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- **PATENT ABSTRACTS OF JAPAN vol. 095, no. 010, 30 November 1995 & JP 07 178242 A (SEGA ENTERP LTD), 18 July 1995**

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Description

[0001] The present invention relates to an image generating device, a medium, and a game machine and more particularly, it relates to an image generating device, a medium, and a game machine relating to computer graphics.

[0002] With the progress of computer graphics technology recent years, game devices and simulation devices have come into wide, general use. Among the game devices, the popularity of gun shooting games, wherein targets (enemies are shot down, remains strong. Generally, this game device comprises a gun unit, CPU for graphics processing, a monitor, etc., and implements the processing of shooting down the enemies on the monitor according to the signal from the gun unit operated by the player.

[0003] As a typical example of a conventional gun shooting game, there is "Virtual Cop" (trademark) manufactured by SEGA ENTERPRISES, LTD. The object of this game is to compete for scores by shooting down the enemies which appear in the imaginary three-dimensional space on the display using a gun unit. In this game, the enemies appear on the display in a predetermined position and in a predetermined timing, whereby the player operates the gun unit with these enemies being the target. That is, the player shoots down the enemies which are indicated each time in a predetermined position and timing on the display. Further, when the player aims the gun unit toward an enemy, the viewpoint on the display approaches the enemy, thus, the enemy is largely indicated on the display.

[0004] Of the other conventional gun shooting games, there is one in which the enemies move on the screen according to the attacks made by the player in this game, when the player attacks an enemy, a prescribed moving route is selected at the branch point of the predetermined moving route, and the enemy moves according to this selected moving route. Similar to the enemy movements, the viewpoint also moves in predetermined directions.

[0005] However, the above conventional image generating devices held the problems indicated below.

[0006] Foremost, since the movement of the viewpoint was uniform, the changes on the screen were limited. The two types of games mentioned above were both of which the viewpoint moved in predetermined directions. Therefore, if the player repeatedly played the game, a similar screen would be repeatedly indicated each time, thus, making the changes in the game a limited one.

[0007] Secondly, it was difficult to capture the enemies, etc., from a position of an optimum viewpoint. In conventional image generating devices, the viewpoint moved uniformly against the enemies from a predetermined direction. Therefore, it was not possible to move the viewpoint to an optimum position against the enemies according to the changes of the enemies, thus, making it difficult to indicate an appealing screen desired by the player.

[0008] Thirdly, due to the movement of the enemies being uniform, a dull game development was being repeated. As mentioned above, in the conventional game devices of gun shooting, the enemies made predetermined movements and could not help but make the game development a dull one.

[0009] The present invention was made in consideration of the problems mentioned above, and a first object of the present invention is to provide an image generating device and an image generating method capable of actualizing a screen with changes by implementing various viewpoint movements.

[0010] A second object of the present invention is to provide an image generating device and an image generating method capable of indicating an appealing screen by implementing an optimum viewpoint movement according to the game development.

[0011] A third object of the present invention is to provide an image generating device and an image generating method capable of actualizing a game development with abundant changes by giving variety to the movement of the enemies.

[0012] JP-A-7178242 discloses a viewpoint changing method for a ball game in a game machine. The viewpoint is changed to trace a traveling object moving from one area to another area.

[0013] JP-A-7075689 discloses a video game device in which an object in a game space is displayed by operating a control object. A position to the control object of the object is calculated, and this is used to catch the object in a display area to enable the object to be tracked in the game space.

[0014] JP-A-7244743 discloses an image display device which moves plural characters in the same direction in a three-dimensional space while setting a display distance, between respective characters in respective display areas, within a specific range.

[0015] The present invention provides an image generating device which generates images of moving objects moving within an imaginary three-dimensional space captured from a viewpoint within said imaginary three-dimensional space, comprising a viewpoint moving processing means which makes said viewpoint follow said moving objects and detects the situation of said moving objects), implementing controlling of the movement of said viewpoint and wherein said viewpoint moving processing means is adapted to move said viewpoint within the vicinity of an imaginary spherical surface with said moving object in the center on the basis of said detection result.

[0016] In the image generating device according to the present invention, preferably the above viewpoint moving processing means calculates the acceleration speed of the viewpoint, and moves the viewpoint in a range wherein the acceleration speed does not exceed a prescribed value.

[0017] In the image generating device according to the present invention, preferably the above viewpoint moving processing means changes the position of the viewpoint if the viewpoint is positioned on the same coordinates in excess of a prescribed time.

[0018] In the image generating device according to the present invention, preferably the above viewpoint moving processing means decreases the radius of the spherical surface together with the decrease in the number of moving objects.

[0019] The medium according to the present invention stores the program which functions a computer as the viewpoint moving processing means.

[0020] A medium includes, for example, a floppy disk, hard disk, magnetic tape, photomagnetic disk, CD-ROM, DVD, ROM cartridge, RAM memory cartridge with battery back-up, flash memory cartridge, fixed RAM cartridge, etc. Further, it includes telecommunication mediums such telephone circuits, etc., which are wire communication mediums, and microwave circuits, etc., which are radio communication mediums. The internet is also included in the telecommunication medium stated herein. A medium has information (mainly digital data or programs) stored therein by some physical means' and is capable of implementing the prescribed functions in a processing device such as a computer, exclusive processor, etc. That is, any means which downloads the program onto a computer and executes the prescribed functions is fine.

[0021] The image generating device according to the present invention preferably comprises a target deciding means which selects one from the plurality of moving objects based on predetermined standards and targets this moving object against the viewpoint.

[0022] In the image generating device according to the present invention, preferably the above target deciding means targets the moving object which was attacked within the plurality of moving objects against the viewpoint.

[0023] In the image generating device according to the present invention, preferably the above target deciding means targets the moving object nearest to the impact area within the plurality of moving objects against the viewpoint.

[0024] In the image generating device according to the present invention, preferably the above target deciding means moves the target against the viewpoint to a moving object among another moving object group if the number of moving objects in the moving object group composed of a plurality of moving objects becomes less than the prescribed value.

[0025] The medium according to the present invention preferably also stores the program which functions a computer as the above target deciding means.

[0026] The image generating device according to the present invention preferably indicates the moving objects according to the situations of such moving objects in the imaginary three-dimensional space.

[0027] In the image generating device according to the present invention, preferably the above moving object controlling means withdraws the moving object away from the impact area if the point of impact is within the area of the prescribed range from the moving object.

[0028] In the image generating device according to the present invention, preferably the above moving object controlling means moves the other moving objects toward a moving object attacking against the viewpoint.

[0029] The medium according to the present invention preferably also stores the program which functions a computer as the above moving object controlling means.

[0030] The game machine according to the present invention comprises an indicator, an operating section, and an image generating device which generates images of moving objects moving within the imaginary three-dimensional space captured from the viewpoint within the imaginary three-dimensional space, wherein such image generating device which is one of the aforementioned devices, generates images based on the output signal of the operating section, and indicates the generated images on the indicator.

[0031] An embodiment of the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is an exterior view of the image generating device of the present embodiment;

Fig. 2 is a block diagram of the image generating device of the present embodiment;

Fig. 3 is a conceptional diagram of the game space of the present embodiment;

Fig. 4 is a diagram showing an example of the game screen of the present embodiment ;

Fig. 5 is the main routine indicating the working of the image generating device of the present embodiment;

Fig. 6 is a flowchart indicating the target deciding processing of the image generating device of the present embodiment;

Fig. 7 is a flowchart indicating the viewpoint moving processing of the image generating device of the present embodiment;

Fig. 8 is a flowchart indicating the enemy controlling processing of the image generating device of the present embodiment;

Fig. 9 is a diagram explaining the target deciding processing of the image generating device of the present embodiment;

Fig. 10 is a diagram explaining the viewpoint moving processing of the image generating device of the present embodiment;

Fig. 11 is a diagram explaining the viewpoint moving processing of the image generating device of the present embodiment;

Fig. 12 is a diagram explaining the viewpoint moving processing of the image generating device of the present embodiment;

Fig. 13 is a diagram explaining the viewpoint moving processing of the image generating device of the present embodiment;

Fig. 14 is a diagram explaining the enemy movement controlling processing of the image generating device of the present embodiment.

[0032] Below, the embodiment of the present invention is explained by referring to the drawings.

(Structure)

[0033] Fig. 1 shows the exterior of this image generating device. In this drawing, numeral 1 indicates the main game device. This main game device 1 has a box-like shape, and is provided with display 1a on the front surface. Speaker installation holes (omitted from drawing) are provided on the side of display 1a, and speaker 14 is installed in the interior of these holes.

[0034] Operating panel 2 is provided on the front surface below display 1a, and gun unit 11 is provided on this operating panel. Gun unit 11 possesses a trigger, and this gun unit 11 is operated by the player.

[0035] Inside main game device 1, a game processing board is provided. Display 1a, gun unit 11 of operating panel 2, and the speaker are connected to game processing board 10. Accordingly, the player may enjoy the gun shooting game by $_{u}$sing display 1a and gun unit 11 on operating panel 2.

[0036] Fig. 2 is a block diagram of the image generating device of the present embodiment. This game device comprises an outline, display 1a, gun unit 11, game processing board 10, and speaker 14.

[0037] Game processing board 10 possesses counter 100, CPU (central processing unit) 101, ROM 102, RAM 102, RAM 103, sound device 104, input/output interface 106, scroll data computing device 107, co-processor (auxiliary processing unit) 108, landform data ROM 109, geometrizer 110, shape data ROM 111, drawing device 112, texture data ROM 113, texture map RAM 114, frame buffer 115, image synthesizing device 116, and D/A converter 117.

