Title: COORDINATE INFORMATION UPDATING DEVICE AND COORDINATE INFORMATION GENERATING DEVICE

Abstract: An object can be displayed on a screen of a two-dimensional coordinate system based on xyz-coordinate values of the object in a three-dimensional coordinate system. Operation information of a two-dimensional coordinate system with respect to the object can be received from an input device, and whether the operation information is in accordance with a predetermined rule or not is determined. If the operation information is not in accordance with the predetermined rule, the operation information is determined in accordance with the predetermined rule, the coordinate value of the object can be updated in accordance with the operation information.
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BACKGROUND

Recently, images showing three-dimensional objects are generated because of development of computer graphics techniques. The screens of various electronic devices such as personal computers, mobile phones, and TVs use a two-dimensional coordinate system; therefore, the coordinate values of the objects of a three-dimensional coordinate system are displayed on the screens after being converted to those of the two-dimensional coordinate system. In order to carry out operations of the three-dimensional coordinate system with respect to the three-dimensional objects which are two-dimensionally shown in this manner, for example, a special mouse described in the art is capable of handling the operations of the three-dimensional coordinate system.

SUMMARY

However, an input device used by a general electronic device is a general mouse, touchpad, or the like which outputs the operation information of the two-dimensional coordinate system. Therefore, in such an electronic device, in order to make a transition to an operation of the three-dimensional coordinate system when carrying out an operation of the two-dimensional coordinate system, a switching operation is required in addition to the operation of the two-dimensional
coordinate system, which is cumbersome. For example, in the state in which a three-dimensional object two-dimensionally shown on a screen is selected by the input device, in other words, in the state in which the object is clicked by a mouse or tapped by a touchpad, when the input device is two-dimensionally moved, the x-coordinate value and the y-coordinate value of the object are changed in accordance with the movement. If the z-coordinate value of the object is required to be changed at this point, first, the selected state of the object is cancelled once, and an operation of giving an order to carry out the operation of the z-coordinate is then carried out. Then, the object is selected again; and, when the input device is two-dimensionally moved, the z-coordinate value of the object can be changed.

Therefore, easily carrying out the processing with respect to the coordinate values of an object in the three-dimensional coordinate system by using an input device capable of outputting the operation information of the two-dimensional coordinate system is desired.

A coordinate information updating device of the present disclosure includes: a coordinate storing unit configured for storing a coordinate value of an object in a three-dimensional coordinate system (x, y, z); a two-dimensional converting unit configured for converting xyz-coordinate values to coordinate values of a two-dimensional coordinate system (X, Y) and displaying the converted coordinate values on a screen; an operation
information receiving unit configured for receiving operation information of the two-dimensional coordinate system with respect to the object from an input device; an operation information determining unit configured for determining whether the operation information is in accordance with a predetermined rule or not; and a coordinate updating unit configured for, based on a result of the determination of the operation information determining unit, if the operation information is not in accordance with the predetermined rule, updating the xy-coordinate values of the object in accordance with the operation information and, if the operation information is in accordance with the predetermined rule, updating a z-coordinate value of the object in accordance with the operation information.

In the coordinate information updating device of the present disclosure, the predetermined rule may be a rule that a trajectory of XY-coordinate values corresponding to the operation information includes a predetermined trajectory.

In the coordinate information updating device of the present disclosure, the predetermined rule may be a rule that the trajectory of XY-coordinate values corresponding to the operation information includes the predetermined trajectory within a predetermined period of time.

In the coordinate information updating device of the present disclosure, the predetermined rule may be a rule that the trajectory of the XY-coordinate values
corresponding to the operation information continuously includes the predetermined trajectory a plurality of times.

In the coordinate information updating device of the present disclosure, the predetermined trajectory may be a trajectory reaching an end point within a predetermined range via a point distant from a start point by a predetermined distance or more, a distance of the end point within the predetermined range from the start point being shorter than the predetermined distance.

In the coordinate information updating device of the present disclosure, the predetermined trajectory may be an approximately-circular trajectory.

In the coordinate information updating device of the present disclosure, the predetermined rule may be a rule that a plurality of trajectories of XY-coordinate values corresponding to the operation information include a predetermined trajectory.

In the coordinate information updating device of the present disclosure, the predetermined rule may be a rule that the plurality of trajectories of the XY-coordinate values corresponding to the operation information include the predetermined trajectory within a predetermined period of time.

In the coordinate information updating device of the present disclosure, when the operation information is determined to be in accordance with the predetermined rule, the coordinate updating unit may update the z-
coordinate value of the object based on a distance and a direction of a trajectory of XY-coordinate values corresponding to the operation information after the determination.

In the coordinate information updating device of the present disclosure, the coordinate updating unit may update the z-coordinate value of the object based on the distance, the direction, and a speed of the trajectory of the XY-coordinate values corresponding to the operation information.

In the coordinate information updating device of the present disclosure, the coordinate updating unit may update the z-coordinate value of the object in accordance with the operation information after the determination that the trajectory of the XY-coordinate values includes the predetermined trajectory.

A coordinate information generating device of the present disclosure includes: an operation information receiving unit configured for receiving from an input device operation information of a two-dimensional coordinate system with respect to an object displayed on a screen of a two-dimensional coordinate system \((X, Y)\); a coordinate generating unit configured for generating a z-coordinate value of the object in a three-dimensional coordinate system \((x, y, z)\) based on the operation information and generating xy-coordinate values of the object based on the z-coordinate value; and a coordinate storing unit configured for storing the xyz-coordinate...
values of the object generated by the coordinate generating unit.

In the coordinate information generating device of the present disclosure, the operation information may include XY-coordinate information specifying XY-coordinate values of the object and z-coordinate information for generating a z-coordinate value of the object; and the coordinate generating unit may generate the z-coordinate value of the object based on the z-coordinate information and generate the xy-coordinate values based on the z-coordinate value and the XY-coordinate information.

