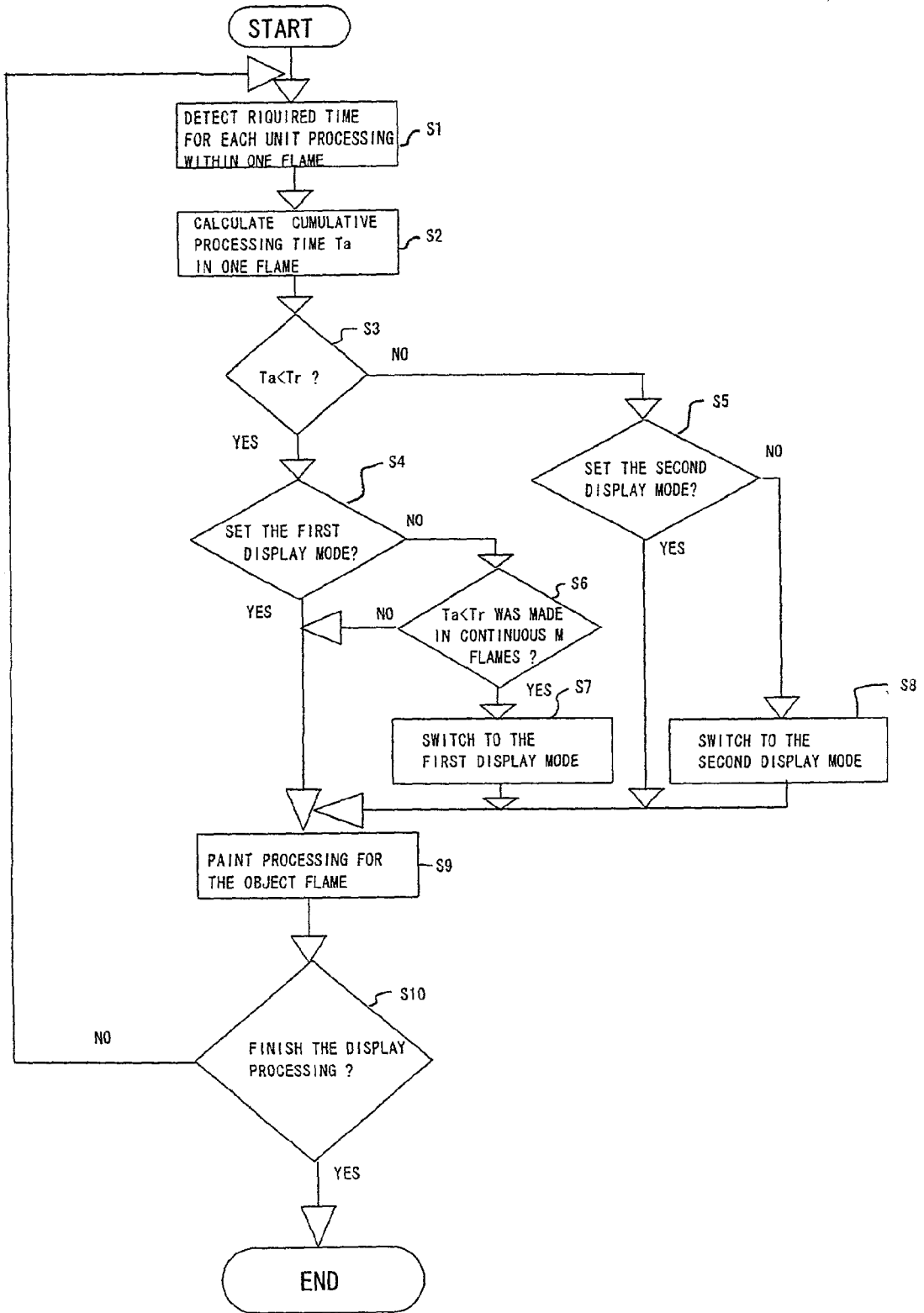
IMAGE DISPLAYING METHOD, GAME SYSTEM AND COMPUTER READABLE STORAGE MEDIUM STORING IMAGE DISPLAYING PROGRAM

BACKGROUND OF THE INVENTION

[0001]   1. Field of the Invention

[0002]   The present invention relates to an image displaying method in a game system and the like, especially belongs to a technical field of an image displaying method for constituting an image by processing image data for each flame and outputting them to a display device.