[0038] CPU 101 is connected via bus line to ROM 102, wherein prescribed programs and image processing programs are stored, RAM 103, which stores data, sound device 104, input/output interface 106, scroll data computing device 107, co-processor 108, and geometrizer 110. RAM 103 functions as a buffer, wherein various commands for the geometrizer (indications of objects, etc.) and data required in various computing are inputted.

[0039] Input/output interface 106 is connected to gun unit 11, and the operating signal of the position of gun unit 11 etc. are provided to CPU 101 as digital data. Sound device 104 is connected to speaker 14 via power amplifier 105, wherein sound signals generated in sound device 104 are transferred to speaker 14 after being power amplified. CPU 101 of the present operation, based on the programs stored in ROM 1.02, reads the operating signals from operating device 11, and diagram data from diagram data ROM 109, or, motion data from motion data ROM 111 ("enemy characters, etc.") and (three-dimensional data of "background, such as land shape, sky, various structural objects, etc."), and implements at least, the calculation of action calculations (simulation) as well as the calculation of special effects.

[0040] The action calculations are for simulating the movements of the enemies in the imaginary space, and after the coordinate values in the three-dimensional space have been decided, a conversion matrix for converting these coordinate values to a field of view coordinate system and shape data (polygon data) are designated to the geometrizer. Diagram data ROM 109 is connected to co-processor 108, and consequently, predetermined diagram data are transferred to co-processor 108 (and CPU 101). Cc-processor 108 is devised such that it mainly undertakes floating-point calculations. As a result, various decisions are executed by co-processor 108, and the results of these decisions are provided to CPU 101, thereby enabling the calculation load of CPU to be reduced.

[0041] Geometrizer 110 is connected to motion data ROM 111 and drawing device 112. In motion data ROM 111, shape data consisting of a plurality of polygons (three-dimensional data of characters, landform, background, etc., comprised of each vertex thereof) are stored in advance, and these shape data are transferred to geometrizer110. Geometrizer 110 implements perspective conversion of the specified shape data using the conversion matrix supplied by CPU 101, thereby receiving data converted from a coordinate system in the imaginary three-dimensional space to a field of view coordinate system. Drawing device 112 applies texture to the converted field of view coordinate system shape data, and outputs it to frame buffer 115. To conduct this texture application, drawing device 112 is connected to texture data ROM 113 and texture map RAM 114, as well as being connected to frame buffer 115. Incidentally, polygon data refers to data groups for the relative or absolute coordinates of each vertex in a polygon (multi-sided shape mainly, three- or four-sided shapes) consisting of a group of plurality of vertices. Diagram data

ROM 109 stores relatively broad polygon data settings which are sufficient for executing the prescribed functions. Contrarily, motion data ROM ill stores more precise polygon data settings relating to shapes constituting screens such as enemies and background.

[0042] Scroll data computing device 107 is for computing scroll screen data, such as text (stored in ROM 102), and this computing device 107 and frame buffer 116 arrive at display 1a via image synthesizing device 116 and D/A converter 117. Thereby, polygon screens (simulation results) of enemies, landform (background), etc., temporarily stored in frame buffer 115 and scroll screens for the required text information are synthesized in a designated priority to create the final game image. This image data is converted to an analog signal by D/A converter 117 and sent to display 1a, and the game image is indicated on a real time basis.

[0043] The programs and data required for CPU 101 device in gig. 2 to operate are provided by various methods. For example, there is a method of inserting the ROM into the prescribed circuit base, after inputting required programs and data into the ROM, which is a semiconductor memory. Further, there is a method of having a floppy disk drive (FDD), which is not shown, read in the floppy diskette in which required programs and data are inputted, and developing the required programs and data on the main memory of CPU 101. In addition, there is a method of comprising a hard disk in which required programs and data are inputted, and developing the required programs and data on the main memory upon reading the data from this hard disk at the time of power input. Moreover, there is a method of comprising a communication means, such as a modem, and developing the required programs and data on the main memory via telephone circuit, ISDN circuit, optical fiber, etc. The article used to provide the required programs and data in these methods is called a medium.

[0044] A medium, for example, includes a floppy disk, hard disk, magnetic tape, photomagnetic disk, CD-ROM, DVD, ROM cartridge, RAM memory cartridge with battery back-up, flash memory cartridge, fixed RAM cartridge, etc. Also included are telecommunication mediums such as telephone circuits, etc., which are wire communication mediums, and microwave circuits, etc. , which are radio communication mediums. The internet is also included in the telecommunication medium stated herein.

[0045] A medium has information (mainly digital data or programs) stored therein by some physical means, and is capable of implementing the prescribed functions in a processing device such as a computer, exclusive processor, etc. That is, any means which downloads the program onto a computer and executes the prescribed functions is fine.

[0046] Fig. 3 is a conceptional view of the game space of the present embodiment. This game space is an imaginary three-dimensional space, which includes images of enemy (moving object) 3a, obstacle 3b, viewpoint 3c, bullet 3d, etc. Enemy 3a is the target, which dodges bullets fired from the viewpoint, moves autonomously, and begins to attack toward the viewpoint. Further, there are a plurality of enemy 3a existing within the game space. Obstacle 3b, for example, is a structural object such as containers and buildings, and is provided to give variation to the game. Enemy 3a and viewpoint 3c are able to move within the game space without colliding to this obstacle 3b.

[0047] Viewpoint 3c is the viewpoint of the player, and is provided on the aircraft body of helicopters, etc. That is, the game space seen from the viewpoint is indicated on display 3a, and the player may indulge in the feeling of, as though, looking down at the game space from a helicopter. Since this viewpoint flies (moves) within the game space while following the enemy, the enemy is continuously indicated on the display With an optimum composition. Further, symbol 3d of the same diagram indicates the bullet fired from the viewpoint. By the player pulling the trigger of gun unit 11, bullet 3d is fired toward the enemy.

[0048] Fig. 4 shows an example of a game screen of the present embodiment. This game screen indicates a game space seen from the viewpoint, and is actually indicated on the display. Elevation 3e is displayed in the game screen, and the position of elevation 3e in the game screen is moved by the player changing the direction of gun unit 11. If elevation 3e overlaps with enemy 3a and the trigger is pulled, the bullet is fired toward enemy 3a.

(Working)

Main Processing

[0049] Next, the working of the image generating device in the present embodiment is explained. Fig. 5 indicates the main routine of image generating in the present embodiment. This main routine is repeatedly executed every one field (1/60 sec.). In this main routine, CPU 101 decides the enemy to become the target of the viewpoint among the plurality of enemies (step S1). In the early stages of the game, the target is established against a predetermined enemy, and a game space with this enemy in the center is indicated on the display. However, together with the development of the game, the target gradually moves to a another enemy.

[0050] CPU 101 moves the viewpoint (step S2) toward the target decided in step SI. When the enemy escapes from the viewpoint (helicopter) , the viewpoint follows this enemy. To make the composition of the enemy on the display an optimum one, the viewpoint moves to an optimum position against the enemy. For example, by moving the viewpoint so that the distance between the enemy and the viewpoint is nearly standardized, the size of the enemy in the game screen will be nearly standardized.

[0051] In step S3, CPU 101 executes various game

processing. That is, together with deciding the screen of the game space seen from the coordinates of the viewpoint decided in step s2, CPU 101 detects the situation of the trigger of gun unit 11 and the position sensor. Further, CPU 101 moves the elevation on the display, and implements the decision of collision of the bullet and the enemy, or the obstacle, etc.

[0052] In step 54, CPU 101 decides the movement of each enemy according to the bullet fired by the player, according to the situation of the game, etc. For example, if a bullet lands near the enemy, that enemy is moved in a direction away from the impact area. Thereafter, CPU 101 returns to step S1, and repeatedly executes the processing of steps S1 to S4.

[0053] Next, the above target deciding processing (step S1), viewpoint moving processing (step s2), and enemy controlling processing (step 54) are explained in detail.

Target Deciding Processing

[0054] Fig. 6 is a flowchart indicating above target deciding processing (step S1). Target deciding processing is implemented by calculating the priority ranking of each enemy and deciding the enemy with the highest priority ranking as the target. The following explanation is a simplified explanation of this processing. As stated above, in the early stages, the target is established to a predetermined enemy. For example, the attacked enemy is selected. In the flowchart of the same diagram, CPU 101 judges whether or not the bullet has hit the enemy (step S101), and if the result is YES, it further judges whether or not the target enemy has disappeared (step S102). If the imaginary life power of the enemy becomes zero and the target enemy disappears (YES in step S102), CPU 101 establishes the target to the enemy nearest to the enemy which disappeared. Contrarily, if the bullet did hit but the enemy has not disappeared (NO in step S102), the target is established to the enemy which was hit by the bullet (step S104).

[0055] Further, if the bullet does not hit the enemy (NO in step S101) but lands near the enemy (YES in step S105), the target is established to the enemy nearest to the impact area. However, if the distance between the target enemy and the impact area exceeds the predetermined value, the target enemy does not change. Therefore, if the impact area is a great distance from the target enemy, the unnaturalness of the target moving to an enemy nearest to the impact area may be avoided.

[0056] Moreover, in step S107, if there is only one enemy left within the group, CPU 101 transfers the target to an enemy in another group (step 5108). When the above processing is complete, CPU 101 returns to the main routine (Fig. 5).