In the coordinate information generating device of the present disclosure, the coordinate generating unit may generate the z-coordinate value of the object based on a distance and a direction of a trajectory of the XY-coordinate values corresponding to the z-coordinate information.

In the coordinate information generating device of the present disclosure, the trajectory of the XY-coordinate values corresponding to the z-coordinate information may include an approximately-circular trajectory.

In the present specification, "unit" includes a unit realized by hardware, a unit realized by software, and a unit realized by using both of them. One unit may be realized by using two or more hardware, and two or more units may be realized by one piece of hardware.
Brief Description of Drawings

Figure 1 includes a drawing showing an example of the functional configuration of a coordinate information updating device.

Figure 2 includes a drawing showing a hardware configuration example of the coordinate information updating device.

Figure 3 includes a drawing showing an example of a point P (x, y, z) in a three-dimensional coordinate system and the point P (X, Y) converted to a two-dimensional coordinate system.

Figure 4 includes a drawing showing examples of the trajectory of the coordinate values of the two-dimensional coordinate system of the operation information for changing a z-coordinate value.

Figure 5 includes a drawing showing an example of the method for determining that the trajectory of the coordinate values of the two-dimensional coordinate system of the operation information is an approximately-circular trajectory.

Figure 6 includes a flow chart showing an example of a coordinate information updating process.

Figure 7 includes a drawing showing an example of the functional configuration of a coordinate information generating device.

Figure 8 includes a flow chart showing an example of a coordinate information generating process.
Figure 9 includes a drawing showing an example of switching to an updating process of the z-coordinate value by the trajectory of the coordinate values of the two-dimensional coordinate system different from an approximately-circular shape.

Figure 10 includes a drawing showing an example of switching to the updating process of the z-coordinate value by a plurality of trajectories of coordinate values of the two-dimensional coordinate system.

**Description**

Figure 1 is a drawing showing the functional configuration of a coordinate information updating device, which is an embodiment of the present disclosure. The coordinate information updating device 10 is an electronic device capable of updating the coordinate values of a three-dimensional object, which is two-dimensionally displayed by a display device 12, in a three-dimensional coordinate system \((x, y, z)\) in accordance with operation information of a two-dimensional coordinate system \((X, Y)\) output from an input device 14, and the coordinate information updating device 10 is, for example, a personal computer or the like. Herein, the display device 12 is a device capable of displaying images by the two-dimensional coordinate system and is a liquid crystal display, an organic EL display, or the like. The input device 14 is a device capable of outputting the operation information of the two-dimensional coordinate system and is a mouse, a touch
panel, a touchpad, or the like. The coordinate information updating device 10 may be composed integrally with the display device 12 and the input device 14 like, for example, a mobile terminal, a TV, or the like.

As shown in Figure 1, the coordinate information updating device 10 is composed of: a coordinate storing unit 20, a two-dimensional converting unit 22, an operation information receiving unit 24, an operation information determining unit 26, and a coordinate updating unit 28. Figure 2 is a drawing showing an example of the hardware configuration of the coordinate information updating device 10. As shown in Figure 2, the coordinate information updating device 10 can be composed of: a CPU 40, a memory 42, a hard disk drive 44, a display interface 46, and an input interface 48. The coordinate storing unit 20 can be composed by using the memory 42 or the hard disk drive 44. The two-dimensional converting unit 22, the operation information receiving unit 24, the operation information determining unit 26, and the coordinate updating unit 28 can be realized when the CPU 40 executes one or more programs stored in the memory 42.

The coordinate storing unit 20 stores the coordinate values of the object in the three-dimensional coordinate system. In other words, the x-axis, y-axis, and z-axis coordinate values of the points specifying the position of the object are stored in the coordinate storing unit 20. Herein, the points specifying the position of the
object are, for example, the center point, vertices, etc. of the object. Note that the three-dimensional coordinate system \((x, y, z)\) can be arbitrarily set, and the system is not limited to the orthogonal coordinate system, but may be a polar coordinate system.

The two-dimensional converting unit 22 converts the coordinate values of the three-dimensional coordinate system to the coordinate values of the two-dimensional coordinate system, thereby two-dimensionally displaying the three-dimensional object by the display device 12 via the display interface 46. In other words, the two-dimensional converting unit 22 converts the coordinate values \((x, y, z)\) of a point \(P\), which is two-dimensionally displayed in a pseudo manner as shown in Figure 3 (a), in the three-dimensional coordinate system to the coordinate values \((X, Y)\) in the two-dimensional coordinate system as shown in Figure 3 (b). Herein, as shown in Figure 3 (a), when the angle formed by the \(x\)-axis and the \(z\)-axis when the three-dimensional coordinate system is two-dimensionally displayed in the pseudo manner is \(\Theta\), the coordinate values \((X, Y)\) of the point \(P\) in the two-dimensional coordinate system can be obtained by \(X=x-z\cos\Theta, Y=y-z\sin\Theta\).

The operation information receiving unit 24 receives the operation information of the two-dimensional coordinate system with respect to the object displayed by the display device 12 from the input device 14 via the input interface 48. Herein, the input device 14 is a
device capable of outputting the two-dimensional coordinate system with respect to the object, in other words, X-axis/Y-axis operation information and is a mouse, touchpad, a touch panel, or the like.

Depending on whether the operation information received by the operation information receiving unit 24 is in accordance with a predetermined rule or not, the operation information determining unit 26 determines whether the operation information represents the operation with respect to XY-coordinate values, in other words, xy-coordinate values or the operation with respect to the z-coordinate value.