[0003]   2. Description of the Related Art

[0004]   Recently, the quality of a game picture has been improved with the improvement of the processing performance of a game machine. In the conventional home use game system, the game picture is constituted by outputting image data to be displayed on the monitor of the NTSC television system by each flame. In such a game system, 60 flames of flame image data are generated in one second corresponding to an NTSC interlace scanning.

[0005]   It is desirable to improve a resolution by increasing pixel number constituting flame image data for the improvement of the game picture. On the other hand, it is necessary to control the total number of pixels of the flame image data because there is certain amount of restriction on memory size for storing flame image data and image processing capacity. Therefor, there exists a conventional method to substantially double the resolution by, for example, shifting a position of an even number flame from that of an odd number flame in vertical direction by half size of one pixel and outputting flame image data by turns. Thus, it is possible to display a high quality game picture with control the data size and processing amount in image processing and.

[0006]   However, even when the above described method is applied, the image processing must be conducted **60** times per one second, resulting in a seriously heavy load of processing. On the other hand, there will be a heavy load when other processing, for example, a calculation of three-dimensional expression is conducted in synchronism with image processing of each flame. In some situation of the game, it possibly happens that all of the processing can not be finished within a flame. As a result, the synchronism for each flame can not be attained and a disorder appears on the game picture.

SUMMARY OF THE INVENTION

[0007]   The present invention is made to solve these problems. It is an object of the present invention to provide with an image display method capable of displaying a high-quality picture without making any disorder on the picture even when the processing load increases.

[0008]   In order to solve the above problems, according to the first embodiment of the present invention, there is provided an image displaying method for displaying an image by outputting image data by each flame to display device, wherein it is possible to set alternatively a first display mode which outputs image data to the display device with a different pixel arrangement for each flame and a second display mode which outputs image data to the display device with an identical pixel arrangement for each flame, judging a scale of a processing load performed within one flame, and setting the first display mode when the load is judged to be light or setting the second display mode when the load is judged to be heavy.

[0009]   The second embodiment of the present invention is a game system displaying an image by outputting image data to a display device for each flame, comprising a display mode setting device for setting alternatively a first display mode outputting image data to the display device with a different pixel arrangement for each flame and a second display mode outputting image data to the display device with an identical pixel arrangement for each flame, wherein the display mode setting device judges a scale of processing load performed within one flame, sets the first display mode when the load is judged to be light, or sets second display mode when the load is judged to be heavy.

[0010]   The third embodiment of the present invention is a computer readable storage medium storing an image display program formed so as to make a computer, performing an image display processing to display an image by outputting image data to a display device by each flame, function as; being able to set alternatively a first display mode which outputs image data to the display device with a different pixel arrangement for each flame and a second display mode which outputs image data to the display device with an identical pixel arrangement for each flame, and judging a processing load performed within one flame and setting the first display mode when the load is judged to be light or setting the second display mode when the load is judged to be heavy.

[0011]   According to these embodiments, an image is displayed by setting the first display mode when the load is light and by setting the second display mode when the load is heavy during outputting the image data to the display device by each flame. Accordingly, the resolution is improved artificially as different pixel arrangement for each flame in normal situation. On the other hand, the processing load is lightened if the processing is too busy to be performed. Therefor, the disorder of picture quality is prevented by arranging identical pixel for each flame and an image is displayed with a well-balanced adjustment between the quantity of processing and the quality of the picture.

[0012]   The fourth embodiment of the present invention is an image displaying method characterized by that the first display mode constitutes image data by arranging pixel data at different pixel positions each other for an odd number flame and an even number flame.

[0013]   The fifth embodiment of the present invention is a game system characterized by that the display mode setting device makes the first display mode constitute image data by arranging pixel data at different pixel positions each other for an odd number flame and an even number flame.

[0014]   The sixth embodiment of the present invention is a computer readable storage medium storing an image displaying program according to claim **10** in the invention according to claim **9** is characterized by that the first display mode constitutes image data by arranging pixel data at different pixel positions each other for an odd number flame and an even number flame.

[0015]   According to these embodiments, as the processing load is judged by comparing the processing time with the

predetermined reference value, judgement for switching the first display mode to the second display mode is performed accurately.

[0016] The seventh embodiment of the present invention is an image display method characterized by that the switching operation to the first display mode is performed if the processing time is continuously less than the reference value during predetermined number of flames in the case where the second display mode is set.

