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Canadian Intellectual Property Office
An agency of Industry Canada

CA 2242166 C 2005/08/16

(11)(21) 2 242 166

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 1998/06/30

(41) Mise à la disp. pub./Open to Public Insp.: 1999/02/04

(45) Date de délivrance/Issue Date: 2005/08/16

(30) Priorité/Priority: 1997/08/04 (08/906,215) US

(51) Cl.Int.^{6}/Int.Cl.^{6} G06F 3/14

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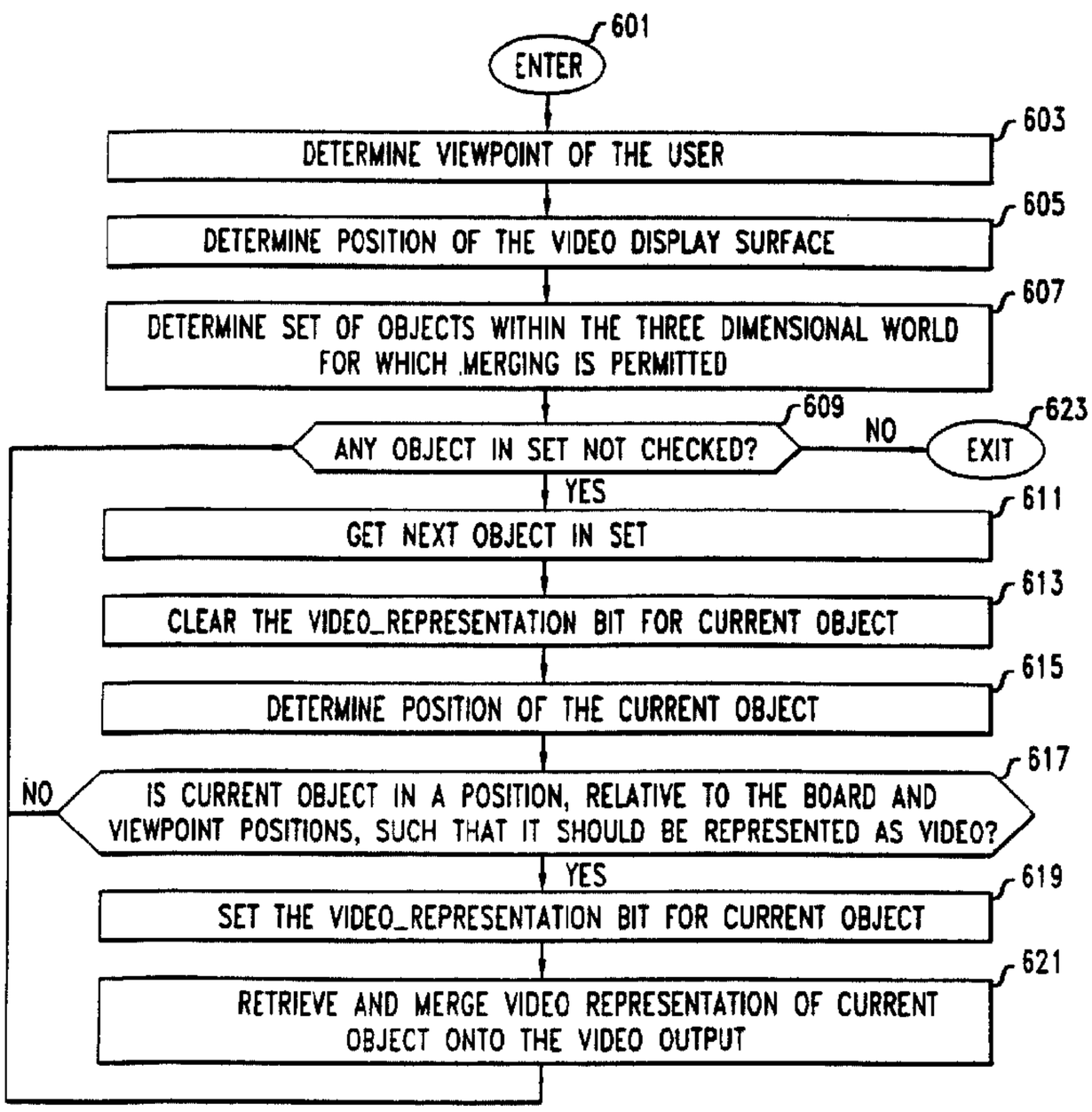
(54) Titre : TECHNIQUES D'AFFICHAGE D'UNE REALITE VIRTUELLE TRIDIMENSIONNELLE
(54) Title: DISPLAY TECHNIQUES FOR THREE DIMENSIONAL VIRTUAL REALITY



(57) Abrégé/Abstract:
A limitation of a three-dimensional world in which objects in the distance may be represented in only two dimensions as a video on a screen occurs when a computer graphic object represented by computer graphics, e.g., in front of, to the side, above, or below the video screen, undergoes a trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video, because such an object would disappear from view by the viewer. This limitation is overcome by having such an object be represented as video on the screen, rather than computer graphics. Thus, the computer graphics object "goes into the video" as video and remains visible to a viewer in front of the video screen, rather than becoming invisible because it is blocked from view by the video screen if it were to be generated at its proper location using computer graphic techniques.

DISPLAY TECHNIQUES FOR THREE DIMENSIONAL VIRTUAL REALITY

Abstract

A limitation of a three-dimensional world in which objects in the distance may be represented in only two dimensions as a video on a screen occurs when a computer graphic object represented by computer graphics, e.g., in front of, to the side, above, or below the video screen, undergoes a trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video, because such an object would disappear from view by the viewer. This limitation is overcome by having such an object be represented as video on the screen, rather than computer graphics. Thus, the computer graphics object "goes into the video" as video and remains visible to a viewer in front of the video screen, rather than becoming invisible because it is blocked from view by the video screen if it were to be generated at its proper location using computer graphic techniques.

DISPLAY TECHNIQUES FOR THREE DIMENSIONAL VIRTUAL REALITY

Technical Field

This invention relates to the integration of computer graphics and video to provide a realistic three dimensional virtual reality experience.