Specifically, the operation information determining unit 26 determines whether the trajectory of the XY-coordinate values corresponding to the operation information is a predetermined trajectory or not. In the present embodiment, when the trajectory of the XY-coordinate values corresponding to the operation information has a clockwise approximately-circular shape as exemplified in Figure 4 (a), the operation information determining unit 26 determines that the operation is intended to change the z-coordinate value of the object in a positive direction. When the trajectory of the XY-coordinate values corresponding to the operation information has an anticlockwise approximately-circular shape as exemplified in Figure 4 (b), the operation information determining unit 26 determines that the operation is intended to change the z-coordinate value of
the object in a negative direction. The reason therefor
is that the operation in which an operation start
position and an operation end position are not different
from each other in the two-dimensional coordinate system
$(x, y)$ is unnatural as an operation for moving the object,
and the possibility of carrying out such an operation
when the xy-coordinate values are to be updated is
conceived to be low.

Note that the operation information determining unit
may determine that the operation information is in
accordance with a predetermined rule when the trajectory
of the two-dimensional coordinate values corresponding to
the operation information continuously form an
approximately-circular trajectory a plurality of times
within predetermined period of time. By virtue of this,
the determination accuracy of the operation information
determining unit 26 can be improved.

Herein, whether the trajectory of the two-
dimensional coordinate values corresponding to the
operation information is approximately circular or not
can be determined depending on, for example, whether the
trajectory of the two-dimensional coordinate values
corresponding to the operation information is included
between two circles having a common center point and
mutually-different radii as shown by the broken lines in
Figure 5. Note that the determination of the
approximately-circular trajectory by the operation
information determining unit 26 is not limited thereto.
The coordinate updating unit 28 updates the xy-coordinate values or the z-coordinate value with respect to the object displayed by the two-dimensional coordinate system based on the determination result of the operation information determining unit 26. For example, in the case in which the z-coordinate value is to be updated by the clockwise or anticlockwise approximately-circular operation as shown in Figure 4, the coordinate updating unit 28 updates the z-coordinate value based on the distance, direction, and speed of the trajectory of the XY-coordinate values corresponding to the operation information. For example, if the trajectory of the XY-coordinate values corresponding to the operation information is circular, the change amount of the z-coordinate value can be caused to be proportional to the number of rotation of the circles. Alternatively, for example, even when the number of rotation of the trajectory of the XY-coordinate values corresponding to the operation information is the same, the change amount of the z-coordinate value per one rotation can be changed in accordance with the moving speed thereof. In other words, for example, even if the circles have the same trajectory, the change amount of the z-coordinate value per one rotation can be caused to be small when the speed is slow, and the change amount of the z-coordinate value per one rotation can be caused to be large when the speed is fast. Note that the speed may be an angular speed or linear speed. Alternatively, for example, even when the
number of rotation of the trajectory of the XY-coordinate values corresponding to the operation information is the same, the change amount of the z-coordinate value per one rotation can be changed in accordance with the size of the circle.

Figure 6 is a flow chart showing an example of an updating process of coordinate information in the present embodiment. For example, the case in which the coordinate values of a plurality of three-dimensional objects in the three-dimensional coordinate system are stored in the coordinate storing unit 20 is presupposed. In this case, the two-dimensional converting unit 22 converts the coordinate values of the three-dimensional coordinate system to the coordinate values of the two-dimensional coordinate system, thereby two-dimensionally displaying the plurality of three-dimensional objects on the display device 12.

In such a state, a user selects a certain object as an operation target and carries out an operation with respect to the object by using the input device 14. As a result, the operation information of the two-dimensional coordinate system with respect to the selected object is output from the input device 14. Herein, the action of selecting the object as the operation target can be carried out, for example, by clicking the object if the input device 14 is a mouse or by tapping the object if the input device 14 is a touchpad or a touch panel.
Then, the operation information receiving unit 24 receives the operation information output from the input device 14 in this manner (S601). The operation information determining unit 26 determines whether the received operation information is in accordance with the predetermined rule or not (S602). In other words, the operation information determining unit 26 determines whether the trajectory of the XY-coordinate values corresponding to the operation information is an approximately-circular trajectory or not.

If the determination result of the operation information determining unit 26 indicates that the operation information is not in accordance with the predetermined rule (S602: N), the coordinate updating unit 28 updates the xy-coordinate values of the object based on the trajectory of the coordinate values corresponding to the operation information (S603).

If the determination result of the operation information determining unit 26 indicates that the operation information is in accordance with the predetermined rule (S602: Y), the operation information receiving unit 24 further receives the operation information of the two-dimensional coordinate system (S604) after the determination of the operation information determining unit 26. Then, after the determination of the operation information determining unit 26, the coordinate updating unit 28 updates the z-coordinate value of the object based on the operation
information of the two-dimensional coordinate system received within a predetermined period (S605). In other words, the coordinate updating unit 28 updates the z-coordinate value of the object based on the distance, direction, and speed of the approximately-circular trajectory of the XY-coordinate values corresponding to the operation information received after the determination. Specifically, if the trajectory of the XY-coordinate values corresponding to the operation information is a clockwise approximately-circular trajectory, the operation information determining unit 26 changes the z-coordinate value of the object toward the positive side in accordance with the distance and the speed of the trajectory. If the trajectory of the XY-coordinate values corresponding to the operation information is an anticlockwise approximately-circular trajectory, the operation information determining unit 26 changes the z-coordinate value of the object toward the negative side in accordance with the distance and the speed of the trajectory.

The direction and the speed of the trajectory of the XY-coordinate values corresponding to the operation information of the two-dimensional coordinate system are not required to be constant, but may be changed during the operation. In other words, the z-coordinate value of the object can be finely adjusted by changing the direction and the speed of the trajectory of the XY-coordinate values corresponding to the operation.
information during the operation. The coordinate updating unit 28 may cause the operation information of the two-dimensional coordinate system received upon the determination by the operation information determining unit 26 to be reflected to the updating amount of the z-coordinate value. For example, in the case in which switching to the updating process of the z-coordinate value is carried out when the trajectory of the XY-coordinate values corresponding to the operation information forms an approximate circle two times, the operation information determining unit 26 may update the z-coordinate value based on the distance, direction, and speed of the trajectory of the two rotations.