[0057] The above target deciding processing is explained by presenting specific examples. In Fig. 9 (A), enemy 20a and 20b exist within the game space, and let it be presumed that enemy 20a is established as the target of viewpoint. Here, if the player does not fire the bullet, the target is not changed, and the target remains established on enemy 20a. Therefore, a game screen with enemy 20a as the target of viewpoint is indicated on the display ((B) of same Fig.).

[0058] However, if the bullet fired by the player hits enemy 20b ((C) of same Fig.), the target of viewpoint moves from enemy 20a to enemy 20b, and a game screen with enemy 20b as the target of viewpoint is indicated on the display ((D) of same Fig.). Thus, because the target of viewpoint automatically moves to the enemy the player is trying to battle, the game screen desired by the player may be provided.

[0059] Further, as a method for changing the target, the target may be established by raising the priority ranking of the enemy which is trying to attack the player. In addition, the priority ranking of the enemy with the highest attacking ability, the enemy which overlapped with the elevation, the enemy which is positioned nearest to the elevation, the enemy which is established as the "Boss" in advance, etc., may be raised. Moreover, as a general rule, by not changing the target until the target enemy disappears, and as an exception, i f the prescribed time is exceeded after the enemy becomes the target, the target may be changed.

Viewpoint moving Processing

[0060] Next, above viewpoint moving processing (step S2 of Fig. 5) is explained by referring to Fig. 7, and Fig. 10 to Fig. 13. Foremost, the outline of viewpoint moving processing is explained using Fig. 10 and Fig. 11. As shown in Fig. 10, viewpoint 21b moves in a position distance D away from target enemy 21a. Further, in order for the game screen to have variation, viewpoint 21b continuously moves in the game space while maintaining distance D from enemy 21a. Therefore, the processing of the viewpoint so that with target enemy 21a in the center is implemented. Moreover, as shown in Fig. 11, when target enemy 21a moves, viewpoint 21b also follows enemy 21a. Therefore, target enemy 21a is continuously indicated on the display in an optimum composition.

[0061] Following, details of above viewpoint moving processing is explained by referring to the subroutine of Fig. 7. In this flowchart, foremost, CPU 101 calculates the coordinates (x, y, z) of the present viewpoint (step 5201) and calculates distance d from the target enemy to the viewpoint (step S202). If the absolute value of the difference between this distance d and predetermined distance D subsides within α, in other words, if the value of distance d approximates to distance D (YES in step S203) , step 5204 is executed.

[0062] In step S204, CPU 101 judges whether or not timer t has exceeded the predetermined timer closing value T. In other words, if t, which is the time of the viewpoint existing in a position distance D from the enemy, exceeds prescribed time T (YES in step S204), distance

D or coordinate y in the direction of the viewpoint height will be changed (step S205). Thereby, the viewpoint will not exist in the same position exceeding the prescribed time, enabling a game screen with variations.

[0063] Next, CPU 101 judges whether or not the number of enemies have been changed (step S206), and if the result of the judgment is YES, it changes distance D. For example, if a fairly large number of enemies are to be indicated on the screen, it is necessary to indicate all of these enemies on the display, including the target enemy. Therefore, distance D between the viewpoint and the target being fairly long is favorable. However, if the number of enemies decrease and there is only one enemy left to be the target, indicating the enemy largely on the display is favorable. Accordingly, in this case, distance D is established short.

[0064] Following, in step 5208, CPU 101 judges whether or not there are any obstacles in the proceeding direction of the viewpoint. If the result of the judgment is YES, CPU 101 changes distance D, viewpoint height y, etc., and avoids the viewpoint from colliding with the obstacles (step S209).

[0065] Thereafter, CPU 101 calculates the acceleration speed of the viewpoint (step 5210), and calculates the moving amount (xd, yd, zd) of the viewpoint based on this acceleration speed (step S210). Here, the moving direction of the viewpoint is decided (step 5212) by suspending a sudden acceleration speed being added to the viewpoint. As a result, the viewpoint coordinates of the moving target (x + xd, y + yd, z + zd) are acquired. After the completion of the above viewpoint moving processing, CPU 101 returns to the main routine of Fig. 5.

[0066] Fig. 12 and Fig. 13 of the above viewpoint moving distance is explained by presenting specific examples. In Fig. 12, if viewpoint 21b is positioned at a distance against enemy 21a, viewpoint 21b moves in a direction approaching against enemy 21a. In position (A), viewpoint 21b changes the moving direction while facing the viewpoint toward enemy 21a. Here, the moving direction of viewpoint 21b is decided to the direction in which the acceleration speed is not sudden. In other words, the viewpoint will not move in the opposite direction to the direction of the viewpoint movement shown in this diagram, that is, the viewpoint will not suddenly proceed into a clockwise direction from the position on the hemisphere of radius D with enemy 21a in the center. Thereby, a game screen in which the player does not feel uncomfortable is indicated. When the distance between viewpoint 21b and enemy 21a becomes D, viewpoint 21b moves on the spherical surface of radius D with enemy 21a in the center (position (C)) .

[0067] In addition, if viewpoint 21b revolves with enemy 21a in the center, the viewpoint revolves with the axis as its center (Fig. 13) , and the horizon is indicated on the game screen slanted. Thereby, the operator is able to enjoy the feeling of as if riding on a helicopter.

Enemy Controlling Processing

[0068] Next, enemy controlling processing (step S4 of Fig. 5) is explained by referring to Fig- 8 and Fig. 14. in the image generating device of the present embodiment, the movement of the enemies are not programmed in advance, and each enemy acts autonomously according to the situation of each enemy in the game space.

[0069] Below, enemy controlling processing is explained by referring to the subroutine shown in Fig. B. CPU 101 calculates distance d g of the impact area and each enemy individually, and judges whether or not. each distance d g is smaller than predetermined distance Dg (step 5401). In other words, if the impact is near the enemy, CPU 101 implements the processing of withdrawing each enemy from the impact area (step S402).

[0070] Further, if distance d g between the approaching bullet and each enemy is smaller than predetermined distance D g (YES in step S403), CPU 101 withdraws each enemy from the approaching bullet (step S404). If the enemy drops its weapon within the game space (YES in step S405), CPU 101 makes that enemy pick up the weapon (step S406).

[0071] Moreover, if there are any obstacles in the proceeding direction of the enemy (YES in step S 407), CPU 101 makes the enemy detour the obstacle (step 5408), and if the comrade enemies are making a resistance (YES in step 5409), CPU 101 makes the enemy support its comrades by moving it toward the comrade enemies (step 6410). Further, if the energy of the enemy has decreased (YES in step 5410), CPU 101 implements the processing of that enemy escaping from the attacking side (viewpoint) (step S412). Thereafter, CPU 101 returns to the main routine of Fig. 5.

[0072] The above enemy controlling processing is explained by presenting specific examples. In Fig. 14 (A), let it be presumed that the impact was near enemy 22a and 22b. In addition, symbol 22c of the same Fig. indicates the explosion of the impact. Thereupon, enemy 22a and 22h withdraw from the impact area ((B) of same Fig.). Further, if the enemy is moving or making a counter attack, it is continuously facing the player side (viewpoint side). However, in such cases as the enemy falling down, the enemy will not face the viewpoint side. In this matter, each enemy acts autonomously while judging its own situation. Therefore, the movements of the enemies will change variously according to the development of the game, and the player may enjoy a game with variations.

[0073] As explained above, with the image generating device and the image generating method of the present invention, the following effects may be obtained.

[0074] Foremost, such as enemies implementing diverse viewpoint movements according to the situation of the game, a game screen with plentiful changes may be provided. In other words, the direction of viewpoint

movement etc. is decided according to the situation of the game, and the viewpoint moves toward this direction etc. Therefore, because a different game screen is developed for each game, the player is able to enjoy a game with plentiful changes.

[0075] In addition, because the viewpoint moves (flies) on the game space while following the enemy, the player is able to enjoy the feeling of as if following the enemy while riding on a helicopter. Secondly, by continuously moving the viewpoint against the enemy to an optimum position, it is possible to provide an appealing game screen. For example, according to the present invention, the viewpoint moves in the vicinity of the imaginary spherical surface with the target enemy in the center. Therefore, the enemy may be displayed in an optimum composition on the game screen. Further, together with the decrease in the number of enemies, the radius of the imaginary spherical surf ace decreases. In other words, since the radius of the imaginary spherical surface grows larger if there are many moving objects, more moving objects may be indicated, and since the radius grows smaller if there are less moving objects, the moving objects as the viewpoint target may be largely indicated.

[0076] Moreover, by adjusting the viewpoint to an enemy with high attacking power, etc., the player may be informed as to which enemy should be preferentially attacked.

[0077] Furthermore, by calculating the acceleration speed of the viewpoint, and by controlling the acceleration speed from becoming excessive, the direction of viewpoint movement is decided. Thereby, the viewpoint may be moved smoothly, and the uncomfortableness of the player may be reduced.

[0078] Thirdly, by letting the movements of the enemies have versatility, it is possible to actualize a game development with plentiful changes. In other words, by deciding the movements of the enemies according to the situations which the enemies are in, within the game space, they may move autonomously and diversely. For example, if the point of impact is near the enemy, the enemy withdraws away from the impact area. Thus, since the enemies implement various movements autonomously due to the bullets fired from the player, etc., a diverse game may be provided for each game.

Claims

1. An image generating device which generates images of moving objects (21a) moving within an imaginary three-dimensional space captured from a viewpoint (21b) within said imaginary three-dimensional space, comprising a viewpoint moving processing means which makes said viewpoint (21b) follow said moving objects (21a) and detects the situation of said moving objects (21a), implementing controlling of the movement of said viewpoint (21b) and wherein said viewpoint moving processing means is adapted to move said viewpoint within the vicinity of an imaginary spherical surface with said moving object (21a) in the center on the basis of said detection resuft.