Background of the Invention

The display of a three dimensional world to a viewer requires considerable computation power, and it is typically costly to develop the necessary highly detailed models required for doing so. In order to simplify the problem, a portion of the world that is in the distance may be represented in only two dimensions as a video displayed on a surface, e.g., a screen. By video it is meant the common usage of the term, such as the placing or projecting of predefined images on the surface, e.g., the electronic version of filmed moving pictures. Thus, such a world is essentially truncated in length to the screen on which the video is displayed. A great reduction in computation power and cost can be achieved by such an arrangement.

Summary of the Invention

A limitation of such a world occurs when a computer graphic object represented by computer graphics, e.g., in front of, to the side of, above, or below the video screen, undergoes a trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video. We have recognized that, in accordance with the principles of the invention, when a computer graphic object undergoes a trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video, such an object should be represented as video on the screen, rather than computer graphics. Thus, the computer graphics object "goes into the video" as video and remains visible to a viewer in front of the video screen, rather than becoming invisible because it is blocked from view by the video screen if it were to be generated at its proper location using computer graphic techniques.

In accordance with one aspect of the present invention there is provided a method for use in processing a view of a three dimensional world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented

by a video display on a video screen which exists in said first portion of said world, wherein said video is made up of a sequence of images, the method comprising the steps of: determining that an object, other than said video screen, is being modeled as computer graphics and has moved to a location that is being represented by said video and at which said object is at least partly occluded from view of a viewer of said world by said video screen although said object should not appear occluded to said viewer when at said location; changing the representation of said object from one modeled as computer graphics to a video representation thereof; and displaying said video representation so that it appears to said viewer to be substantially integrated with said video on said video screen.

In accordance with another aspect of the present invention there is provided a system for displaying an apparently three dimensional world to a user, in which a first part of said three dimensional world is displayed as computer graphics and a second part is displayed as video on a video screen, wherein said video is made up of a sequence of images, said system comprising: a processor for determining that an element displayed in said first part of said world transited from said first part to said second part by having moved to a location that is being represented by said second part and at which said element is at least partly occluded from view of a viewer of said world by a said video screen although said object should not appear occluded to said viewer when at said location; and a rendering engine for displaying said world with said element displayed so that it appears to said viewer to be substantially integrated into said second part rather than said first part.

In accordance with yet another aspect of the present invention there is provided a system for displaying an apparently three dimensional world to a user, in which a first part of said three dimensional world is displayed as computer graphics and a second part is displayed as video on a video screen, wherein said video is made up of a sequence of images, said system comprising: a processor for determining that a portion of an element initially in said first part of said world has moved to a location within said second part by virtue of having moved to a location that is being represented by said second part and at which portion of said element is at least partly occluded from view of a viewer of said world by said video screen although said object should not appear occluded to said viewer when at said location; and a rendering engine for displaying said world with said element displayed so that it appears to said viewer to be substantially integrated into said second part rather than said first part.

In accordance with still yet another aspect of the present invention there is provided an apparatus for use in processing a view of a three dimensional world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video, wherein said video is made up of a sequence of images, the apparatus comprising: means for determining that an object being modeled as computer graphics has moved to a location that is being represented by said video by having moved to a location that is being represented by said second portion and at which said object is at least partly occluded from view of a viewer of said world by said video although said object should not appear occluded to said viewer when at said location; and means for changing the representation of said object from one modeled as computer graphics to a video representation thereof displayed so that it appears to said viewer to be substantially integrated into said second portion rather than said first portion.

The above-identified apparatus may include means for displaying said video representation of said object merged with said portion of said world that is represented by said video.

In accordance with still yet another aspect of the present invention there is provided an apparatus for use in processing a view of a world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video on a video surface which exists in said first portion of said world, wherein said video is made up of a sequence of images, said apparatus comprising: means for displaying and using a video representation of said object displayed on said video surface when at least a portion of said object is determined to be at a location in the world that is not represented as computer graphics but is instead within the field represented by said video on the video surface; and means for displaying said object as a computer graphics object in said first portion of said world in addition to and independent from said video representation of said object on said video surface when said object is determined to be at a location in the world that is represented as computer graphics.

The above-identified apparatus may contain both of said means for displaying are comprised within a single system and or both of said means for displaying may be implemented using a single processor running different software for each means.

In accordance with still yet another aspect of the present invention there is provided an apparatus for use in processing a view of a three dimensional world in which a first

portion of said world is modeled as computer graphics and a second portion of said world is represented by a video on a video surface which exists in said first portion of said world, wherein said video is made up of a sequence of images, the apparatus comprising: means for merging the representation of an object that had been modeled as computer graphics with that of said video surface, so that said object is represented as part of said video displayed on said video surface as a function of a distance between said object and said video surface; and means for supplying said merged representation to a display for displaying said merged representation to a user.

Brief Description of the Drawings

FIGs. 1-4 show an example of that which a user sees according to the invention when a computer graphic object undergoes a trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video, such an object should be represented as video on the screen, rather than computer graphics;

FIG. 5 shows an exemplary process for displaying the world to a user, in accordance with the principles of the invention;

FIG. 6 shows an exemplary process, in accordance with the principles of the invention, for composing a frame of video for display on a video screen;

FIG. 7 is a representation of a three dimensional world and an associated three dimensional display system according to an embodiment of the present invention; and

FIG. 8 is a representation of a three dimensional world and an associated view processing system according to an embodiment of the present invention.

Detailed Description

To better understand the invention, FIGs. 1-4 show an example of that which a user sees according to the invention when a computer graphic object undergoes a trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video, such an object should be represented as video on the screen, rather than computer graphics. In other words, FIGs. 1-4 show an example of a computer graphics object "going into the video" as video and remaining visible to a viewer in front of the video screen, rather than becoming invisible because it is blocked from view by

the video screen if it were to be generated at its proper location using computer graphic techniques.

FIG. 1 shows world 101, which is a bicycle path in a park, e.g., Central Park in New York City. World 101 is divided into two portions, video screen 103, on which is shown the current frame of a video and the remainder of the world 105, which is represented using computer graphic techniques, and is thus referred to herein as computer graphics part (CG Part) 105. Within CG Part 105 there are various elements, such as bicyclist 107 representing the user, another bicyclist 109, and road 111.