Then, the coordinate updating unit 28 updates the xyz-coordinate values, which are recorded in the coordinate storing unit 20, in accordance with the updated xy-coordinate values or z-coordinate value (S606). When the xyz-coordinate values recorded in the coordinate storing unit 20 are updated, the two-dimensional converting unit 22 converts the updated xyz-coordinate values to XY-coordinate values of the two-dimensional coordinate system (S607) and updates the two-dimensional display position of the object displayed by the display device 12 (S608).

While the input of the operation information with respect to the selected object is carried out, the process of updating the xy-coordinate values or the z-coordinate value based on the operation information (S601
to S608) is repeatedly executed (S609: N). The input of the operation information with respect to the object is finished when the selected state of the object is cancelled (S609: Y). Herein, the cancellation of the selected state of the object can be carried out by, for example, cancelling the click or clicking another object if the input device 14 is a mouse; or, if the input device 14 is a touchpad or a touch panel, the cancellation can be carried out by cancelling the tap or tapping another object.

In this manner, according to the coordinate information updating device 10 of the present embodiment, whether update of the xy-coordinate values is to be carried out or update of the z-coordinate value is to be carried out can be switched by determining whether the operation information of the two-dimensional coordinate system is in accordance with the predetermined rule or not. In other words, switching between the updating process of the xy-coordinate values of the object and the updating process of the z-coordinate value of the object can be switched while remaining in the moving operation of the two-dimensional coordinate system (X, Y) without carrying out a cumbersome switching operation.

Figure 7 is a drawing showing the functional configuration of a coordinate information generating device which is an embodiment of the present disclosure. The coordinate information generating device 100 is an
electronic device capable of generating the coordinate values of a three-dimensional object, which is two-dimensionally displayed by the display device 12, in the three-dimensional coordinate system \((x, y, z)\) in accordance with the operation information of the two-dimensional coordinate system \((X, Y)\) output from the input device 14.

As shown in Figure 7, the coordinate information generating device 100 is composed of: a coordinate storing unit 110, an operation information receiving unit 112, a coordinate generating unit 114, and a coordinate recording unit 116. The coordinate information generating device 100 can have a hardware configuration similar to that of the coordinate information updating device 10 of the embodiment described above, and the coordinate storing unit 110 can be composed by using the memory 42 or the hard disk drive 44. Therefore, the operation information receiving unit 112, the coordinate generating unit 114, and the coordinate recording unit 116 can be realized by executing a program(s) stored in the memory 42 by the CPU 40.

The coordinate storing unit 110 stores the xyz-coordinate values of the two-dimensionally-displayed three-dimensional object in the three-dimensional coordinate system. The xyz-coordinate values in the three-dimensional coordinate system are generated in accordance with the operations of a user.
The operation information receiving unit 112 receives the operation information of the two-dimensional coordinate system with respect to the three-dimensional object, which is displayed by the display device 12, from the input device 14.

The coordinate generating unit 114 generates a z-coordinate value of the object in the three-dimensional coordinate system based on the operation information of the two-dimensional coordinate system with respect to the three-dimensional object and, based on the generated z-coordinate value, generates xy-coordinate values of the object in the three-dimensional coordinate system. Specifically, the coordinate generating unit 114 generates the z-coordinate value based on the distance, direction, and speed of the trajectory of XY-coordinate values corresponding to the operation information. In the present embodiment, the coordinate generating unit 114 generates the z-coordinate value by a clockwise or anticlockwise approximately-circular operation as exemplified in Figure 4. For example, if the trajectory of the XY-coordinate values corresponding to the operation information is circular, the change amount of the z-coordinate value can be caused to be proportional to the number of rotation of the circles. Alternatively, for example, even when the number of rotation of the trajectory of the XY-coordinate values corresponding to the operation information is the same, the change amount of the z-coordinate value per one rotation can be changed
in accordance with the moving speed thereof. In other words, for example, even if the circles have the same trajectory, the change amount of the z-coordinate value per one rotation can be caused to be small when the speed is slow, and the change amount of the z-coordinate value per one rotation can be caused to be large when the speed is fast. Note that the speed may be an angular speed or linear speed. Alternatively, for example, even when the number of rotation of the trajectory of the XY-coordinate values corresponding to the operation information is the same, the change amount of the z-coordinate value per one rotation can be changed in accordance with the size of the circle.

The coordinate recording unit 116 records the coordinate values of the object in the three-dimensional coordinate system, which are generated by the coordinate generating unit 114, into the coordinate storing unit 110.

Figure 8 is a flow chart showing an example of a coordinate information generating process in the present embodiment. Herein, the state in which a three-dimensional object of which coordinate values in the three-dimensional coordinate system is unknown is two-dimensionally displayed by the display device 12 is presupposed.

In this state, the operation information receiving unit 112 receives the XY-coordinate values of a particular point of the object in the two-dimensional coordinate system, wherein the point serves as a target
for generating the coordinate values thereof in the three-dimensional coordinate system (S801). The particular point of the object can be specified by selecting the particular point of the two-dimensionally-displayed object by the input device 14. Herein, the action of selecting the particular point of the object can be carried out, for example, by clicking the target point if the input device 14 is a mouse; or, if the input device 14 is a touchpad or a touch panel, the action can be carried out by tapping the target point.

Furthermore, the operation information receiving unit 112 receives the operation information of the two-dimensional coordinate system with respect to the selected particular point (S802). Then, the coordinate generating unit 114 generates the z-coordinate value of the selected particular point based on the received operation information (S803). In the present embodiment, the coordinate generating unit 114 generates the z-coordinate value of the selected particular point based on the distance, direction, and speed of the approximately-circular trajectory of the XY-coordinate values corresponding to the operation information. Specifically, if the XY-coordinate values corresponding to the operation information form a clockwise approximately-circular trajectory as exemplified in Figure 4 (a), the coordinate generating unit 114 changes the z-coordinate value in a positive direction from an initial value (for example, zero) in accordance with the
distance and the speed of the trajectory. If the XY-coordinate values corresponding to the operation information form an anticlockwise approximately-circular trajectory as exemplified in Figure 4 (b), the coordinate generating unit 114 changes the z-coordinate value in a negative direction from the initial value (for example, zero) in accordance with the distance and the speed of the trajectory.