2. An image generating device according to Claim 1, wherein said viewpoint moving processing means calculates the acceleration speed of said viewpoint (21b), and in a range of said acceleration speed not exceeding a prescribed value, moves said viewpoint (21b).

3. An image generating device according to Claim 1, wherein said viewpoint moving processing means changes the position of said viewpoint (21b) if said viewpoint (21b) is positioned on the same coordinates in excess of a prescribed time.

4. An image generating device according to Claim 1, wherein said viewpoint moving processing means, together with the decrease in the number of said moving objects (21a), decreases the radius of said imaginary spherical surface.

5. A medium which stores a program to function a computer as said viewpoint moving processing means according to any one of Claims 1 to 4.

6. An image generating device according to Claim. 1, comprising a target deciding means which selects one from a plurality of said moving objects (20a, 20b) based on predetermined standards, targeting this moving object (20a) from the viewpoint.

7. An image generating device according to claim 6, wherein said target deciding means, within the plurality of moving objects (20a,20b), targets the moving object (21a) attacking the viewpoint.

8. An image generating device according to Claim 6, wherein said target deciding means, within the plurality of moving objects (20a,20b), targets the moving object (20b) nearest to the impact area from the viewpoint.

9. An image generating device according to claim 6, wherein said target deciding means, if the number of moving objects (20a,20b) of the moving object group made from a plurality of moving objects (20a, 20b) becomes less than a prescribed figure, moves the target from the viewpoint to a moving object in another moving object group.

10. A medium which stores a program to function a computer as said target deciding means according to any one of Claims 6 to 9.

11. An image generating device according to Claim 1, comprising a moving object controlling means which indicates said moving object (22a,22b) according to the situation of said moving object (22a, 22b) in the imaginary three-dimensional space.

12. An image generating device according to Claim 11, wherein said moving object controlling means, if the point of impact (22c) is within a prescribed range from said moving object (22a,22b), withdraws said moving object from the impact area (22c).

13. An image generating device according to Claim 12, wherein said moving object controlling means moves the other moving objects (22a,22b) toward the moving object which is attacking against the viewpoint.

14. A medium which stores a program to function a computer as said moving object controlling means according to any one of Claims 11 to 13.

15. A game machine comprising an indicator (1a); an operating section (2); and an image generating device which generates images of moving objects moving within an imaginary three-dimensional space captured from a viewpoint within the imaginary three-dimensional space, wherein said image generating device is according to any one of Claims 1 to 4, Claims 6 to 9, or Claims 11 to 13, generates images based on the output signal of said operating section (2), and indicates this generated image on said indicator (1a).

Patentansprüche

1. Bilderzeugungsapparat, welcher Bilder von bewegten Objekten (21a) erzeugt, die sich innerhalb eines imaginären dreidimensionalen Raumes bewegen, aufgenommen von einem Beobachtungspunkt (21b) innerhalb des imaginären dreidimensionalen Raumes, welcher ein Bearbeitungsmittel für die Beobachtungspunktbewegung aufweist, welches den Beobachtungspunkt (21b) den bewegten Objekten (21a) nachführt und die Lage der bewegten Objekte (21a) detektiert, wobei die Steuerung der Bewegung des Beobachtungspunktes (21b) realisiert ist und worin das Bearbeitungsmittel für die Beobachtungspunktbewegung derart angepasst ist um den Beobachtungspunkt in der Nähe der imaginären sphärischen Oberfläche mit dem bewegten Objekt (21a) im Zentrum auf der Basis der detektierten Lage des bewegten Objektes zu bewegen.

2. Bilderzeugungsapparat nach Anspruch 1, worin das Bearbeitungsmittel für die Beobachtungspunktbewegung die Anlaufgeschwindigkeit des Beobachtungspunktes (21b) berechnet und den Beobachtungspunkt (21b) in einem Bereich der Anlaufgeschwindigkeit bewegt ohne einen vorbestimmten Wert zu übersteigen.

3. Bilderzeugungsapparat nach Anspruch 1, worin das Bearbeitungsmittel für die Beobachtungspunktbewegung die Lage des Beobachtungspunktes (21b) verändert, wenn nach einer vorbestimmten Zeit der Beobachtungspunkt (21b) auf den gleichen Koordinaten positioniert ist.

4. Bilderzeugungsapparat nach Anspruch 1, worin das Bearbeitungsmittel für die Beobachtungspunktbewegung, zusammen mit der Abnahme der Anzahl von bewegten Objekten (21a), den Radius der imaginären sphärischen Oberfläche vermindert.

5. Medium, welches ein Programm speichert zum Betrieb eines Computers als das Bearbeitungsmittel für die Beobachtungspunktbewegung entsprechend einem der Ansprüche 1 bis 4.

6. Bilderzeugungsapparat nach Anspruch 1, aufweisend ein Zielentscheidungsmittel, welches eines aus einer Vielzahl der bewegten Objekte (20a,20b) auf der Grundlage von vorbestimmten Standards auswählt, die von dem Beobachtungspunkt auf dieses bewegte Objekt (20a) zielen.

7. Bilderzeugungsapparat nach Anspruch 6, worin das Zielentscheidungsmittel innerhalb der Vielzahl von bewegten Objekten (20a,20b) auf das bewegte Objekt (20b) zielt, welches den Beobachtungspunkt angreift.

8. Bilderzeugungsapparat nach Anspruch 6, worin das Zielentscheidungsmittel innerhalb der Vielzahl von bewegten Objekten (20a,20b) auf das bewegte Objekt (20b) zielt, welches vom Beobachtungspunkt aus dem Aufschlaggebiet am nächsten ist.

9. Bilderzeugungsapparat nach Anspruch 6, worin das Zielentscheidungsmittel, für den Fall, dass die Anzahl der bewegten Objekte (20a,20b) der Gruppe von bewegten Objekten, dargestellt aus einer Vielzahl von bewegten Objekten (20a,20b), kleiner wird als eine vorbestimmte Zahl, das Ziel von dem Beobachtungspunkt zu einem bewegten Objekt in einer anderen Gruppe von bewegten Objekten bewegt.

10. Medium, welches ein Programm speichert zum Betrieb eines Computers als das Zielentscheidungsmittel entsprechend einem der Ansprüche 6 bis 9.

11. Bilderzeugungsapparat nach Anspruch 1, aufweisend ein Steuermittel für ein bewegtes Objekt, wel-

ches das bewegte Objekt (22a,22b) entsprechend der Lage des bewegten Objektes (22a,22b), in dem imaginären dreidimensionalen Raum anzeigt.

12. Bilderzeugungsapparat nach Anspruch 11, worin das Steuermittel für das bewegte Objekt, für den Fall, dass der Aufschlagpunkt (22c) sich innerhalb eines vorbestimmten Bereiches von dem bewegten Objekt (22a,22b) befindet; das bewegte Objekt von dem Aufschlaggebiet zurückzieht.

13. Bilderzeugungsapparat nach Anspruch 12, worin das Steüermittel für das bewegte Objekt die anderen bewegten Objekte (22a,22b) in Richtung auf das bewegte Objekt bewegt, welches gerade gegen den Beobachtungspunkt angreift.

14. Medium, welches ein Programm speichert zum Betrieb eines Computers als das Steuermittel für das bewegte Objekt entsprechend einem der Ansprüche 11 bis 13.

15. Spielmaschine, die Folgendes aufweist:

eine Anzeigeeinrichtung (1a); einen Betriebsabschnitt (2);
und einen Bilderzeugungsappparat, welcher Bilder von bewegten Objekten erzeugt, die sich innerhalb eines imaginären dreidimensionalen Raumes bewegen und von einem Beobachtungspunkt innerhalb des imaginären dreidimensionalen Raumes aufgenommen werden, worin der Bilderzeugungsapparat einem der Ansprüche 1 bis 4, Ansprüche 6 bis 9, oder Ansprüche 11 bis 13 entspricht und Bilder, basierend auf dem Ausgangssignal des Betriebsabschnittes (2) erzeugt und diese erzeugten Bilder auf der Anzeigeeinrichtung (1a) anzeigt.

Revendications

1. Dispositif de génération d'images qui génère des images d'objets en mouvement (21a) se déplaçant dans un espace virtuel à trois dimensions, captés depuis un point d'observation (21b) à l'intérieur dudit espace imaginaire à trois dimensions, comportant des moyens de traitement pour le déplacement du point d'observation qui amènent ledit point d'observation (21b) à suivre lesdits objets en mouvement (21a) et qui détectent la situation desdits objets en mouvement (21a) exécutant une commande du mouvement dudit point d'observation (21b), et dans lequel lesdits moyens de traitement pour les déplacements du point d'observation sont conçus pour déplacer ledit point d'observation au voisinage d'une surface sphérique virtuelle dont le centre est constitué par ledit objet en mouvement (21a) sur la base de la situation détectée de l'objet en mouvement.

2. Dispositif de génération d'images selon la revendication 1, dans lequel lesdits moyens de traitement pour le déplacement du point d'observation calculent la vitesse d'accélération dudit point d'observation (21b), et, dans la mesure où ladite vitesse d'accélération ne dépasse pas une valeur prescrite, déplacent ledit point d'observation (21b).

3. Dispositif de génération d'images selon la revendication 1, dans lequel lesdits moyens de traitement pour le déplacement du point d'observation modifient la position dudit point d'observation (21b) si ledit point d'observation (21b) est positionné sur les mêmes coordonnées au-delà d'un temps prescrit.

