(57) [Summary] Kind Code: A1 Abstract: Low processing for representation of transparent objects image processing program, image processing system, To provide an image processing apparatus and an image processing method. A first texture including first color information; A second texture containing 2 color information and a second texture containing height information. 3 Manage textures. based on the first correspondence the first texture obtained corresponding to the surface of the object Obtain the first color information of the color. the surface of the object and The second correspondence relationship with the second texture is defined as the virtual Relationship between camera viewing direction and object surface orientation , and height information identified based on the third correspondence based on the information, and based on the corrected second correspondence to obtain the second color information from the second texture. and , determine the drawing color using the acquired color information, and draw the surface of the object. [Selection drawing] Fig. 22

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[Claims] [Claim 1] An image processing program for drawing an object placed in a virtual space, the computer, A first object associated with the surface of the object based on a first correspondence relationship a first texture containing color information and a second correspondence to the surface of the object; a second texture containing second color information associated with a surface of the object; and a third texture including height information, which is associated based on the third correspondence relationship. control measures to manage virtual camera control means for controlling a line-of-sight direction of a virtual camera placed in the virtual space; The surface corresponding to the surface of the object obtained based on the first correspondence relationship the first color information of the first texture, the line-of-sight direction of the virtual camera, and the object Based on the height information specified based on the relationship with the orientation of the surface and the third correspondence relationship obtained based on the corrected correspondence obtained by correcting the second correspondence by the correction obtained by the second color information of the second texture corresponding to the surface of the object; drawing means for determining a drawing color using both and drawing the surface of the object; An image processing program that functions as [Claim 2] The rendering means stores the position in the second texture referred to during rendering in the second pair. setting a position further shifted based on the correction from the position identified based on the correspondence 20 2. The image processing program according to claim 1, wherein said second color information is obtained by: [Claim 3] The drawing means is adapted to shift a position within the second texture referred to during drawing and The amount of displacement is relative to the line-of-sight direction of the virtual camera and the orientation of the surface of the object. 3. The image processing program according to claim 2, wherein the determination is based on the relationship. [Claim 4] The drawing

means may be arranged such that the line-of-sight direction of the virtual camera is opposite to the normal direction of the surface of the object. 3. The shift amount is determined so that the shift amount becomes smaller as the direction is closer to the direction. image processing program. [Claim 5] 30 The image processing program causes the computer to arrange a virtual light source in the virtual space. Further functions as a light source arrangement means for placing, The drawing means synthesizing at least the first color information and the second color information at a predetermined ratio; Therefore, the drawing color is determined, the surface of the object if the light source is located behind the surface of the object; The drawing is performed so that the ratio of the second color information is higher than when the light source is positioned on the plane side. 2. An image processing program as claimed in claim 1, which determines color. [Claim 6] 40. An image processing device that renders an object placed in a virtual space, A first color associated with a surface of the object based on a first correspondence relationship. based on a first texture containing information and a second correspondence to the surface of the object; a second texture containing second color information associated with a surface of the object; and a third texture including height information, which is associated based on the third correspondence relationship control measures to virtual camera control means for controlling a line-of-sight direction of a virtual camera placed in the virtual space; The first corresponding to the surface of the object, obtained based on the first correspondence. The first color information of one texture, the line-of-sight direction of the virtual camera, and the surface of the object Based on the height information specified based on the relationship with the orientation of the surface and the third correspondence relationship acquired based on the post-correction correspondence obtained by correcting the second correspondence by the correction based on (3) JP 2023-11505 A 2023.1.24

and the second color information of the second texture corresponding to the surface of the object. and drawing means for drawing the surface of the object by determining the drawing color using at least image processing device. [Claim 7] An image processing system that draws an object placed in a virtual space, A first color associated with a surface of the object based on a first correspondence relationship. based on a first texture containing information and a second correspondence to the surface of the object; a second texture containing second color information associated with a surface of the object; and a third texture including height information, which is associated based on the third correspondence relationship control measures, 10 virtual camera control means for controlling a line-of-sight direction of a virtual camera placed in the virtual space; The first corresponding to the surface of the object, obtained based on the first correspondence. The first color information of one texture, the line-of-sight direction of the virtual camera, and the surface of the object Based on the height information specified based on the relationship with the orientation of the surface and the third correspondence relationship Acquired based on the post-correction correspondence obtained by correcting the second correspondence by the correction based on and the second color information of