Then, based on the XY-coordinate values of the selected particular point and the generated z-coordinate value, the coordinate generating unit 114 generates the xy-coordinate values thereof in the three-dimensional coordinate system (S804). Herein, when the angle formed by the x-axis and the z-axis when the three-dimensional coordinate system is displayed on a two-dimensional screen in the pseudo manner is \( \Theta \), the xy-coordinate values in the three-dimensional coordinate system can be obtained by \( x = X + z \cdot \cos \Theta, \ y = Y + z \cdot \sin \Theta \). Note that the coordinate generating unit 114 can display the xyz-coordinate values of the three-dimensional coordinate system by the display device 12 during generation of the values with respect to the selected particular point.

While the input of the operation information with respect to the selected object is carried out, the process of updating the z-coordinate value and the xy-coordinate values based on the operation information (S802 to S804) is repeatedly executed (S805: N). Note that the input of the operation information with respect
to the object is finished when the selected state of the particular point of the object is cancelled (S805: Y). Herein, the cancellation of the selected state of the particular point of the object can be carried out by, for example, cancelling the click or clicking another point if the input device 14 is a mouse; or, if the input device 14 is a touchpad or a touch panel, the cancellation can be carried out by cancelling the tap or tapping another point.

Then, the coordinate recording unit 116 records the generated xyz-coordinate values of the three-dimensional system in the coordinate storing unit 110 in association with the information representing the particular point of the object such as XY-coordinate values thereof in the two-dimensional coordinate system (S806).

In this manner, according to the coordinate information generating device 100 of the present embodiment, the coordinate values of the particular point of the two-dimensionally-displayed three-dimensional object in the three-dimensional coordinate system can be generated while remaining in the operation of the two-dimensional coordinate system (X, Y) without carrying out a cumbersome switching operation between the two-dimensional operation and the three-dimensional operation.

Therefore, various processes in three-dimensional space using the coordinate values of the three-dimensional coordinate system can be carried out. For example, the position of an object in three-dimensional space can be
changed by using the generated coordinate values of the three-dimensional coordinate system by the method shown in the embodiment described above, or the direction of a three-dimensional object upon two-dimensional display can be changed.

The present disclosure is not limited to the above described embodiments, and various modifications, additions, and omission can be made by those skilled in the art without deviating from the idea and scope expressed by the claims.

For example, in one embodiment, the operation information determining unit 26 determines that the update of the z-coordinate value is to be carried out when the trajectory of the coordinate values of the two-dimensional coordinate system corresponding to the operation information is approximately circular; however, the predetermined rule for determining the operation information is not limited thereto.

For example, the operation information determining unit 26 may determine that the update of the z-coordinate value is to be carried out when the trajectory of the XY-coordinate values corresponding to the operation information reaches an end point E via a position distant from a start point S by a predetermined distance d1 or more, wherein the distance of the end point E from the start point S is within a predetermined range d2 (<d1) as shown in Figure 9. The reason therefor is that, as well as the case of the approximately-circular shape, the
possibility of carrying out such an operation is conceived to be low when the xy-coordinate values are to be normally updated.

Alternatively, for example, the operation information determining unit 26 may determine that the update of the z-coordinate value is to be carried out when a plurality of trajectories of XY-coordinate values corresponding to the operation information are predetermined trajectories. For example, if the input device 14 is a touchpad or a touch panel, the determination that the update of the z-coordinate value is to be carried out may be made when a pinching action or an expanding action is carried out by two fingers 120 and 122 with respect to a selected object as exemplified in Figure 10. The reason therefor is that, normally, there is no possibility that the xy-coordinate values are updated based on a plurality of simultaneously generated trajectories. Then, after it is determined that the update of the z-coordinate value is to be carried out, the coordinate updating unit 28 may update the z-coordinate value based on the distance, direction, and speed of the trajectories of the XY-coordinate values corresponding to the pinching action or expanding action.

In the first embodiment, the trajectory of the XY-coordinate values corresponding to the operation information upon switching to the updating process of the z-coordinate value and the trajectory of the XY-coordinate values corresponding to the operation
information upon updating of the z-coordinate value are both approximately-circular trajectories; however, the rules of the operation information upon switching and upon update are not required to be the same. For example, switching to the updating process of the z-coordinate value may be carried out when the trajectory of the XY-coordinate values corresponding to the operation information is approximately circular; and, then, for example, the z-coordinate value may be updated in accordance with the distance, direction, and speed of an approximately-linear trajectory of the XY-coordinate corresponding to operation information. The same also applies to the case in which it is determined that the update of the z-coordinate value is to be carried out when the plurality of trajectories corresponding to the operation information are predetermined trajectories.

The embodiments and the technical characteristics of various modifications explained above can be employed in arbitrary combinations.