Note that the viewpoint of the user is actually behind the representation of both bicyclists 107 and 109. Also note that bicyclist 107, is moving slower than bicyclist 109. If this continues, eventually, bicyclist 109 will reach screen 103 while bicyclist 107 lags behind. This occurs in FIG. 2, which shows world 101 of FIG. 1, but at a later time and from a side perspective. If the relative motion difference continues between bicyclists 107 and 109, part, and then all, of bicyclist 109 will intersect with, or go past, video screen 103. If this happens, part, and then all, of bicyclist 109 will become occluded by video screen 103 from a user in front of video screen 103, and so it will no longer be visible to such a user. Therefore, in accordance with the principles of the invention, bicyclist 109 is represented as video 309 that is merged into the video being displayed on video screen 103 rather than being represented using computer graphic techniques as 109 within CG Part 105, as shown in FIG 3. A corresponding side view is shown in FIG. 4.

The determination to represent an object, such as bicyclist 109, as video, such as video 309, that is merged into the video being displayed on the video screen rather than being represented using computer graphic techniques within CG Part 105, may be made when the object is within a predetermined distance from the video screen rather than requiring the change in representation to be at the exact point when the object intersects the video screen.. Furthermore, the distance employed may be determined dynamically, e.g., as a function of the speed and trajectory of the bicyclist. The merging in may also take place only once it is determined that a predetermined portion of the object has actually intersected, or passed through, the video screen.

In other implementations of the invention, computer graphics representation 109 may remain visible from other viewpoints, such as overhead. Thus, in accordance with an aspect of the invention, the determination as to whether or not to merge an object that is being represented using computer graphic techniques into the video being displayed on the video screen rather than continuing to be represented by using computer graphic techniques may be additionally a function of the viewpoint of the user. Preferably, but not necessarily, no viewpoint should have both video 309 and computer graphics 109 visible at the same time.

In the event that bicyclist 107 speeds up or bicyclist 109 slows down, so that based on the relative motion between them bicyclist 109 would no longer be at or beyond video screen 103, bicycle 109 may again be rendered using computer graphics techniques, as shown in FIG. 1.

FIG. 5 shows an exemplary process for displaying the world to a user, in accordance with the principles of the invention. The process is entered in step 501 whenever the world view of the user needs to be updated. It may be necessary to update the world view of the user a) whenever a new frame of video must be displayed; b) when an object within computer graphics part of the world, e.g., CG Part 105, has moved; c) when the user's viewpoint is changed; or d) for any combination of the foregoing reasons. Thereafter, steps 503 and 505 are performed, and these steps may be performed in parallel. In step 503, each object that is still within the view of the user and has not been merged into the video is rendered within the computer graphics part of the world. In step 505 a frame of video is displayed on video screen. This may be either a new frame of video, if it is time to update the video frame being displayed, or it may be the same frame of video that was previously displayed, if the world view of the user is being updated because of a need to change the representation of the computer graphics part of the world. Note that the frame of video that is displayed may be a "composed" frame of video in that includes a background video and video representing at least one object that was formerly

represented the computer graphics portion of the world using computer graphics techniques. The process then exits in step 507.

FIG. 6 shows an exemplary process, in accordance with the principles of the invention, for composing a frame of video that is displayed in step 505 (FIG. 5). The process is entered in step 601 whenever it is determined that a new frame of video is required for display. Thus, execution of the process of FIG. 6 may be linked to step 505 or it may be independent thereof. Next, in step 603, the viewpoint of the user is determined. Thereafter, in step 605, the position of the video display surface, e.g., screen, is determined, and then, in step 607, the set of objects within the three dimensional world for which merging is permitted is determined. Such objects may be identified by a set flag, such as a VIDEO_PERMITTED flag, within their data structure.

Conditional branch point 609 tests to determine if there remain any objects in the set of objects for which merging is permitted that have not yet been checked to determine if they should be displayed as video or using computer graphic techniques. If the test result in step 609 is NO, indicating that all the objects for which merging is permitted have been checked to determine if they should be displayed as video or using computer graphic techniques, control passes to step 623 and the process is exited. If the test result in step 609 is YES, indicating that all the objects for which merging is permitted have not been checked to determine if they should be displayed as video or using computer graphic techniques, control passes to step 611, in which the next object from the set that has not yet been checked is retrieved, and the retrieved object is made the current object.

Next, in step 613, a flag, e.g., a bit called VIDEO_REPRESENTATION, for the current object is cleared. In step 615, the position of the current object is determined. Optionally, the motion of the current object, e.g., its speed and trajectory, are also determined.

Thereafter, in accordance with the principles of the invention, conditional branch point 617 tests to determine if the current object should be represented by video. As noted above, if the object is at a point in its trajectory that takes it to a location in the world that is not represented as computer graphics, but instead is within the field represented by the video, the object should be represented as video, rather than using computer graphics. More specifically, such a determination may be based, in accordance with an aspect of the invention, on the distance of the object from the video screen. This distance may be determined dynamically, e.g., as a function of the speed and trajectory of the bicyclist. The determination to represent an object as video may be made only if a predetermined portion of the object has actually intersected, or passed through, the video screen.

If the test result in step 617 is NO, indicating that the object may be displayed using computer graphics, control passes back to step 609 and the process continues as described above. If the test result in step 617 is YES, indicating that the computer graphics object must go into the video as video, control passes to step 619 in which the VIDEO_REPRESENTATION bit for the current object is set. This indicates that the object is being represented as video and so should not be displayed in the computer graphics part of the world. Thereafter, in step 621, a video representation of the current object is retrieved and merged with the already composed video frame. This may be achieved by using a replacement technique to replace that part of the already composed video frame by retrieved video representation. Alternatively, a merging technique may be employed. Control then passes back to step 609 and the process continues as described above.

The development of the merged video of step 621 may be achieved using an alternative method. Instead of developing a single frame of video for display, multiple, stacked video screens may be employed, with one screen displaying the frame that would be displayed if no objects were merged into the video and each of the other screens displaying the video representation of each object that is currently merged into the video. The viewer in front of all the screens would see a composite image containing all the video elements and appearing as a single screen. In such a case, step 505 (FIG. 5) would encompass displaying the videos of all of the screens.