[0017] The eighth embodiment of the present invention is a game system characterized by that the display mode setting device sets a switching to the first display mode when the processing time is continuously less than the reference value during predetermined number of flames in the case where the second display mode is set.

[0018] The ninth embodiment of the present invention is a computer readable storage medium storing an image displaying program characterized by that the program is formed so as to make the computer switch to the first display mode when the processing time is continuously less than the reference value during predetermined number of flames in the case where said second display mode is set.

[0019] According to these embodiments, a the switching operation is not immediately conducted even when the processing load is lightened during the setting to the second display mode, and the switching operation is conducted after the consecutive situation where the processing load is light, a steady switching operation can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 is a block diagram showing brief constitution of the game system of one embodiment of the invention;

[0021] FIG. 2 is a diagram showing a data structure of the flame picture used in the first display mode; and

[0022] FIG. 3 is a flowchart showing a display processing in the embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] There will be explained hereinafter a preferred embodiment of the invention with referring to the drawings. Here, the embodiment in which the present invention is applied to a conventional home-use game system will be explained.

[0024] FIG. 1 is a block diagram showing a brief constitution of the game system of this embodiment. The game system shown in FIG.1 comprises a CPU 11, a ROM 12, a RAM 13, an interface 14, a controller 15, an external memory 16, a paint processing portion 17, a flame buffer 18, a monitor 19, a DVD-ROM drive 20, a sound processing portion 21 and a speaker 22. The system makes the required game be operated by setting the DVD-ROM 10 storing a game program and game data on the DVD-ROM drive 20.

[0025] In FIG. 1, CPU 11 controls the operation of whole game system and gives/receives control signals and data by being connected to each constitutional element. The ROM 12 and the RAM 13 are used as storing devices. The operating system program and various kinds of data required for the operation control of the whole game system are

stored in the ROM 12. A memory area is provided on the RAM 13 for tentatively storing game program readout from the DVD-ROM 10, or data necessary for the game proceeding.

[0026] The controller 15 connected via the interface 14 functions as an operation device for the player's operation during the game. The controller 15 comprises operation members such as a cross key 15a for inputting vertical and horizontal direction and a push button key 15b. Signals corresponding to the operation status of these operation members are output to the CPU 11. Further, external memory 16 is connected attachably to/detachably from CPU 11 via an interface 14 and is used for rewritablly storing the data which indicates the progress of the game. The player of the game can record a desired data on the external memory 16 by commanding it with the controller 15 as required.

[0027] The DVD-ROM 10 is a storage medium storing program for executing the game and various kind of collateral data such as image data and sound data relating to the game. The DVD-ROM drive 20 reads out required programs and data by conducting read-out motion on the inserted DVD-ROM 10 under the control of the CPU 11.

[0028] The paint processing portion 17 conducts painting process for image data which is read out from DVD-ROM 10 and processed by the CPU 11. As the display of the image data is made by each flame, the flame image data for each flame is generated at the paint processing portion. Flame image data is constituted by allegation of the pixel data included in the image area of pixel number H for the horizontal direction and pixel number V for the vertical direction. The paint processing portion 17 performs display processing by generating 60 flame image data one by one per one second according to the NTSC system.

[0029] There are the first display mode and the second display mode as display processing of the game screen of this embodiment. As described latter, switching operation to one display mode is conducted under the certain conditions by the control of the CPU 11. The first display mode is an arrangement where the pixel location is dislocated each other by half-pixel size in the vertical direction between odd number flames and even number flames, and they correspond to different pictures respectively. Accordingly, the resolution can actually be doubled by the flame image data of the odd number flame and the even number flame. On the other hand, the pixel location of the odd number flame is same as that of the even number flame, and the resolution equals half of that of the first display mode.

[0030] Here, there will be explained a structure of a flame image data used in the first display mode by showing FIG. 2. In FIG. 2, a pixel arrangement of the flame image data for the odd number flame and the even number flame is respectively shown. In both of them, pixels number V in vertical direction and pixels number H in horizontal direction, V×H of pixel data p in total, are arranged. It is apparent that their pixel location is dislocated by half size of a pixel each other in vertical direction as indicated with the dotted line by comparing the odd number flame with the even number flame. Accordingly, in the case where the odd number flame and the even number flame are displayed alternately, pixel numbers in the vertical direction are increased to 2H, resulting in the improvement of the resolution.