the second texture corresponding to the surface of the object. and drawing means for drawing the surface of the object by determining the drawing color using at least image processing system. [Claim 8] The computer of the image processing device that draws the objects placed in the virtual space is executed. An image processing method comprising: to said computer; A first color associated with a surface of the object based on a first correspondence relationship. based on a first texture containing information and a second correspondence to the surface of the object; a second texture containing second color information associated with a surface of the object; and a third texture including height information, which is associated based on the third correspondence relationship let controlling the line-of-sight direction of a virtual camera placed in the virtual space; The surface corresponding to the surface of the object obtained based on the first correspondence relationship 30 of the first color information of the first texture, the line-of-sight direction of the virtual camera and the object The height information specified based on the relationship with the orientation of the surface and the third correspondence relationship Acquired based on the corrected correspondence obtained by correcting the second correspondence by correction based on the second color information of the second texture corresponding to the surface of the object, An image processing method for determining a drawing color and drawing the surface of the object using at least . [Detailed description of the invention] [Technical field] [0001] The present invention relates to image processing for expressing a three-dimensional object having transparency. [Background technology] 40 [0002] Conventionally, texture images have been used as one of the techniques for drawing 3D virtual objects. There is a technique called texture mapping that draws by pasting it onto an object. (for example, Patent Document 1). [Prior art documents] [Patent document] [0003] [Patent Document 1] JP-A-2012-141822 [Outline of the Invention] [Problems to be solved by the invention] 50 (4) JP 2023-11505 A 2023.1.24

[0004] The above texture mapping enhances the expressiveness of the surface texture of the object. can be done. However, objects with a sense of transparency, such as objects with translucent surfaces, When representing objects, this method may not be sufficient. Therefore, transparent When trying to draw an object, for example, it is possible to perform transparency processing using the α-blending method. was common. However, conventional transmissive processing generally requires a high processing load. was For example, the surface of the first object is transparent, and the second object on the other side Let's assume the case of expressing that the target is visible. In this case, first, the destination object Render the second object, which is the object. Next, place a translucent object in front of the second object. Place and draw the first object, which is the object. Alternatively, translucent first object 10 Place the object over the second object and draw it. At this time, the first object It is also possible to draw various effects on the surface of the object. Also, the second Objects can also be drawn with effects that further distort the image. There is also a case. In this kind of processing, the drawing order of objects is important. processing is complicated, and the processing load increases due to interference with the drawing order.

As a result, Depending on the case, there was a possibility that a broken image would be displayed. [0005] Therefore, an object of the present invention is to enable representation of transparent objects with low processing load. to provide an image processing program, an image processing apparatus, an image processing system, and an image processing method is. 20 [Means for solving the problem] [0006] In order to achieve the above object, for example, the following configuration examples are given. [0007] (Configuration 1) Configuration 1 is an image processing program for drawing objects placed in virtual space. A computer is made to function as management means, virtual camera control means, and drawing means. be. The managing means is associated with the surface of the object based on the first correspondence , a first texture containing first color information and a second correspondence with respect to the surface of the object. a second texture containing second color information and 30 and a third texture including height information, which is associated based on the third correspondence relationship. understand. The virtual camera control means controls the line-of-sight direction of the virtual camera placed in the virtual space. . The rendering means (1) corresponds to the surface of the object obtained based on the first correspondence relationship and (2) the line-of-sight direction of the virtual camera and the table of the object Compensation based on the height information specified based on the relationship with the orientation of the surface and the third correspondence relationship Object obtained based on the corrected correspondence obtained by correcting the second correspondence by positive drawing color using at least second color information of a second texture corresponding to the surface of the object; decide. Then, the drawing means draws the surface of the object using the drawing color. [0008] According to the above configuration example, transparency processing, etc. that actually makes the surface of the object transparent is performed. In the process of determining the drawing color of each pixel, the object with a sense of transparency is expression becomes possible. Therefore, it is possible to express transparent objects with low processing load. can be expressed. [0009] (Configuration 2) Configuration 2 is the configuration 1 above, wherein the drawing means is a is further shifted based on the correction from the position specified based on the second correspondence relationship The second color information may be obtained by positioning the [0010] According to the above configuration example, the second correspondence is corrected for each pixel. In other words, the hypothetical 50 (5) JP 2023-11505 A 2023.1.24