Note that the video screen may be any surface and need not be simply a planar surface.

FIG. 7 shows a three dimensional world display system 50 for displaying an apparently three dimensional world 30 to a user on a display screen 33. The three dimensional world 30 represented on the display screen 33 comprises a first portion 31 displayed as computer graphics and a second portion 32 displayed as video. The video is made up of a sequence of images.

With reference to FIG. 7, a processor 52 determines that an element (e.g. see bicyclist 109 in FIG. 1 - FIG. 2) displayed in said first portion 31 of the world 30 transited from the first portion 31 to the second portion 32. A rendering engine 51 displays the world 30 with the element displayed so that it appears to the viewer to be substantially integrated into the second portion 32 rather than the first portion 31 of the world 30.

The arrangement of the first and second portions 31, 32 is for pedagogic illustrative purposes only and is not representative. The first and second portions 31, 32 can also be arranged vertically or within each other (i.e. second portion 32 within first portion 31), for example.

FIG. 8 shows a view processing system 40 for processing a view of a three dimensional world 30 to be displayed by a display screen 33 according to an embodiment of the present invention. The three dimensional world 30 represented on the display screen 33 comprises a first portion 31 modeled as computer graphics and a second portion 32 represented by a video. The video is made up of a sequence of images.

With reference to FIG. 8, a video object locating mechanism 42 determines that an object (e.g. see police van 113 in FIG. 1 - FIG. 3) which is being modeled as computer graphics has moved to a location (second portion 32) that is being represented by the video by having moved to a location that is being represented by the second portion 32 and at which the object is at least partly occluded from view of a viewer of the world by the video although the object should not appear occluded to the viewer when at the location. The video object locating mechanism 42 relays information about the determined object to a graphics-to-video / video-to-graphics conversion mechanism 41. The graphics-to-video / video-to-graphics conversion mechanism 41 changes the representation of the object from one modeled as computer graphics to a video representation thereof. It thereby appears to the viewer that the object is substantially integrated into the second portion 32 rather than the first portion 31.

The foregoing merely illustrates the principles of the inventions. It will thus be appreciated that those skilled in the art will be able to devise various arrangements which, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope.

Claims

1. A method for use in processing a view of a three dimensional world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video display on a video screen which exists in said first portion of said world, wherein said video is made up of a sequence of images, the method comprising the steps of:

determining that an object, other than said video screen, is being modeled as computer graphics and has moved to a location that is being represented by said video and at which said object is at least partly occluded from view of a viewer of said world by said video screen although said object should not appear occluded to said viewer when at said location;

changing the representation of said object from one modeled as computer graphics to a video representation thereof; and

displaying said video representation so that it appears to said viewer to be substantially integrated with said video on said video screen.

2. A method for use in processing a view of a three dimensional world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video displayed on a video surface which exists as a first object in said computer graphics portion of said world, comprising the step of:

merging the representation of a second object that had been modeled as computer graphics with that of said video surface, so that said second object is represented as part of said video displayed on said video surface as a function of a distance between said object and said video surface independent of a distance between a viewer and said object.

3. The method as defined in claim 2 wherein said second object is represented as part of said video displayed on said video surface as a further function of a speed of said object.

4. The method as defined in claim 2 wherein said second object is represented as part of said video displayed on said video surface as a further function of a trajectory of said object.

5. The method as defined in claim 2 wherein said second object is represented as part of said video displayed on said video surface as a further function of a viewpoint of a viewer of said three dimensional world.

6. A method for use in processing a view of a world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video on a video surface which exists in said computer graphics portion of said world, said video initially depicting at least a first object of said world, wherein said video is made up of a sequence of images, the method comprising the steps of:

changing the representation of a second object that is initially represented as computer graphics from a computer graphics representation to a video representation when said object undergoes a trajectory that takes at least a portion of said object to a location in the world that is not represented as computer graphics but instead is being represented by said video on said video surface and at which said second object is at least partly occluded from view of a viewer of said world by said video surface although said second object should not appear occluded to said viewer when at said location; and

displaying said world so that it appears to said viewer that said video representation of said second object is substantially integrated with said video on said video surface.

7. The method as defined in claim 6 wherein said changing step is a function of a viewpoint of a viewer.

8. The method as defined in claim 6 wherein said changing step is a function of a speed of said object.

9. A method for use in processing a view of a world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video on a video surface which exists in said first portion of said world, wherein said video is made up of a sequence of images, the method comprising the steps of:

displaying an object using only a video representation of said object displayed on said video surface when at least a portion of said object is determined to be at a location in the world that is not represented as computer graphics but instead is within the field represented by said video on the video surface; and

displaying said object as a computer graphics object in said first portion of said world in addition to and independent from the video representation of the object on said video surface when said second object is determined to be at a location in the world that is represented as computer graphics.

10. The method as defined in claim 9 wherein said video representation of said object is displayed on said video surface.

11. The method as defined in claim 9 further including the step of changing a representation of said object from computer graphics to video when said portion of said object transits from a location in the world that is represented as computer graphics to a location within the field represented on the video surface.

12. The method as defined in claim 9 further including the step of changing a representation of said object from video to computer graphics when said portion of said object transits from a location in the world represented on the video surface to a location within the field that is represented as computer graphics.

13. A system for displaying an apparently three dimensional world to a user, in which a first part of said three dimensional world is displayed as computer graphics and a second part is displayed as video on a video screen, wherein said video is made up of a sequence of images, said system comprising:

a processor for determining that an element displayed in said first part of said world transited from said first part to said second part by having moved to a location that is being represented by said second part and at which said element is at least partly occluded from view of a viewer of said world by said video screen although said element should not appear occluded to said viewer when at said location; and

a rendering engine for displaying said world with said element displayed so that it appears to said viewer to be substantially integrated into said second part rather than said first part.