Reference Signs List

10 COORDINATE INFORMATION UPDATING DEVICE
12 DISPLAY DEVICE
14 INPUT DEVICE
20 COORDINATE STORING UNIT
22 TWO-DIMENSIONAL CONVERTING UNIT
24 OPERATION INFORMATION RECEIVING UNIT
26 OPERATION INFORMATION DETERMINING UNIT
28  COORDINATE UPDATING UNIT
40  CPU
42  MEMORY
44  HARD DISK DRIVE
5  46  DISPLAY INTERFACE
48  INPUT INTERFACE
100  COORDINATE INFORMATION GENERATING DEVICE
110  COORDINATE STORING UNIT
112  OPERATION INFORMATION RECEIVING UNIT
10  114  COORDINATE GENERATING UNIT
116  COORDINATE RECORDING UNIT
Claims

1. A coordinate information updating device comprising:

   a coordinate storing unit configured to store a coordinate value of an object in a three-dimensional coordinate system \((x, y, z)\);

   a two-dimensional converting unit configured to convert \(xyz\)-coordinate values to coordinate values of a two-dimensional coordinate system \((X, Y)\) and display the converted coordinate values on a screen;

   an operation information receiving unit configured to receive operation information of the two-dimensional coordinate system to update \(xy\)-coordinate values with respect to the object from an input device;

   an operation information determining unit configured to determine whether a trajectory of \(XY\)-coordinate values corresponding to the operation information for updating the \(xy\)-coordinate values continuously includes an approximately-circular predetermined trajectory a plurality of times or not; and

   a coordinate updating unit configured to,

   if the trajectory of the \(XY\)-coordinate values corresponding to the operation information is determined to not continuously include the predetermined trajectory a plurality of times based on a result of determination of the operation information determining unit, update the \(xy\)-coordinate values of the object in accordance with the operation information and,
if the trajectory of the XY-coordinate values corresponding to the operation information is determined to continuously include the predetermined trajectory a plurality of times, update a z-coordinate value of the object based on a distance, direction, and speed of the predetermined trajectory of the XY-coordinate values in accordance with the operation information after the determination.

2. A coordinate information updating device comprising:

- a coordinate storing unit configured to store a coordinate value of an object in a three-dimensional coordinate system \((x, y, z)\);

- a two-dimensional converting unit configured to convert xyz-coordinate values to coordinate values of a two-dimensional coordinate system \((x, y)\) and display the converted coordinate values on a screen;

- an operation information receiving unit configured to receive operation information of the two-dimensional coordinate system to update xy-coordinate values with respect to the object from an input device;

- an operation information determining unit configured to determine whether the operation information for updating the xy-coordinate values is in accordance with a predetermined rule or not; and

- a coordinate updating unit configured to, based on a result of the determination of the operation information determining unit,
if the operation information is not in accordance with the predetermined rule, update the xy-coordinate values of the object in accordance with the operation information and,

if the operation information is in accordance with the predetermined rule, update a z-coordinate value of the object in accordance with the operation information.

3. The coordinate information updating device according to claim 2, wherein

the predetermined rule is a rule that a trajectory of XY-coordinate values corresponding to the operation information includes a predetermined trajectory.

4. The coordinate information updating device according to claim 3, wherein

the predetermined rule is a rule that the trajectory of the XY-coordinate values corresponding to the operation information includes the predetermined trajectory within a predetermined period of time.

5. The coordinate information updating device according to claim 3, wherein

the predetermined rule is a rule that the trajectory of the XY-coordinate values corresponding to the operation information continuously includes the predetermined trajectory a plurality of times.

6. The coordinate information updating device according to claim 3, wherein

the predetermined trajectory is a trajectory reaching an end point within a predetermined range via a
point distant from a start point by a predetermined distance or more, a distance of the end point within the predetermined range from the start point being shorter than the predetermined distance.

7. The coordinate information updating device according to claim 6, wherein the predetermined trajectory is an approximately-circular trajectory.

8. The coordinate information updating device according to claim 2, wherein the predetermined rule is a rule that a plurality of trajectories of XY-coordinate values corresponding to the operation information include a predetermined trajectory.

9. The coordinate information updating device according to claim 8, wherein the predetermined rule is a rule that the plurality of trajectories of the XY-coordinate values corresponding to the operation information include the predetermined trajectory within a predetermined period of time.

10. The coordinate information updating device according to claim 2, wherein, when the operation information is determined to be in accordance with the predetermined rule, the coordinate updating unit is configured to update the z-coordinate value of the object based on a distance and a direction of a trajectory of XY-coordinate values corresponding to the operation information after the determination.
11. The coordinate information updating device according to claim 10, wherein
the coordinate updating unit is configured to update
the z-coordinate value of the object based on the
distance, the direction, and a speed of the trajectory of
the XY-coordinate values corresponding to the operation
information.

12. The coordinate information updating device according to claim 10, wherein
the coordinate updating unit is configured to update
the z-coordinate value of the object in accordance with
the operation information after the determination that
the trajectory of the XY-coordinate values includes the
predetermined trajectory.

13. A coordinate information generating device comprising:

an operation information receiving unit configured
to receive operation information of a two-dimensional
coordinate system \((X, Y)\) to specify XY-coordinate values
or operation information of the two-dimensional
coordinate system to specify a z-coordinate value in a
three-dimensional coordinate system \((x, y, z)\) with
respect to an object displayed on a screen of the two-
dimensional coordinate system from an input device;

a coordinate generating unit configured to generate
a z-coordinate value of the object based on the operation
information of the two-dimensional coordinate system to
specify the z-coordinate value and generate xy-coordinate
values of the object based on the z-coordinate value and
XY-coordinate values specified by the operation
information of the two-dimensional coordinate system to
specify the XY-coordinate values; and
5 a coordinate storing unit configured to store the
xyz-coordinate values of the object generated by the
coordinate generating unit.

14. The coordinate information generating
device according to claim 13, wherein
10 the coordinate generating unit is configured to
generate the z-coordinate value of the object based on a
distance and a direction of a trajectory of the operation
information of the two-dimensional coordinate system to
specify the z-coordinate value.

15. The coordinate information generating
device according to claim 14, wherein
15 the trajectory of the operation information of the
two-dimensional coordinate system to specify the z-
coordinate value includes an approximately-circular
20 trajectory.

16. A coordinate information updating method
comprising:
25 two-dimensionally displaying an object on a screen
of a two-dimensional coordinate system (X, Y) based on
xyz-coordinate values of the object in a three-
dimensional coordinate system (x, y, z) stored in a
predetermined storing unit;
receiving operation information of the two-dimensional coordinate system for updating xy-coordinate values with respect to the object from an input device; determining whether the operation information for updating the xy-coordinate values is in accordance with a predetermined rule or not; and, based on a result of the determination, if the operation information is not in accordance with the predetermined rule, updating the xy-coordinate values of the object in accordance with the operation information, and if the operation information is in accordance with the predetermined rule, updating the z-coordinate value of the object in accordance with the operation information.