4. Dispositif de génération d'images selon la revendication 1, dans lequel lesdits moyens de traitement pour le déplacement du point d'observation diminuent, en association avec la diminution du nombre desdits objets en mouvement (21a), le rayon de ladite surface sphérique virtuelle.

5. Support qui stocke un programme pour faire fonctionner un ordinateur constituant lesdits moyens de traitement pour le déplacement du point d'observation selon l'une quelconque des revendications 1 à 4.

6. Dispositif de génération d'images selon la revendication 1, comportant un moyen de décision de cible qui sélectionne l'un d'une pluralité desdits objets en mouvement (20a, 20b) sur la base de normes prédéterminées, ciblant cet objet en mouvement (20a) depuis le point d'observation.

7. Dispositif de génération d'images selon la revendication 6, dans lequel ledit moyen de décision de cible cible, dans la pluralité d'objets en mouvement (20a, 20b), l'objet en mouvement (21a) attaquant le point d'observation.

8. Dispositif de génération d'images selon la revendication 6, dans lequel ledit moyen de décision de cible cible, dans la pluralité d'objets en mouvement (20a, 20b), l'objet en mouvement (20b) le plus proche de la zone d'impact depuis le point d'observation.

9. Dispositif de génération d'images selon la revendication 6, dans lequel ledit moyen de décision de cible déplace la cible depuis le point d'observation vers un objet en mouvement dans un autre groupe d'objets en mouvement si le nombre d'objets en mouvement (20a, 20b) du groupe d'objets en mouvement formé d'une pluralité d'objets en mouve-

ment (20a, 20b) devient inférieur à une valeur prescrite.

10. Support qui stocke un programme pour faire fonctionner un ordinateur constituant ledit moyen de décision de cible selon l'une quelconque des revendications 6 à 9.

11. Dispositif de génération d'images selon la revendication 1, comportant un moyen de commande d'objet en mouvement qui indique ledit objet en mouvement (22a, 22b) conformément à la situation dudit objet en mouvement (22a, 22b) dans l'espace virtuel à trois dimensions.

12. Dispositif de génération d'images selon la revendication 11, dans lequel ledit moyen de commande d'objet en mouvement retire, si le point d'impact (22c) est situé en deçà d'une portée prescrite dudit objet en mouvement (22a, 22b), ledit objet en mouvement de la zone d'impact (22c).

13. Dispositif de génération d'images selon la revendication 12, dans lequel ledit moyen de commande de l'objet en mouvement déplace les autres objets en mouvement (22a, 22b) vers l'objet en mouvement qui effectue une attaque contre le point d'observation.

14. Support qui stocke un programme pour faire fonctionner un ordinateur constituant ledit moyen de commande d'objets en mouvement selon l'une quelconque des revendications 11 à 13.

15. Machine de jeu comportant un indicateur (la) ; une section de manoeuvre (2) ; et un dispositif de génération d'images qui génère des images d'objets en mouvement se déplaçant dans un espace virtuel à trois dimensions, captées depuis un point d'observation à l'intérieur de l'espace virtuel à trois dimensions, dans laquelle ledit dispositif de génération d'images est conforme à l'une quelconque des revendications 1 à 4, des revendications 6 à 9 ou des revendications 11 à 13, génère des images sur la base du signal de sortie de ladite section de manoeuvre (2), et indique cette image générée sur ledit indicateur (1a).