14. A system for displaying an apparently three dimensional world to a user, in which a first part of said three dimensional world is displayed as computer graphics and a second part is displayed as video on a video screen, wherein said video is made up of a sequence of images, said system comprising:

a processor for determining that a portion of an object initially in said first part of said world has moved to a location within said second part by virtue of having moved to a location that is being represented by said second part and at which portion of said object is at

least partly occluded from view of a viewer of said world by said video screen although said object should not appear occluded to said viewer when at said location; and

a rendering engine for displaying said world with said object displayed so that it appears to said viewer to be substantially integrated into said second part rather than said first part.

15. Apparatus for use in processing a view of a three dimensional world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video, wherein said video is made up of a sequence of images, the apparatus comprising:

means for determining that an object being modeled as computer graphics has moved to a location that is being represented by said video by having moved to a location that is being represented by said second portion and at which said object is at least partly occluded from view of a viewer of said world by said video although said object should not appear occluded to said viewer when at said location; and

means for changing the representation of said object from one modeled as computer graphics to a video representation thereof displayed so that it appears to said viewer to be substantially integrated into said second portion rather than said first portion.

16. The apparatus as defined in claim 15 further comprising means for displaying said video representation of said object merged with said portion of said world that is represented by said video.

17. Apparatus for use in processing a view of a world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video on a video surface which exists in said first portion of said world, wherein said video is made up of a sequence of images, said apparatus comprising:

means for displaying an object using a video representation of said object displayed on said video surface when at least a portion of said object is determined to be at a location in the world that is not represented as computer graphics but is instead within the field represented by said video on the video surface; and

means for displaying said object as a computer graphics object in said first

portion of said world in addition to and independent from said video representation of said object on said video surface when said object is determined to be at a location in the world that is represented as computer graphics.

18. The apparatus as defined in claim 17 wherein both of said means for displaying are comprised within a single system.

19. The apparatus as defined in claim 17 wherein both of said means for displaying are implemented using a single processor running different software for each means.

20. Apparatus for use in processing a view of a three dimensional world in which a first portion of said world is modeled as computer graphics and a second portion of said world is represented by a video on a video surface which exists in said first portion of said world, wherein said video is made up of a sequence of images, the apparatus comprising:

means for merging the representation of an object that had been modeled as computer graphics with that of said video surface, so that said object is represented as part of said video displayed on said video surface as a function of a distance between said object and said video surface; and

means for supplying said merged representation to a display for displaying said merged representation to a user.

Application number / numéro de demande: 2242166

Figures: 1-4

Pages:

Unscannable items
received with this application
(Request original documents in File Prep. Section on the 10th floor)

Documents reçu avec cette demande ne pouvant être balayés
(Commander les documents originaux dans la section de préparation des dossiers au 10ème étage)