It is possible to perform drawing that accurately reflects the positional relationship between the virtual camera and the object for each pixel. [0011] (Composition 3) Configuration 3 is the above configuration 2, wherein the rendering means is a second texture referenced during rendering. The direction and amount to shift the position of the virtual camera and the direction of the surface of the object may be determined based on the relative relationship between [0012] According to the above configuration example, the relationship between the direction of the virtual camera (line-of-sight direction) and the direction of the surface of the object is taken into account to determine the shift

direction and shift amount. This allows transparent objects It is possible to provide an image with less sense of incongruity in appearance. Ten (Composition 4) Configuration 4 is the above configuration 2, wherein the drawing means is such that the line-of-sight direction of the virtual camera is the object surface Even if the amount of shift is determined so that the amount of shift becomes smaller as the direction is closer to the direction opposite to the normal direction of the surface, good. [0013] According to the above configuration example, for example, if the line-of-sight direction of the virtual camera is in water with respect to the object (surface), The closer to flatness, the greater the amount of shift. As a result, the unevenness of the object surface and the height difference It is possible to make the expression of transparency based on the richer. [0014] (Configuration 5) 20 Configuration 5 is any one of Configurations 1 to 4 above, wherein the image processing program is a computer may further function as light source arrangement means for arranging a virtual light source in the virtual space. The rendering means synthesizes at least the first color information and the second color information at a predetermined ratio. The drawing color may be determined by When positioned, the ratio of the second color information than when the light source is positioned on the surface side of the object The drawing color may be determined so that . [0015] According to the above configuration example, the first color information and the second determines the color synthesis ratio related to the color information of . Specifically, the positional relationship with the light source is backlight If there is a relationship, the ratio of colors related to the second color information will be higher than in the case of front lighting. Synthesize as follows. Therefore, in the case of backlight, the color related to the second color information is stronger than in the case of front light. can be expressed. By considering the positional relationship with the light source, it is possible to express a richer sense of transparency. It becomes possible. [The invention's effect] [0016] According to this embodiment, it is possible to express transparent objects with low processing load. be. [Brief description of the drawing] [0017] 1 is a block diagram showing an example of the configuration of a game device 2 40 FIG. 2 is a diagram for explaining an overview of processing according to the embodiment; FIG. 3 is a diagram for explaining an outline of processing according to the present embodiment; FIG. 4 is a schematic diagram showing an example of a first texture; FIG. 5 is a schematic diagram showing an example of a second texture; FIG. 6 is a screen example when the processing according to the present embodiment is not used [Fig. 7] Screen example when the processing according to the present embodiment is not used FIG. 8 is a screen example when the processing according to the present embodiment is not used [Fig. 9] Screen example when processing according to the present embodiment is used FIG. 10 is an example of a screen when processing according to the present embodiment is used [Fig. 11] Screen example 50 when processing according to the present embodiment is used (6) JP 2023-11505 A 2023.1.24

FIG. 12 is a diagram for explaining parallax mapping; FIG. 13 is a diagram for explaining an outline of processing according to the present embodiment; FIG. 14 is a screen example when the processing according to the present embodiment