[0031] On the other hand, in the second display mode, the odd number flame and the even number flame are arranged

at the same location with no difference in pixel arrangement of flame image data. Accordingly, the resolution of the image by the second display mode is actually half of that by the first display mode.

[0032] Then going back to **FIG. 1**, the flame buffer **18** stores 1 flame size of flame image data generated by paint processing portion **17**. Accordingly, the paint processing portion has a capacity for storing the flame image data comprising at least V×H of pixel data. The flame image data stored in the flame buffer **18** is read out by 60 flames per one second from flame buffer **18** and is output to the monitor **19**. As the monitor **19**, a home-use television set referenced to the NTSC system can be used.

[0033] The sound processing portion **21** converts the sound data readout from the DVD-ROM **10** into analogue sound signal and outputs it to the speaker **22**. Further, the sound processing portion **21** generates sound effect and musical sound required during the game and converts them into analogue signal and then outputs it to the speaker **22** in compliance with the command made by the CPU **11**.

[0034] Then, there will be explained display processing in the embodiment of the present invention by referring to **FIG. 3**. **FIG. 3** is a flow chart showing a display processing for displaying a game screen on the monitor **19**. In this embodiment, switching operation to/from above described first display mode or the second display mode is made corresponding to the scale of the processing load controlled by the CPU **11**. Here, the processing controlled by the CPU **11** performs each processing unit one by one as a loop so as to be synchronized with one flame. For example, these processing unit comprises a judgement routine of the content of the operation by the controller **15**, a consideration routine of the character, display control routine, and various kind of other processing.

[0035] Firstly, in step S1, a required time for a unit processing within one flame is detected. If the processing performed in each flame includes a plurality of unit processing, the time required for each unit processing may be detected. For example, the time required for each unit processing can be detected by providing a clock device controlled by the CPU **11**. Next, in step S2, the cumulative processing time Ta required for each unit processing is calculated. The cumulative processing time Ta may be directly detected by means of the clock device.

[0036] Next, in step S3, the cumulative processing time Ta within one flame is compared with the predetermined reference value Tr. This reference value may be set as approximately same as a time for one flame. With the comparison result in step S3, if it is judged to be Ta<Tr (step S3; YES), then the process proceeds to step S4. If it is not judged to be Ta<Tr (step S3; NO), then the process proceeds to step S5.

[0037] In step S4, it is judged whether the above described first display mode is currently being set in display processing. In step S5, it is judged whether the above described second display mode is currently being set in display processing. With the judgement result instep S4, if it is judged that the first display mode is currently set(step S4; YES), then the process proceeds to step S9. In a same manner, with the judgement result in step S5, if it is judged that the second display mode is currently set(step S5; YES), then the

process also proceeds to step S9. Namely, both cases correspond to the case where the current display mode is kept as it is.

[0038] On the other hand, with the judgement result in step S4, if it is judged that the first display mode is not set but the second display mode is set (step S4; NO), then it is judged whether the situation of Ta<Tr is consecutively made in M flames in step S6. The purpose of this process is to wait for the stability of the status at a certain level even if the processing load is lightened in the setting process to the second display mode. In addition, the consecutive flame number M in step S6 may be settled appropriately by considering the rapidness and the stability of switching.

[0039] If a continuous M flames of the condition Ta<Tr is made as a result of the judgement in step S6 (step S6; YES), the process proceeds to step S9 after switching to the first display mode in step S7. Namely, in this case, as it is judged that there is an enough margin in processing load, a priority is set on the picture quality and display processing with the flame image data in which pixel position of odd number flames is dislocated from that of even number flames as described above is performed hereafter. On the other hand, if the number of flames in which the condition Ta<Tr is made is less than M as a result of judgement in S6 (step S6; NO), the process proceeds to step S9.

[0040] Besides, it is judged that not the second display mode but the first display mode is settled as a result of step S5, (step S5; NO), the process proceeds to step S9 after switching to the second display mode in step S8. Namely, in this case, as it is judged that there is not an enough margin in processing load, for lightening the processing load, the display processing with the flame image data in which the pixel positions of odd number flames and even number flames are arranged in the common position as described above is performed hereafter.