17. A coordinate information generating method comprising:

receiving operation information of a two-dimensional coordinate system \((X, Y)\) for specifying XY-coordinate values or operation information of the two-dimensional coordinate system for specifying a z-coordinate value in a three-dimensional coordinate system \((x, y, z)\) with respect to an object displayed on a screen of the two-dimensional coordinate system from an input device; generating a z-coordinate value of the object based on the operation information of the two-dimensional coordinate system for specifying the z-coordinate value and generating xy-coordinate values of the object based
on the z-coordinate value and XY-coordinate values specified by the operation information of the two-dimensional coordinate system for specifying the XY-coordinate values; and

5 recording the xyz-coordinate values of the object in a predetermined storing unit.

18. The coordinate information updating device according to claim 1, wherein the operation information determining unit is configured to determine operation information for updating the xy-coordinate values is in accordance with a predetermined rule or not.

19. The coordinate information updating device of claim 1, wherein the predetermined rule is a rule that a trajectory of XY-coordinate values corresponding to the operation information includes the approximately-circular predetermined trajectory.

20. The coordinate information updating device according to claim 18, wherein

the predetermined rule is a rule that the trajectory of the XY-coordinate values corresponding to the operation information includes the predetermined trajectory within a predetermined period of time.

21. The coordinate information updating device according to claim 18, wherein

the predetermined rule is a rule that the trajectory of the XY-coordinate values corresponding to the operation information continuously includes the predetermined trajectory a plurality of times.
22. The coordinate information updating device according to claim 18, wherein
the predetermined trajectory is a trajectory reaching an end point within a predetermined range via a
point distant from a start point by a predetermined distance or more, a distance of the end point within the
predetermined range from the start point being shorter than the predetermined distance.

23. The coordinate information updating device according to claim 18, wherein
the predetermined rule is a rule that a plurality of trajectories of XY-coordinate values corresponding to the
operation information include a predetermined trajectory.

24. The coordinate information updating device according to claim 18, wherein
the predetermined rule is a rule that the plurality of trajectories of the XY-coordinate values corresponding to the
operation information include the predetermined trajectory within a predetermined period of time.

25. The coordinate information updating device according to claim 18, wherein,
when the operation information is determined to be in accordance with the predetermined rule, the coordinate
updating unit is configured to update the z-coordinate value of the object based on a distance and a direction
of a trajectory of XY-coordinate values corresponding to the operation information after the determination.
26. The coordinate information updating device according to claim 25, wherein
the coordinate updating unit is configured to update
the z-coordinate value of the object based on the
distance, the direction, and a speed of the trajectory of
the XY-coordinate values corresponding to the operation
information.

27. The coordinate information updating device
according to claim 25, wherein
the coordinate updating unit is configured to update
the z-coordinate value of the object in accordance with
the operation information after the determination that
the trajectory of the XY-coordinate values includes the
predetermined trajectory.

28. The coordinate information updating device
according to claim 13, further comprising an operation
information determining unit configured to determine
whether the operation information for updating the xy-
coordinate values is in accordance with a predetermined
rule or not.

29. The coordinate information updating device
according to claim 28, wherein
the predetermined rule is a rule that a trajectory
of XY-coordinate values corresponding to the operation
information includes a predetermined trajectory.

30. The coordinate information updating device
according to claim 29, wherein
the predetermined rule is a rule that the trajectory of the XY-coordinate values corresponding to the operation information includes the predetermined trajectory within a predetermined period of time.

31. The coordinate information updating device according to claim 29, wherein

the predetermined rule is a rule that the trajectory of the XY-coordinate values corresponding to the operation information continuously includes the predetermined trajectory a plurality of times.

32. The coordinate information updating device according to claim 29, wherein

the predetermined trajectory is a trajectory reaching an end point within a predetermined range via a point distant from a start point by a predetermined distance or more, a distance of the end point within the predetermined range from the start point being shorter than the predetermined distance.

33. The coordinate information updating device according to claim 29, wherein

the predetermined trajectory is an approximately-circular trajectory.

34. The coordinate information updating device according to claim 28, wherein

the predetermined rule is a rule that a plurality of trajectories of XY-coordinate values corresponding to the operation information include a predetermined trajectory.
35. The coordinate information updating device according to claim 34, wherein
the predetermined rule is a rule that the plurality of trajectories of the XY-coordinate values corresponding to the operation information include the predetermined trajectory within a predetermined period of time.

36. The coordinate information updating device according to claim 28, wherein,
when the operation information is determined to be in accordance with the predetermined rule, the coordinate updating unit is configured to update the z-coordinate value of the object based on a distance and a direction of a trajectory of XY-coordinate values corresponding to the operation information after the determination.

37. The coordinate information updating device according to claim 36, wherein
the coordinate updating unit is configured to update the z-coordinate value of the object based on the distance, the direction, and a speed of the trajectory of the XY-coordinate values corresponding to the operation information.

38. The coordinate information updating device according to claim 36, wherein
the coordinate updating unit is configured to update the z-coordinate value of the object in accordance with the operation information after the determination that the trajectory of the XY-coordinate values includes the predetermined trajectory.
39. A coordinate information updating method comprising:

storing a coordinate value of an object in a three-dimensional coordinate system \((x, y, z)\);

converting xyz-coordinate values to values of a two-dimensional coordinate system;

displaying the converted coordinate values on a screen;

receiving operation information of the two-dimensional coordinate system to update xy-coordinate values with respect to the object from an input device;

determining whether a trajectory of XY-coordinate values corresponds to the operation information to determine whether a trajectory of XY-coordinate values corresponding to the operation information for updating the xy-coordinate values continuously includes an approximately-circular predetermined trajectory a plurality of times or not;

determining if the trajectory of the XY-coordinate values corresponding to the operation information does not continuously include the predetermined trajectory a plurality of times based on a result of determination of the operation information determining unit; and

updating the xy-coordinate values of the object in accordance with the operation information.