is not used FIG. 15 is a screen example when the processing according to the present embodiment is not used FIG. 16 is a screen example when the processing according to the present embodiment is not used FIG. 17 is a screen example when processing according to the present embodiment is used FIG. 18 is a screen example when processing according to the present embodiment is used; FIG. 19 is a screen example when processing according to the present embodiment is used 20 shows an example of programs and data stored in the storage unit 84 of the game device 2. FIG. [Fig. 21] Flowchart 10 showing details of processing according to the present embodiment FIG. 22 is a flowchart showing details of object drawing processing; [Mode for carrying out the invention] [0018] An embodiment will be described below. [0019] [Hardware Configuration of Information Processing Device] First, an information processing apparatus for executing information processing according to this embodiment will be described. The information processing device is, for example, a smartphone, a stationary or portable game device, a tablet devices, mobile phones, personal computers, wearable devices, and so on. Also, real The information processing according to the embodiment is composed of the game device and the like as described above and a predetermined server. It can also be applied to a game system that In this embodiment, a stationary game device (hereinafter simply game device) will be described as an example of the information processing device. [0020] FIG. 1 is a block diagram showing an example of the internal configuration of a game device 2 according to this embodiment. game The home device 2 comprises a processor 81 . Processor 81 executes in game device 2 an information processing unit that executes various types of information processing, for example, a CPU (Central Processing Unit), or may be composed of CPU function, GPU (Graphics Processing Unit) including multiple functions such as C (System-on-a-chip). Processor 81 Various information processing is performed by executing the information processing program stored in the storage unit 84. line. Note that the storage unit 84 is, for example, a flash memory or a DRAM (Dynamic Random Access Memory) or other internal storage media. It is also possible to use an external storage medium or the like that is mounted in a slot that is not used. [0021] In addition, since the game device 2 performs wired or wireless communication with the controller 4 , the game device 2 A controller communication unit 86 is provided for this purpose. Although illustration is omitted, the controller 4 includes: Various buttons such as cross keys and ABXY buttons, analog sticks, etc. are provided. ing. [0022] The game device 2 also has a display unit 5 (for example, a television) 40 via an image/audio output unit 87. is connected. Processor 81 generated (eg, by executing the information processing described above) Images and sounds are output to the display unit 5 via the image/sound output unit 87 . [0023] An example of processing according to the present embodiment will be described below. The process according to the present embodiment includes (3 dimensional) object. More specifically, transparent objects It relates to drawing processing for expressing objects. In addition, the drawing process is, for example, a game process can be done as part of [0024] In general, there is a technique that uses a texture image to express the texture of the surface of an object. known (so-called texture mapping). Then, in this embodiment, a certain

At least two textures are used to represent the transparency of the object. 1st tech Conceptually, a texture (hereinafter referred to as the first texture) is a texture for representing the surface of an object. It is an image (the foreground color, so to speak). The second texture (hereinafter referred to as the second texture) is a concept An image that is assumed to be positioned inside an object, This is an image assuming that the surface can be seen through. i.e. transparent This is an image that expresses what is inside the object (so to speak, the background color of the transparent destination). Then, when drawing the object (each pixel corresponding to), out of the first texture , Blend the color of the second texture for the pixels in the part where you want to give a sense of transparency. be. By adjusting the blending ratio at this time, for the relevant part of the first texture image , it is possible to express that the image related to the texture of the second sheet can be seen through. For example, 1 sheet 10 If you increase the blending ratio of the color of the eye texture, the image of the second texture will be slightly You can express a translucent feeling that you can see through. Also, the blend rate of the second texture If you raise it higher, you can express the feeling that the surface of the object is more transparent. [0025] Even with the above method, it is possible to express a certain degree of transparency on the surface of the object. However, in this embodiment, the processing described below is used to create an object with a more transparent appearance. It enables the expression of the project. Details will be described later, but in this embodiment, the second texture Only for images, a so-called parallax mapping technique is used to make them look more three-dimensional. process to draw. This gives the surface of the object a more transparent appearance, and also allows the transparent More effective expression of depth and three-dimensionality inside visible (or desired to appear) objects 20 can. In addition, when using transparent processing to express such objects with a sense of transparency, It can be realized with a relatively low processing load. [0026] FIG. 2 to FIG. 11 are used to illustrate object images when the processing according to the present embodiment is not used. An example and an example of an object image when the processing according to the present embodiment is used are shown. here As an example, let's take an example of drawing a vertically long rectangular column-shaped object as shown in Figure 2. show. The pillar object has a square opening on the first side and a round opening on the second side. A mouth is provided. In addition, as the movement of the virtual camera, a high Therefore, it is assumed that the camera is moved so as to wrap around the second surface from the state in which an image is being captured (see FIG. 3). see). Also, in this example, we assume that the inner walls of these openings can be seen through. ing. [0027] As the first texture, a texture as shown in FIG. 4 is prepared. Assume that a texture as shown in FIG. 5 is prepared as a character. each schematically As shown, the first texture is an image corresponding to the surface portion of the pillar object. and can be said to be a basic image. In FIG. 4, the first texture has square openings and round openings. The image represents the opening. Also, to simplify the explanation,