[0041] Next, in step S9, a paint processing for object flame is performed by the first display mode or the second display mode. Namely, the flame image data to be stored in flame buffer **18** is read out and output on the monitor **19** as a game picture of one flame size. Then, in step **10**, it is judged weather the display processing of the game picture is finished. If it is judged that the processing is continued (step S10; NO), steps after S1 are repeated. If it is judged that the processing is finished step S10; YES),the process in **FIG. 3** is finalized.

[0042] As described above, in the process of **FIG. 3** the switching from the first display mode to the second display mode or from the second display mode to the first display mode is performed. If the whole processing scale expands and it becomes impossible to catch up the paint processing, then the second display mode which requires lighter load for paint processing is settled. On the other hand, if the whole processing scale shrinks and there is an enough margin for paint processing, the first display mode which provides with a better picture quality is applied. Accordingly, the disorder of the picture displayed on the monitor **19** can be prevented beforehand and a high quality picture can be realized.

[0043] Although the case where the invention is applied to the game system in the above described embodiment, this invention is not limited to the embodiment. The invention also can be applied to other forms of systems with image

display processing. Besides, as a storage medium for storing game program which makes the invention function, the CD-ROM, the floppy disc, the hard disc, and various kind of storage medium can be used in addition to the DVD-ROM.

[0044] As described above, according to this invention, a high quality image display is realized without the disorder on the screen even if the processing load increases during the image displaying.

[0045] The entire disclosure of Japanese Patent Application NO 2000-130254 filed on Apr. 28, 2000 including specification, claims, drawings and summary are incorporated herein by reference in its entirety. While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. An image displaying method for displaying an image by outputting image data by each flame to a display device, wherein being capable to set alternatively a first display mode which outputs image data to said display device with a different pixel arrangement for each flame and a second display mode which outputs image data to said display device with an identical pixel arrangement for each flame, comprising steps of:

judging a scale of a processing load performed within one flame, and

setting said first display mode when the load is judged to be light or setting said second display mode when the load is judged to be heavy.

2. An image displaying method according to claim 1, wherein said first display mode constitutes image data by arranging pixel data at different pixel positions each other for an odd number flame and an even number flame.

3. An image displaying method according to claim 1, further comprising steps of;

measuring a processing time required for the processing performed within one flame, and

judging a scale of a load by comparing said processing time with a predetermined reference value.

4. An image displaying method according to claim 3, wherein a switching operation to said first display mode is performed if said processing time is continuously less than said reference value during predetermined number of flames in the case where said second display mode is set.

5. A game system displaying an image by outputting image data to a display device for each flame, comprising a display mode setting device for setting alternatively a first display mode outputting image data to said display device with a different pixel arrangement for each flame and a

second display mode outputting image data to said display device with an identical pixel arrangement for each flame, wherein said display mode setting device judges a scale of processing load performed within one flame, sets said first display mode when the load is judged to be light, or sets second display mode when the load is judged to be heavy.

6. A game system according to claim 5, wherein said display mode setting device makes said first display mode constitute image data by arranging pixel data at different pixel positions each other for an odd number flame and an even number flame.

7. A game system according to claim 5, wherein said display mode setting device measures a processing time required for the processing performed in one flame and judges a scale of load by comparing said processing time with a predetermined reference value.

8. A game system according to claim 7, wherein said display mode setting device sets a switching to said first display mode when said processing time is continuously less than said reference value during predetermined number of flames in the case where said second display mode is set.

9. A computer readable storage medium storing an image display program formed so as to make a computer, performing an image display processing to display an image by outputting image data to a display device by each flame, function as;

being able to set alternatively a first display mode which outputs image data to said display device with a different pixel arrangement for each flame to a second display mode which outputs image data to said display device with an identical pixel arrangement for each flame, and

judging a processing load performed within one flame and setting said first display mode when the load is judged to be light or setting said second display mode when the load is judged to be heavy.

10. A computer readable storage medium storing an image display program according to claim 9, wherein said first display mode constitutes image data by arranging pixel data at different pixel positions each other for an odd number flame and an even number flame.

11. A computer readable storage medium storing an image display program according to claim 9, wherein the program is formed so as to make the computer measure a processing time required for the processing performed in one flame and judge a scale of load by comparing said processing time with a predetermined reference value.

12. A computer readable storage medium storing an image display program according to claim 11, wherein the program is formed so as to make the computer switch to said first display mode when said processing time is continuously less than said reference value during predetermined number of flames in the case where said second display mode is set.

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