40. A coordinate information updating method comprising:
41. A coordinate information updating device comprising:

- storing a coordinate value of an object in a three-dimensional coordinate system \((x, y, z)\);
- converting xyz-coordinate values to values of a two-dimensional coordinate system;
- displaying the converted coordinate values on a screen;
- receiving operation information of the two-dimensional coordinate system to update xy-coordinate values with respect to the object from an input device;
- determining whether a trajectory of XY-coordinate values corresponds to the operation information to determine whether a trajectory of XY-coordinate values corresponding to the operation information for updating the xy-coordinate values continuously includes an approximately-circular predetermined trajectory a plurality of times or not;
- determining if the trajectory of the XY-coordinate values corresponding to the operation information is determined to continuously include the predetermined trajectory a plurality of times; and
- updating a z-coordinate value of the object based on a distance, direction, and speed of the predetermined trajectory of the XY-coordinate values in accordance with the operation information after the determination.
converting xyz-coordinate values to coordinate values of a two-dimensional coordinate system \((X, Y)\) and display the converted coordinate values on a screen;

receiving operation information of the two-dimensional coordinate system to update xy-coordinate values with respect to the object from an input device;

determining whether the operation information for updating the xy-coordinate values is in accordance with a predetermined rule or not;

determining if the operation information is not in accordance with the predetermined rule; and

updating the xy-coordinate values of the object in accordance with the operation information and,

42. A coordinate information updating device comprising:

storing a coordinate value of an object in a three-dimensional coordinate system \((x, y, z)\);

converting xyz-coordinate values to coordinate values of a two-dimensional coordinate system \((X, Y)\) and display the converted coordinate values on a screen;

receiving operation information of the two-dimensional coordinate system to update xy-coordinate values with respect to the object from an input device;

determining whether the operation information for updating the xy-coordinate values is in accordance with a predetermined rule or not;

determining if the operation information is in accordance with the predetermined rule; and
updating a z-coordinate value of the object in accordance with the operation information.

43. A coordinate information updating device comprising:

an operation information receiving unit configured to receive operation information of a two-dimensional coordinate system to update xy-coordinate values with respect to an object from an input device;

an operation information determining unit configured to determine whether a trajectory of XY-coordinate values corresponding to the operation information for updating the xy-coordinate values continuously includes a predetermined trajectory a plurality of times or not; and

a coordinate updating unit configured to,

if the trajectory of the XY-coordinate values corresponding to the operation information is determined to not continuously include the predetermined trajectory a plurality of times based on a result of determination of the operation information determining unit, update the xy-coordinate values of the object in accordance with the operation information and,

if the trajectory of the XY-coordinate values corresponding to the operation information is determined to continuously include the predetermined trajectory a plurality of times, update a z-coordinate value of the object based on a distance, direction, and speed of the predetermined trajectory of the XY-coordinate values in
accordance with the operation information after the
determination.

44. A coordinate information updating device
comprising:

an operation information receiving unit configured
to receive operation information of a two-dimensional
coordinate system to update xy-coordinate values with
respect to an object from an input device;

an operation information determining unit configured
to determine whether the operation information for
updating the xy-coordinate values is in accordance with a
predetermined rule or not; and

a coordinate updating unit configured to,

based on a result of the determination of the
operation information determining unit,

if the operation information is not in accordance
with the predetermined rule, update the xy-coordinate
values of the object in accordance with the operation
information and,

if the operation information is in accordance with
the predetermined rule, update a z-coordinate value of
the object in accordance with the operation information.
FIG. 3

(A)

POINT P (x, y, z) •

(B)

POINT P (X, Y) •
COORDINATE INFORMATION UPDATING PROCESS

S601

RECEIVE TWO-DIMENSIONAL OPERATION INFORMATION WITH RESPECT TO TWO-DIMENSIONALLY-DISPLAYED THREE-DIMENSIONAL OBJECT

S602

Y

PREDETERMINED RULE

N

S603

UPDATE xy-COORDINATE VALUES BASED ON TWO-DIMENSIONAL OPERATION INFORMATION

S604

RECEIVE TWO-DIMENSIONAL OPERATION INFORMATION

S605

UPDATE z-COORDINATE VALUE BASED ON TWO-DIMENSIONAL OPERATION INFORMATION

S606

RECORD THREE-DIMENSIONAL xyz-COORDINATE VALUES IN COORDINATE STORING UNIT

S607

CONVERT THREE-DIMENSIONAL xyz-COORDINATE VALUES OF OBJECT TO TWO-DIMENSIONAL xy-COORDINATE VALUES

S608

UPDATE TWO-DIMENSIONAL DISPLAY OF OBJECT BASED ON TWO-DIMENSIONAL xy-COORDINATE VALUES

S609

INPUT OF OPERATION INFORMATION WITH RESPECT TO OBJECT IS FINISHED

END
FIG. 8

COORDINATE INFORMATION GENERATING PROCESS

S801
RECEIVE TWO-DIMENSIONALLY-EXPRESSED XY-COORDINATE VALUES OF OBJECT

S802
RECEIVE TWO-DIMENSIONAL OPERATION INFORMATION

S803
GENERATE z-COORDINATE VALUE BASED ON TWO-DIMENSIONAL OPERATION INFORMATION

S804
GENERATE xy-COORDINATE VALUES BASED ON XY-COORDINATE VALUES AND z-COORDINATE VALUE

S805
INPUT OF OPERATION INFORMATION WITH RESPECT TO OBJECT IS FINISHED

S806
RECORD xyz-COORDINATE VALUES IN COORDINATE STORING UNIT

END