FIG. 5

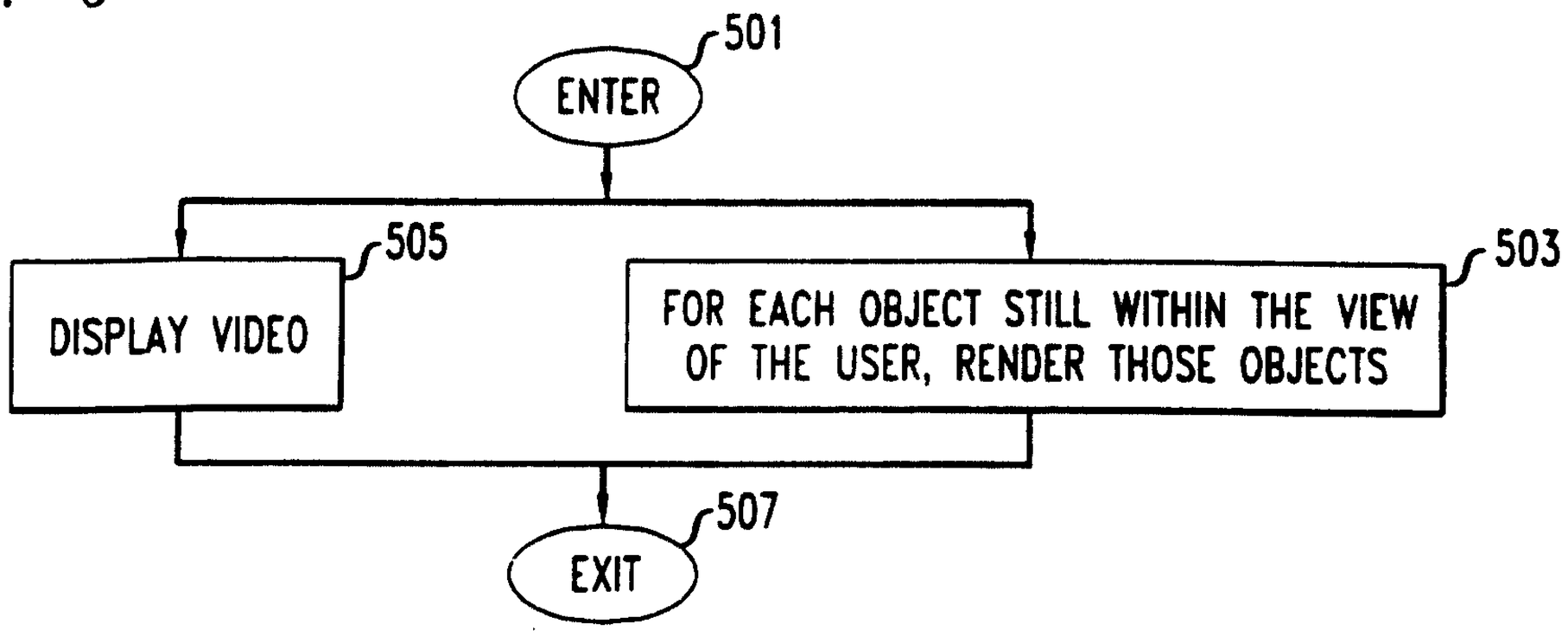
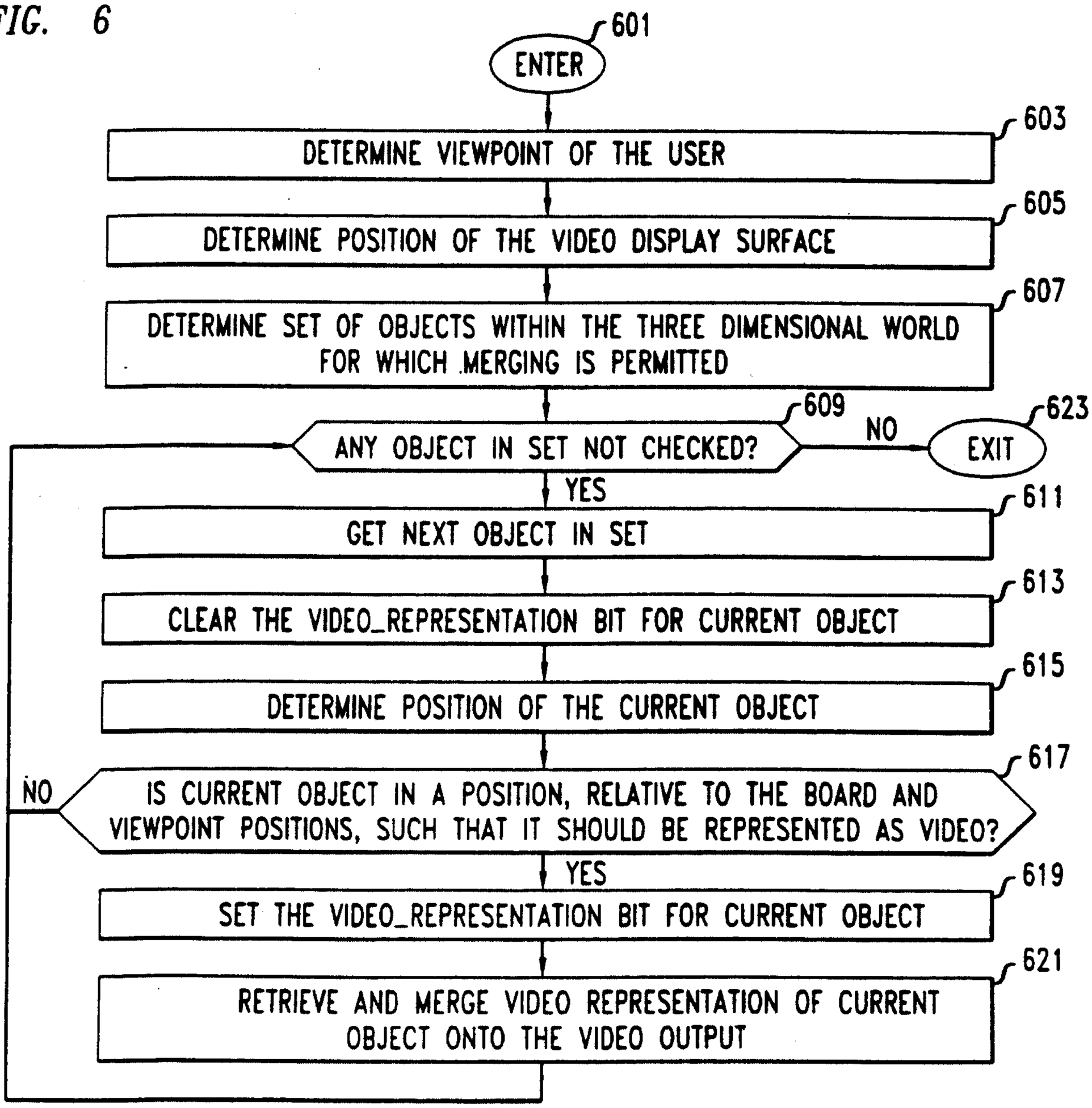

501
ENTER
505
DISPLAY VIDEO
503
FOR EACH OBJECT STILL WITHIN THE VIEW OF THE USER, RENDER THOSE OBJECTS
507
EXIT

FIG. 6


601
ENTER
603
DETERMINE VIEWPOINT OF THE USER
605
DETERMINE POSITION OF THE VIDEO DISPLAY SURFACE
607
DETERMINE SET OF OBJECTS WITHIN THE THREE DIMENSIONAL WORLD FOR WHICH MERGING IS PERMITTED
609
ANY OBJECT IN SET NOT CHECKED?
NO
623
EXIT
YES
611
GET NEXT OBJECT IN SET
613
CLEAR THE VIDEO_REPRESENTATION BIT FOR CURRENT OBJECT
615
DETERMINE POSITION OF THE CURRENT OBJECT
617
NO
IS CURRENT OBJECT IN A POSITION, RELATIVE TO THE BOARD AND VIEWPOINT POSITIONS, SUCH THAT IT SHOULD BE REPRESENTED AS VIDEO?
YES
619
SET THE VIDEO_REPRESENTATION BIT FOR CURRENT OBJECT
621
RETRIEVE AND MERGE VIDEO REPRESENTATION OF CURRENT OBJECT ONTO THE VIDEO OUTPUT