FIG 1

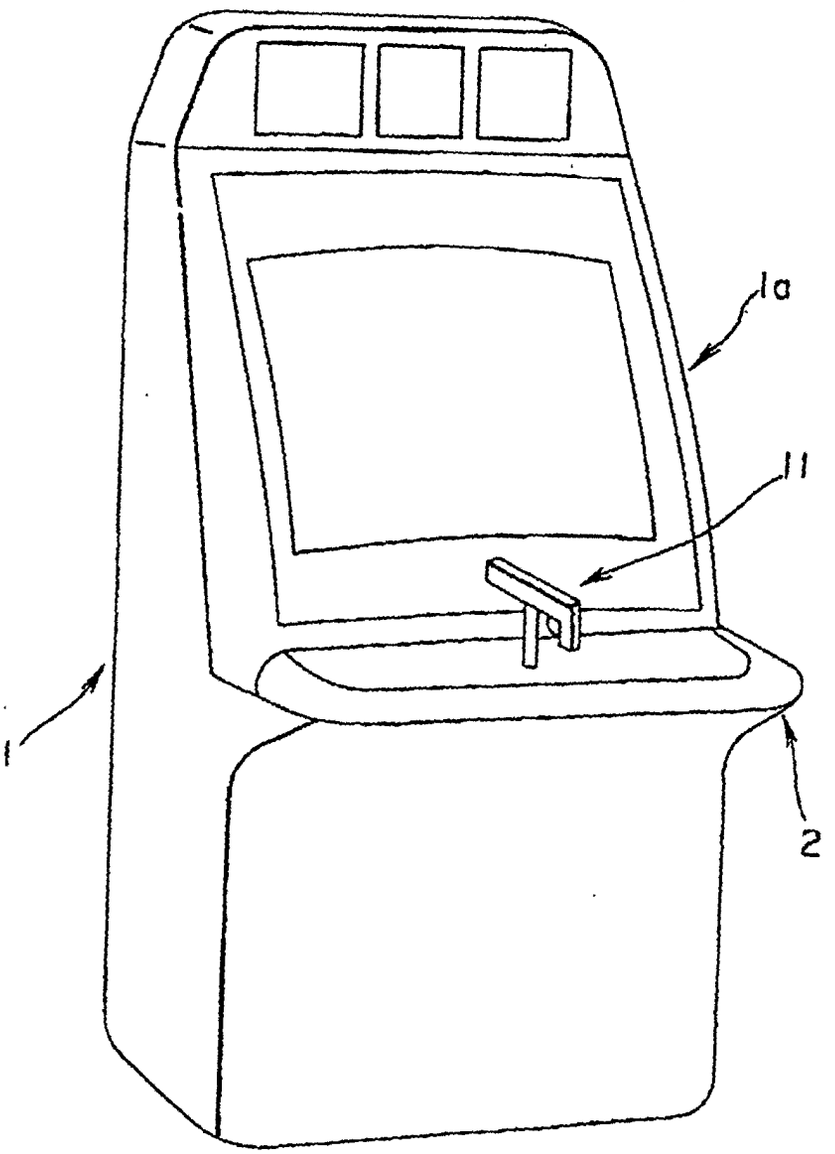


FIG.2

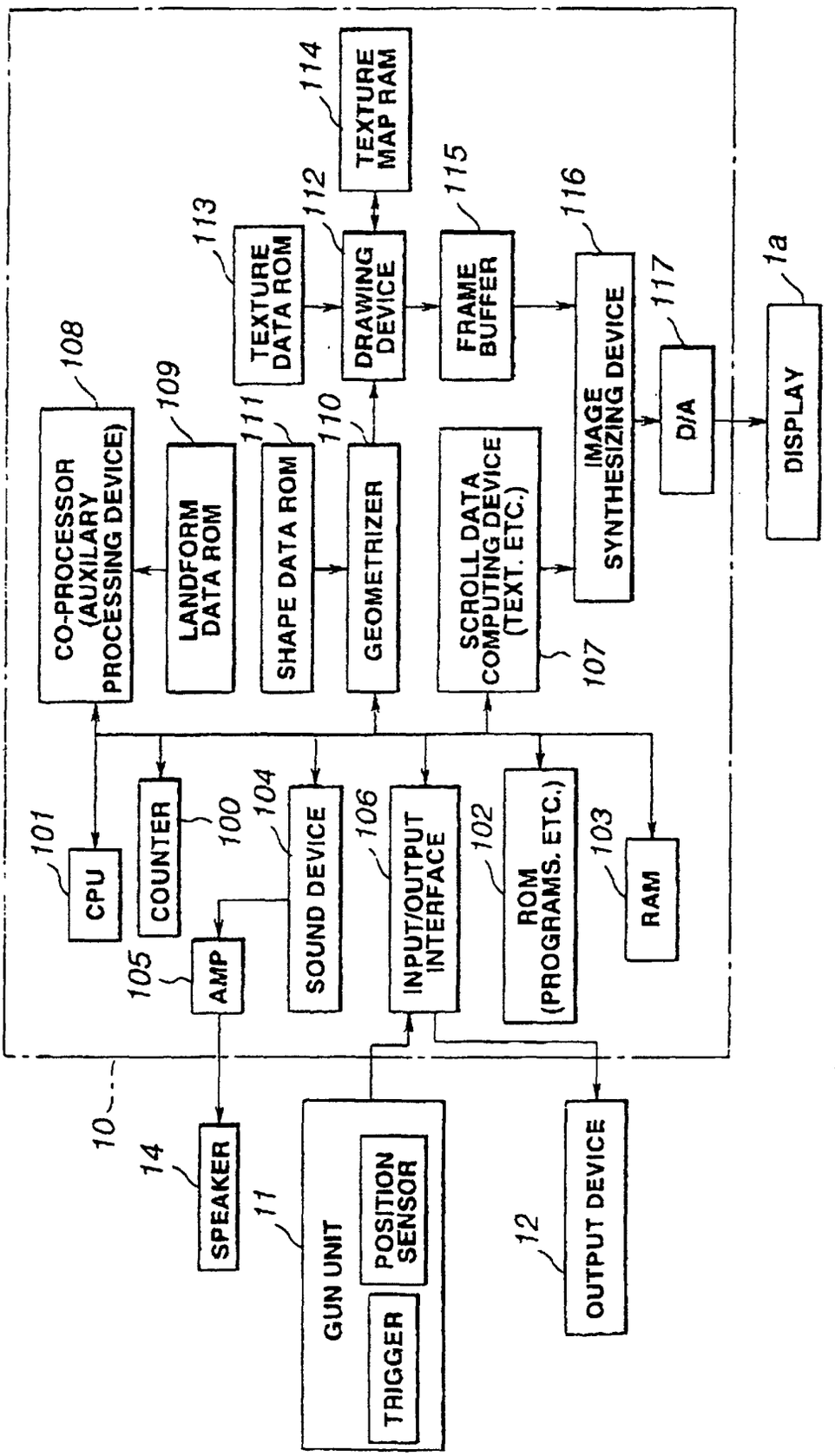

CO-PROCESSOR (AUXILARY PROCESSING DEVICE)
108
LANDFORM DATA ROM
109
SHAPE DATA ROM
111
GEOMETRIZER
110
SCROLL DATA COMPUTING DEVICE (TEXT. ETC.)
107
TEXTURE DATA ROM
113
DRAWING DEVICE
112
TEXTURE MAP RAM
114
FRAME BUFFER
115
IMAGE SYNTHESIZING DEVICE
116
D/A
117
DISPLAY
1a
CPU
101
COUNTER
100
AMP
105
SOUND DEVICE
104
INPUT/OUTPUT INTERFACE
106
ROM (PROGRAMS. ETC.)
102
RAM
103
10
SPEAKER
14
GUN UNIT
11
TRIGGER
POSITION SENSOR
OUTPUT DEVICE
12

FIG 3

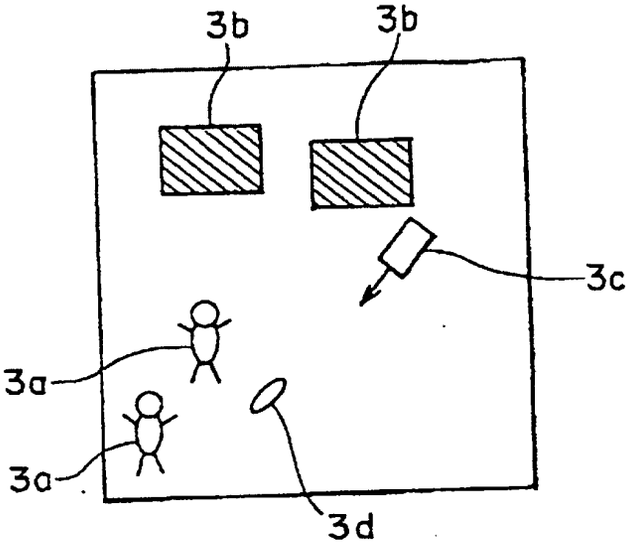


FIG 4

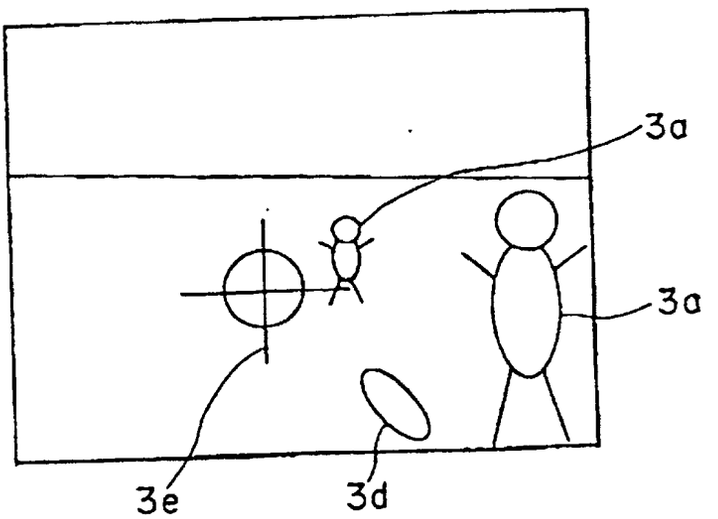


FIG.5

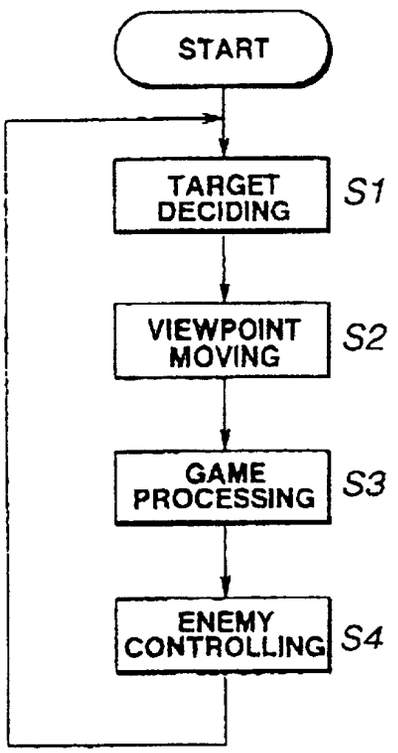

START
TARGET DECIDING
S1
VIEWPOINT MOVING
S2
GAME PROCESSING
S3
ENEMY CONTROLLING
S4

FIG.6

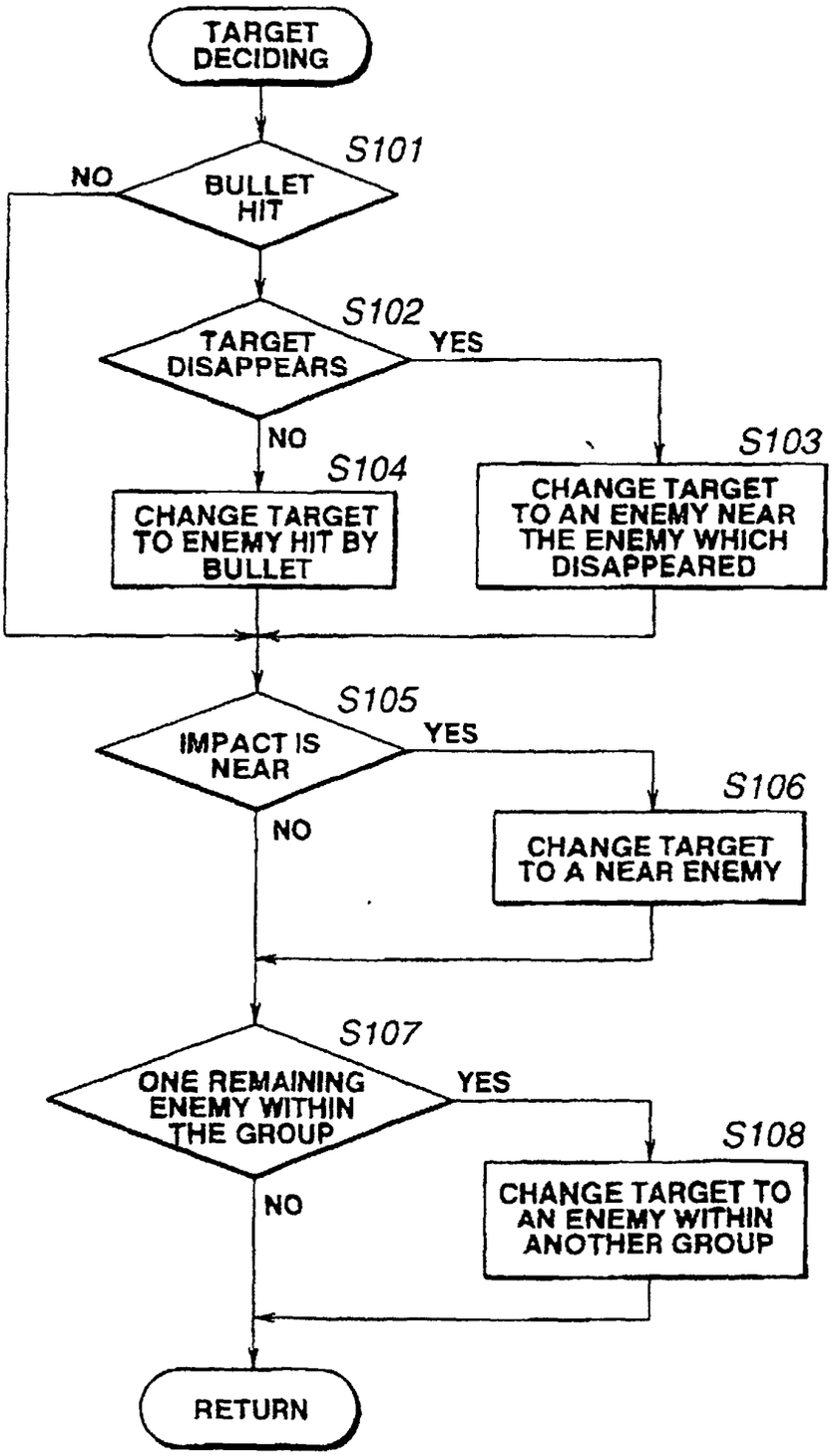

TARGET DECIDING
S101
BULLET HIT
NO
S102
TARGET DISAPPEARS
YES
NO
S103
CHANGE TARGET TO AN ENEMY NEAR THE ENEMY WHICH DISAPPEARED
S104
CHANGE TARGET TO ENEMY HIT BY BULLET
S105
IMPACT IS NEAR
YES
NO
S106
CHANGE TARGET TO A NEAR ENEMY
S107
ONE REMAINING ENEMY WITHIN THE GROUP
YES
NO
S108
CHANGE TARGET TO AN ENEMY WITHIN ANOTHER GROUP
RETURN

FIG.7

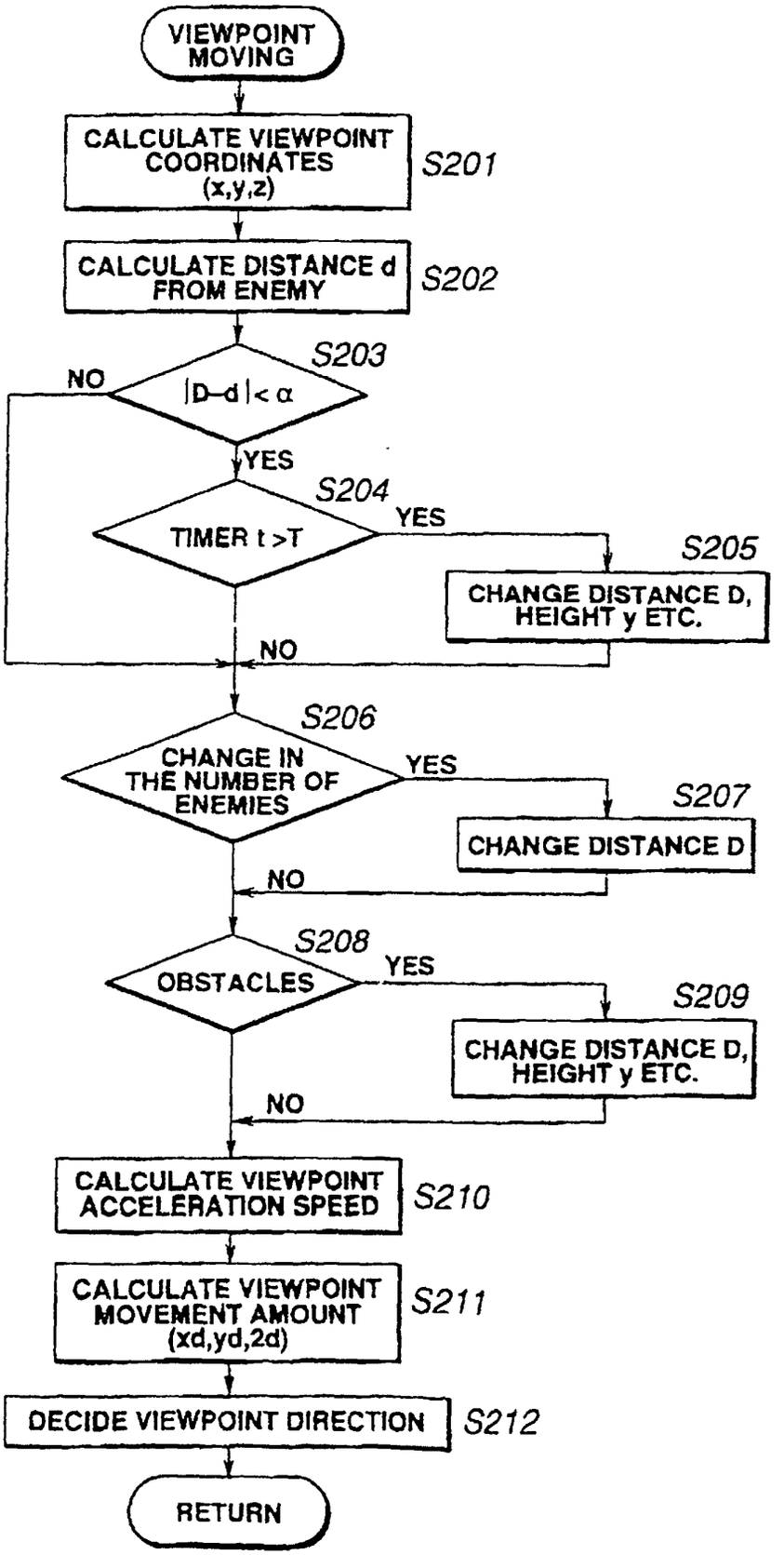

VIEWPOINT MOVING
CALCULATE VIEWPOINT COORDINATES (x,y,z)
S201
CALCULATE DISTANCE d FROM ENEMY
S202
S203
|D-d|< α
NO
YES
S204
TIMER t >T
YES
S205
CHANGE DISTANCE D, HEIGHT y ETC.
NO
S206
CHANGE IN THE NUMBER OF ENEMIES
YES
S207
CHANGE DISTANCE D
NO
S208
OBSTACLES
YES
S209
CHANGE DISTANCE D, HEIGHT y ETC.
NO
CALCULATE VIEWPOINT ACCELERATION SPEED
S210
CALCULATE VIEWPOINT MOVEMENT AMOUNT (xd,yd,2d)
S211
DECIDE VIEWPOINT DIRECTION
S212
RETURN

FIG.8

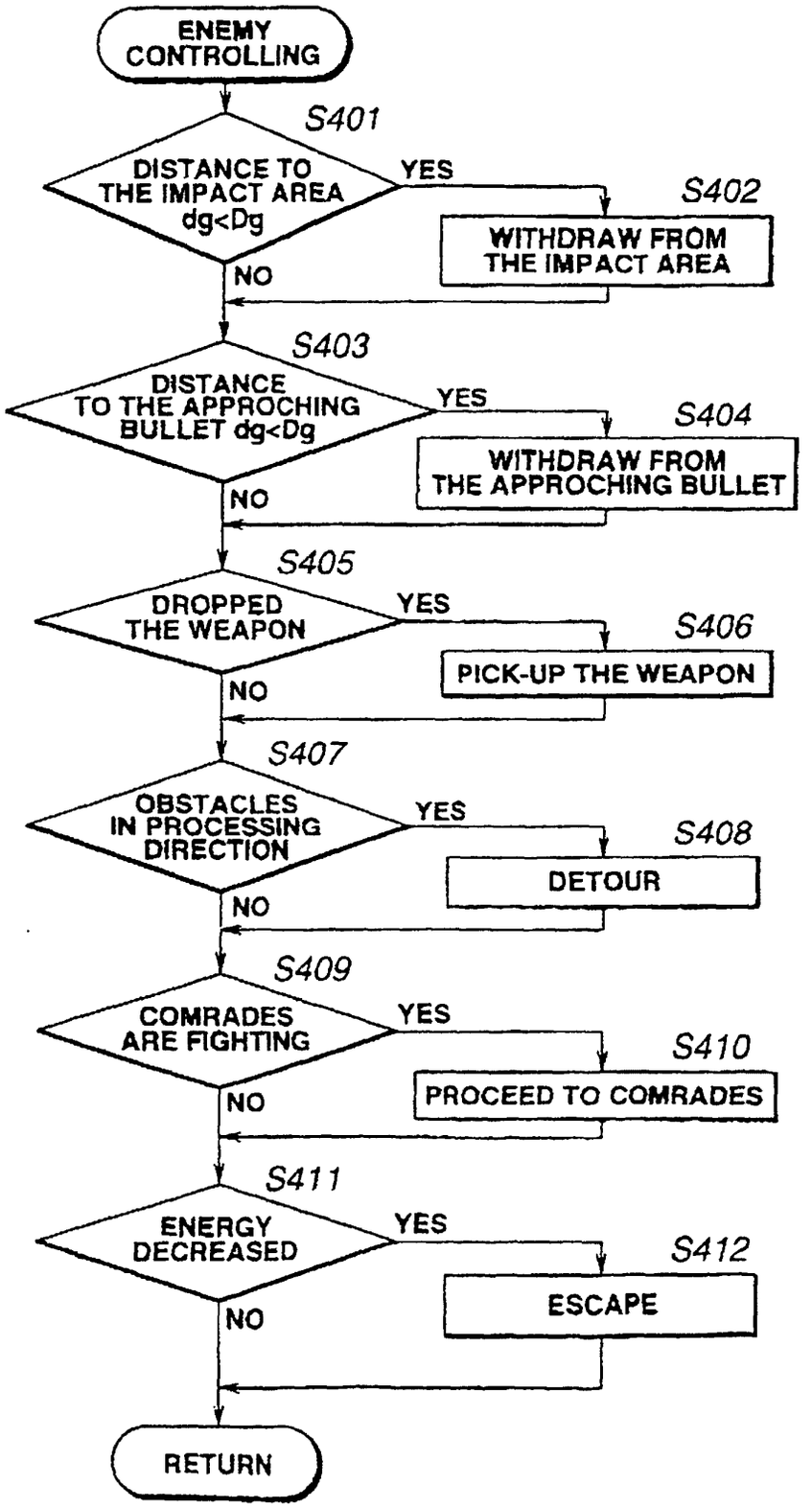

ENEMY CONTROLLING
S401
DISTANCE TO THE IMPACT AREA dg<Dg
YES
S402
WITHDRAW FROM THE IMPACT AREA
NO
S403
DISTANCE TO THE APPROCHING BULLET dg<Dg
YES
S404
WITHDRAW FROM THE APPROCHING BULLET
NO
S405
DROPPED THE WEAPON
YES
S406
PICK-UP THE WEAPON
NO
S407
OBSTACLES IN PROCESSING DIRECTION
YES
S408
DETOUR
NO
S409
COMRADES ARE FIGHTING
YES
S410
PROCEED TO COMRADES
NO
S411
ENERGY DECREASED
YES
S412
ESCAPE
NO
RETURN