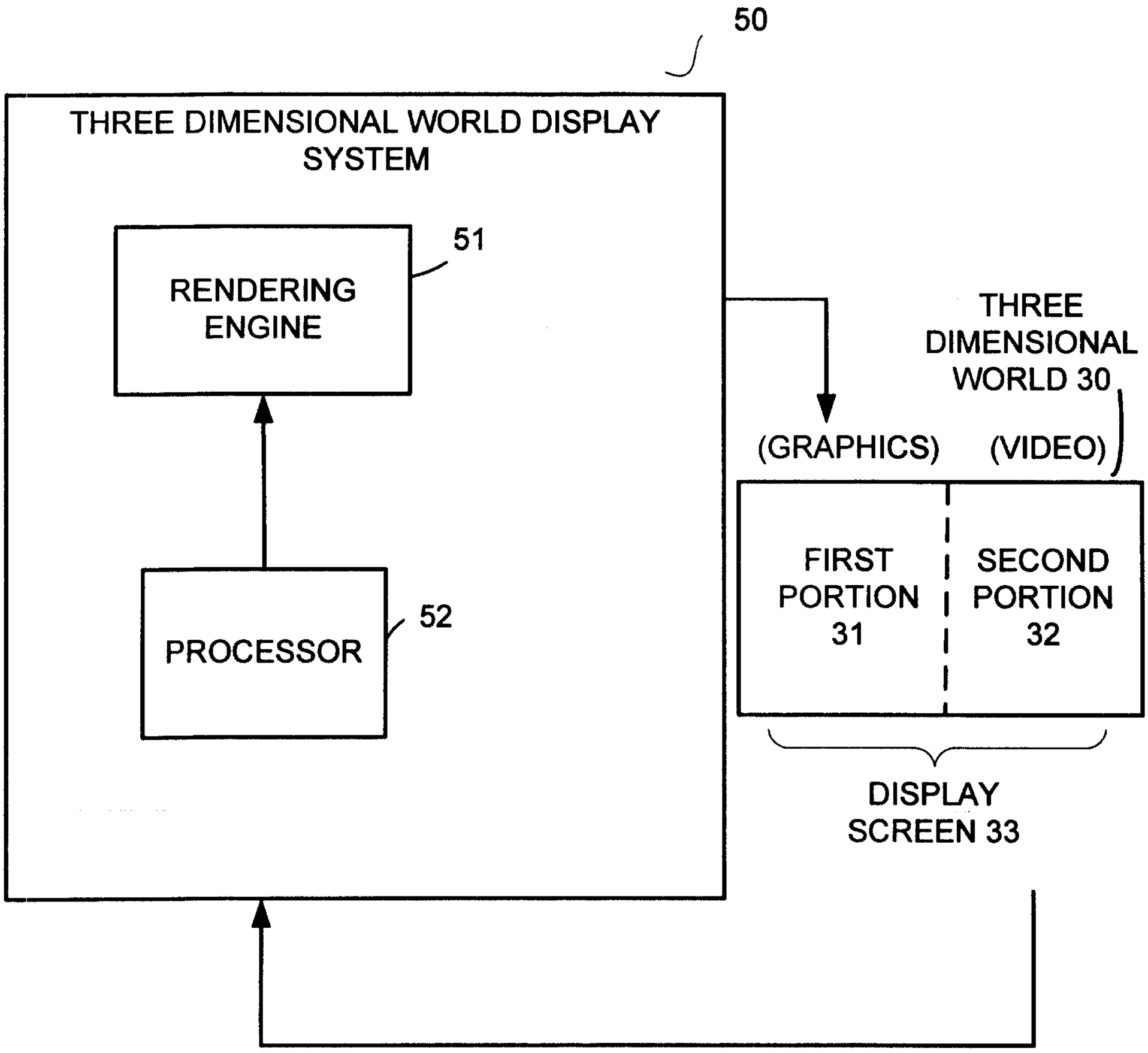

50
THREE DIMENSIONAL WORLD DISPLAY SYSTEM
RENDERING ENGINE
51
PROCESSOR
52
THREE DIMENSIONAL WORLD 30
(GRAPHICS)
(VIDEO)
FIRST PORTION 31
SECOND PORTION 32
DISPLAY SCREEN 33