FIG 9

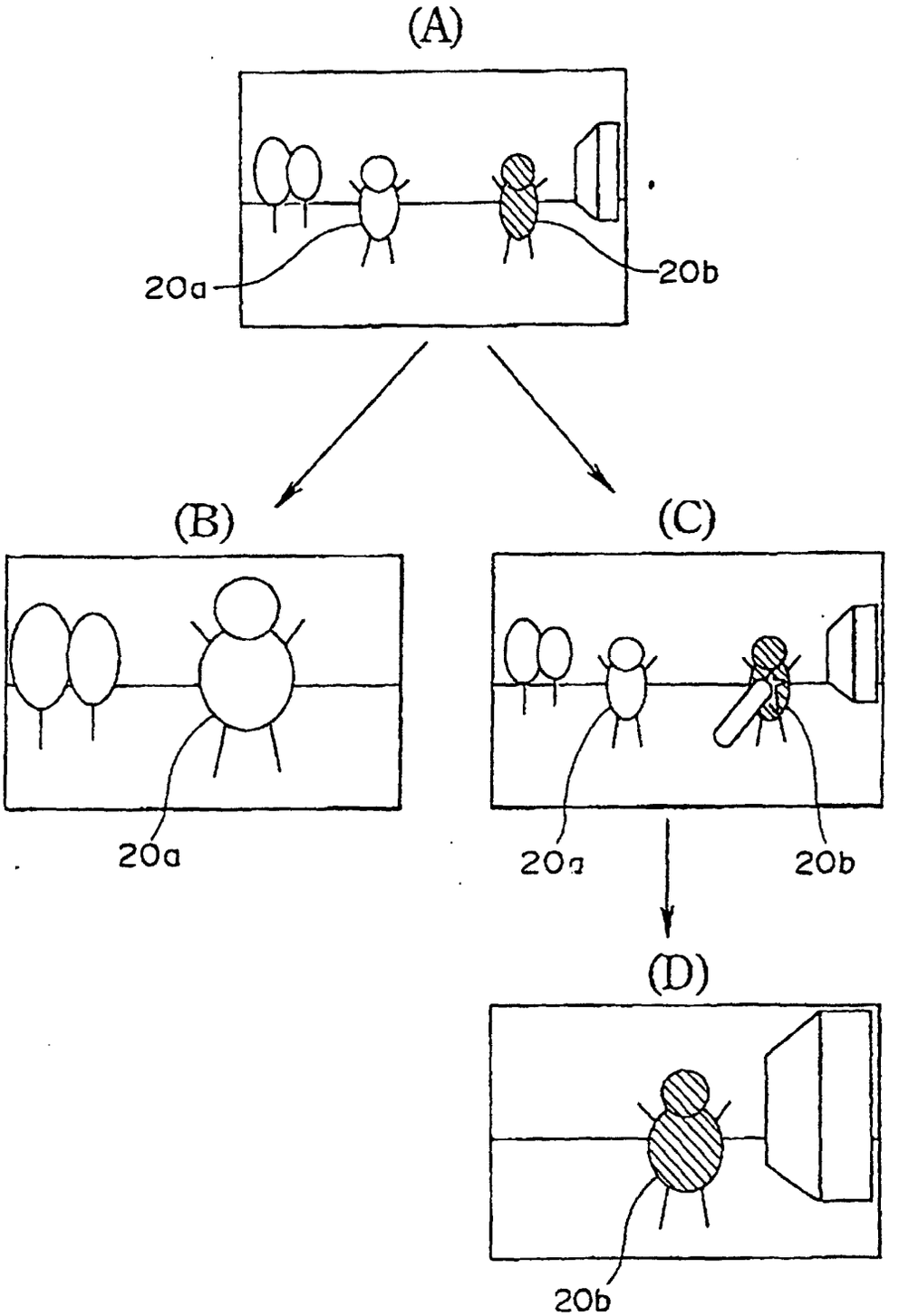


FIG 10

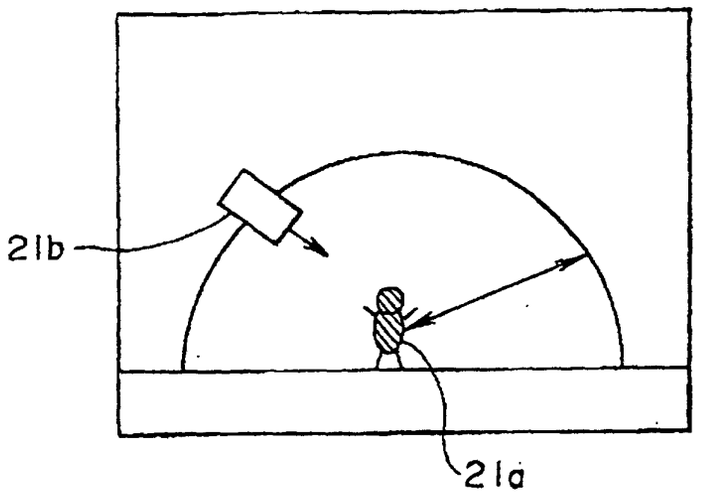


FIG 11

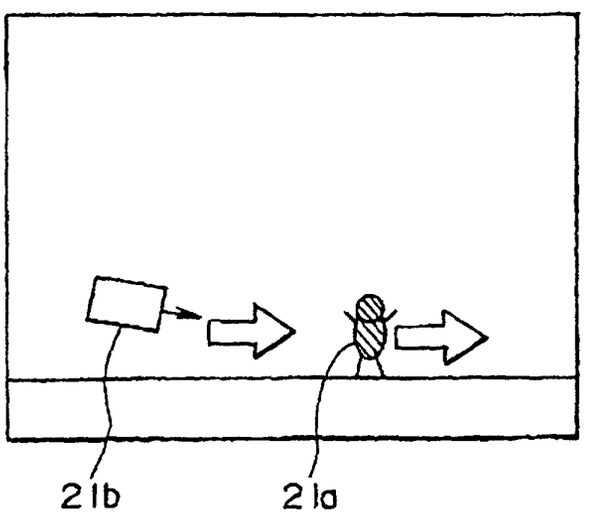


FIG 12

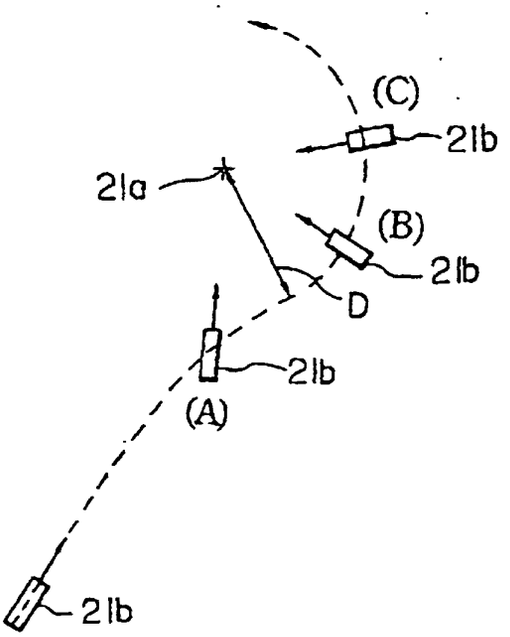


FIG 13

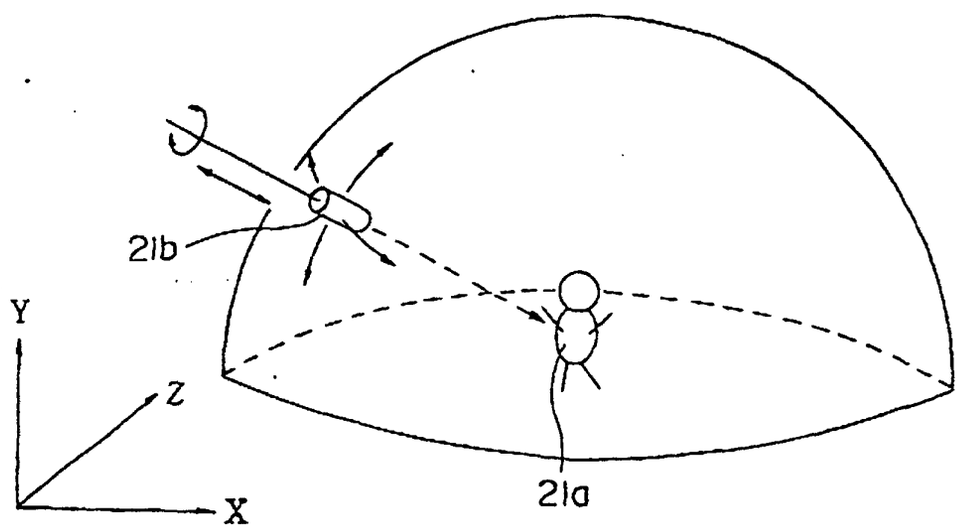
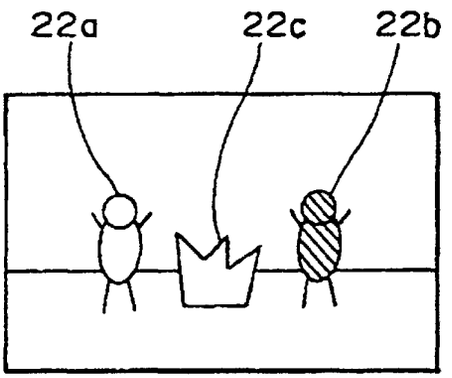


FIG 14

(A)



(B)