FIG. 7

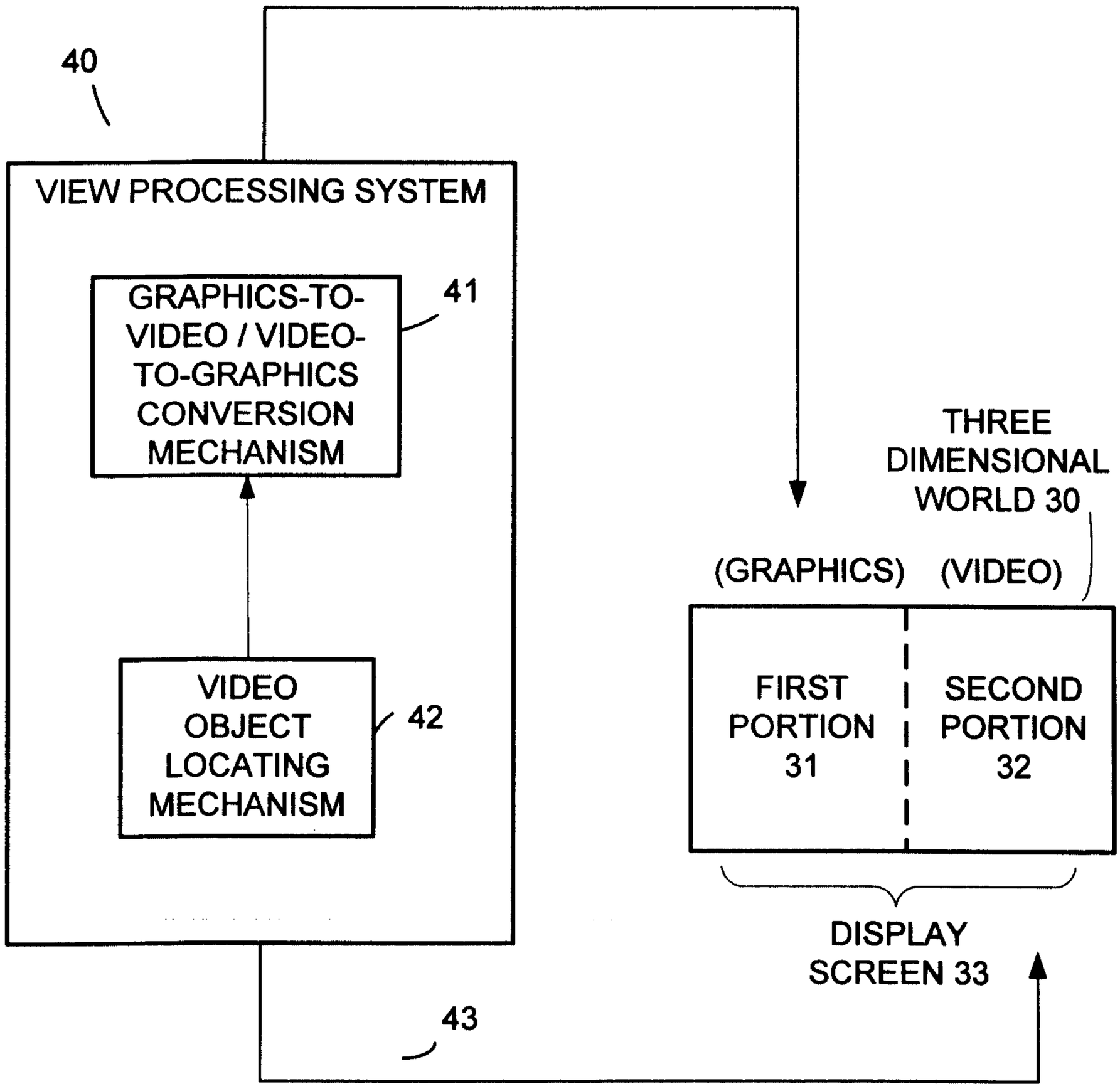
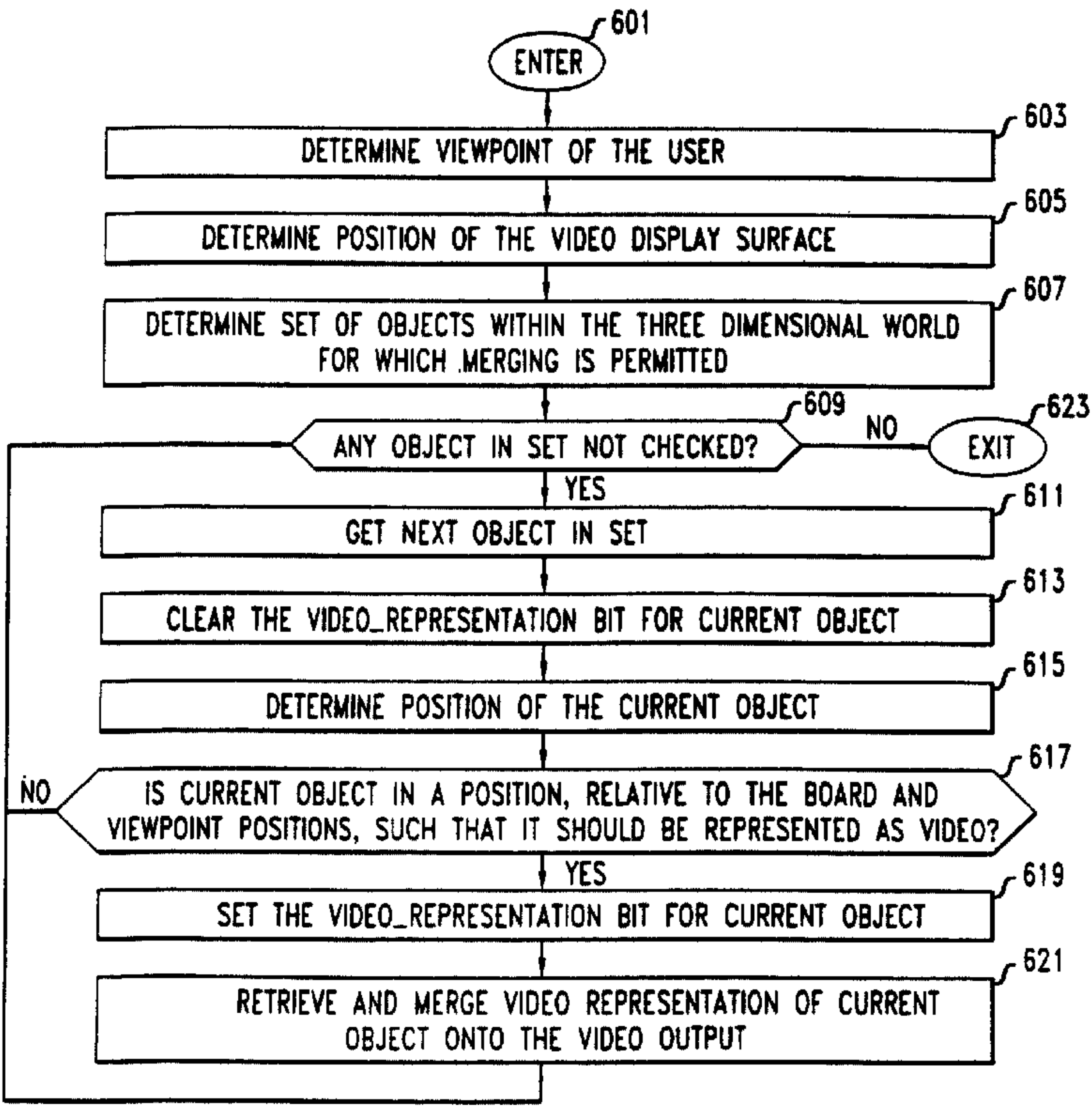

40
VIEW PROCESSING SYSTEM
GRAPHICS-TO-VIDEO / VIDEO-TO-GRAPHICS CONVERSION MECHANISM
41
VIDEO OBJECT LOCATING MECHANISM
42
43
THREE DIMENSIONAL WORLD 30
(GRAPHICS)
(VIDEO)
FIRST PORTION 31
SECOND PORTION 32
DISPLAY SCREEN 33

FIG. 8


601
ENTER
603
DETERMINE VIEWPOINT OF THE USER
605
DETERMINE POSITION OF THE VIDEO DISPLAY SURFACE
607
DETERMINE SET OF OBJECTS WITHIN THE THREE DIMENSIONAL WORLD FOR WHICH MERGING IS PERMITTED
609
ANY OBJECT IN SET NOT CHECKED?
NO
623
EXIT
YES
611
GET NEXT OBJECT IN SET
613
CLEAR THE VIDEO_REPRESENTATION BIT FOR CURRENT OBJECT
615
DETERMINE POSITION OF THE CURRENT OBJECT
617
NO
IS CURRENT OBJECT IN A POSITION, RELATIVE TO THE BOARD AND VIEWPOINT POSITIONS, SUCH THAT IT SHOULD BE REPRESENTED AS VIDEO?
YES
619
SET THE VIDEO_REPRESENTATION BIT FOR CURRENT OBJECT
621
RETRIEVE AND MERGE VIDEO REPRESENTATION OF CURRENT OBJECT ONTO THE VIDEO OUTPUT