the first texture It is assumed that the color of the pillar object to be drawn is a predetermined single color. That is, the first texture is a single color is an image of 40 On the other hand, the second texture is an image assuming an inner wall that can be seen through the opening. . In this example, the second texture is applied to the portion corresponding to the "edge" of the opening. It is an image expressed using a color different from the single color of . For example, the first text above The predetermined solid color in the color is orange, and the "edge" part of the second texture is white. Suppose that Also, the color of the second texture other than the "edge" is the same color as the first texture Suppose that [0029] Using the above texture, the pillar object can be created without performing the processing according to this embodiment. An example of drawing is shown. 6 to 8 are examples of screens in such a case. in Figure 6 50, the virtual camera captures the rectangular opening from a height that looks down slightly from the upper right corner. (8) JP 2023-11505 A 2023.1.24

is in a state of In FIG. 6, for the locations (pixels) that become the "edges" of the square opening, The color of the texel on the first texture (hereinafter referred to as the first color) corresponding to the A blended color of the texel colors on the two textures (hereafter referred to as the second color) is used as the drawing color. It indicates that Also, for the round opening in the upper right, This indicates that the drawing color is a blend of the first color and the second color. . [0030] From the state of FIG. 6, when the virtual camera moves around to the second plane side, the state shown in FIGS. The image shown is displayed. In any of the figures, for the "edge" of each opening, It is drawn with a drawing color in which the second color is blended with the first color. So in these figures, 10 It shows that the "edge" part of each opening is expressed as if it is slightly transparent. there is [0031] Next, FIG. 9 to FIG. 11 show screen examples of the pillar object when the processing according to the present embodiment is applied. shown. In these figures, the portion indicated by the shaded pattern is the second texture Shows the location (pixel) where the second color related to the above "edge" part is blended and drawn in ing. When the processing according to this embodiment is applied, the above-mentioned The part where the second color of the "edge" is blended and drawn is larger than in the case of FIGS. It has a large (wide) range. Also, in these figures, the position of the virtual camera (imaging direction and 20 - It shows that the range is also changing. This kind of drawing makes it possible to see through It is possible to change the appearance of the inner wall part of the opening (the part with different drawing colors) according to the change of the viewpoint. can be done. This makes it possible to create a more three-dimensional and Images with a sense of depth can be expressed, and images with a greater sense of transparency can be provided. In this example, The expression is such that the transparency around the opening can be felt more strongly than in the above case. devil In addition, the processing related to the expression does not actually make the object transparent. It is a process to make it look like it. In other words, it does not perform so-called transparent processing, etc. Therefore, there is no need to control the drawing order of objects, etc., and the processing load is

light. there is Note that the processing according to the present embodiment is a so-called fragment shader (pixel shader). This is the processing in the reader). 30 [0032] Next, the principle and outline of object drawing processing according to the present embodiment will be described. In this embodiment, in addition to the two textures described above, Three textures including a third texture (hereinafter referred to as third texture) are used. Below, each texture will be described again. [0033] First, the first texture is a texture that conceptually corresponds to the "surface of the object". It is cha. In this embodiment, the first texture is, for example, a so-called albedo image (light source unaffected image, also called albedo map, etc.). 40 The second texture is an image of what you want to appear "see through", as above. be. In this embodiment, a normal RGB image will be described as an example. For example, the content may be specified using RGB values for the brightness and density of the color. In this case, R When viewed as a GB image, it becomes, for example, a grayscale image. [0035] The third texture is a texture used when using the parallax mapping technique. Specifically, it is called a "height map", which is also used in bump mapping. It will be revealed. The height map is information indicating the height (concavity and convexity) of the object surface. (height data) is stored in the image data in RGB format. For example, heightmap is in the range of 0 to 1, with the highest height being 1 (white) and the lowest height being 0 (black). (9) JP 2023-11505 A 2023.1.24

is image data in which the data indicated by the value of is stored (for example, a grayscale image). [0036] Here, regarding the parallax mapping technique, since this is a known technique per se, a detailed explanation is Although omitted, points relating to the processing of this embodiment will be briefly described. First, parallax mapping combines a smooth texture with height information associated with each pixel to create an object It is a lighting technique that expresses the three-dimensional effect of the uneven surface of the object and the difference in height. In addition, the above The height map is information specifying the height of the object surface. And the parallax mapping is , consider this height and shift the texture coordinates referred to when drawing the object (shift). This allows shading to take height into account 10 be. This parallax is the line-of-sight direction of the virtual camera and the direction of the surface (polygon) of the object (normal) is determined based on the angle difference. In addition, the direction in which the above coordinates are shifted (hereinafter referred to as the shift direction) The amount of shift (hereinafter referred to as shift amount) depends on the positional relationship (parallax) between the virtual camera and the object surface. changes. For example, if the viewing direction of the virtual camera with respect to the surface of the object (polygon) is The closer to the horizontal, the greater the amount of shift. Conversely, if the viewing direction of the virtual camera is The more the direction along the front direction of the plane, the smaller the shift amount (when photographed from the front) shift amount becomes 0). In addition, based on the case where the object is imaged from the front, it is assumed that The shift direction is determined depending on which direction the imaginary camera has moved:

up, down, left, or right. example For example, if the virtual camera moves rightward, the shift direction is determined leftward. that is, The technique of difference mapping takes into account the orientation of the virtual camera and the height indicated by the height map above, 20 This technique shifts the texture coordinates to be referred to. For example, consider height as shown in FIG. There is an object coordinate that is the gaze point of the virtual camera when not, and the height with respect to this coordinate (height map) and the above-mentioned parallax, the shift in the position of the gaze point is obtained. stop Then, the texture coordinates corresponding to the coordinates reflecting this shift are referenced. . [0037] By applying the parallax mapping technique as described above, in this embodiment, the following processing is performed. draw an object. First, before drawing the object, the table of the object Mapping information indicating which part of the surface (mesh) uses which part of the texture, That is, the texture coordinates corresponding to the object surface are specified in advance. i.e. of 30 A first correspondence indicating first texture coordinates corresponding to portions of the surface of the object, object A second correspondence indicating second texture coordinates corresponding to portions of the surface of the object, object A third correspondence is established indicating third texture coordinates corresponding to each portion of the surface of the . After Below, these correspondences are collectively referred to as "basic correspondence definitions". [0038] Next, the color used to draw each pixel is obtained from each texture. Then, according to the above basic correspondence definition, the first The color of the texture coordinates of the texture (hereinafter referred to as first texture coordinates) is obtained. [0039] On the other hand, for the second color, the texture locus 40 of the second texture determined according to the basic correspondence definition. Instead of using the target (hereinafter, second texture coordinates) as it is, the above parallax mapping technique is used as the second color. Exchange In other words, in this embodiment, for the second color, the parallax mapping technique is used to map the second color. After correcting the correspondence relationship, the second texture coordinates for obtaining (referring to) the second color to decide. For example, for the second texture coordinates, texture coordinates as shown in FIG. Suppose A is the second texture coordinate based on the basic correspondence definition above. in this case, The technique of parallax mapping shifts that coordinate to texture coordinate B, and this texture The color of color coordinate B may be determined as the second color. As a result, as shown in FIGS. Then, the color of the "edge" of the opening is blended with the first color and drawn with the blended color. The part (shaded part in FIGS. 9 to 11) changes according to the orientation and height of the virtual camera. (10) JP 2023-11505 A 2023.1.24

image will be represented. For example, in the example of the above figure, the "edge" part (color) is , so to speak, it can be a picture that has been stretched. Also, depending on the change in the position of the virtual camera, Expression is made such that the amount to be stretched varies. [0040] Furthermore, in this embodiment, when blending the first color and the second color, the virtual camera, the object It also performs processing that considers the object and the

position of the light source. Specifically, as seen from the virtual camera, the light When the source is closer to the viewer than the object (front lighting), and when the light source is closer to the object Change the blend ratio of the first color and the second color depending on whether it is on the depth side of the line of sight (in the case of backlight) I am letting In this embodiment, in the case of front light, the ratio of the first color is higher than that of the second color. and blend. In the case of backlight, the ratio of the second color is higher than that of the first color. Lend. As a result, in the case of front lighting, the light looks like it is reflecting off the surface of the object. can express Also, in the case of backlight, the light is transmitted and the interior of the object is illuminated more. It is possible to express the transparency of the object more strongly. [0041] In the above description, we used a pillar object with an opening as an example. It is also excellent when you want to express the transparency of an object such as "ice", which has a transparency even in the world. The treatment described above is useful. 14 to 16, the ice block object is processed as described above. An example of the case of drawing without drawing is shown. Also, the above processing is applied to FIGS. An example of the case of drawing with Also, the motion of the virtual camera assumed in the changes of these figures As a rule, while moving from right to left, slightly approaching the ice block object 20 It is assumed that the movement of the Also, the texture used for the ice block object For the first texture, for example, an image created with a bright blue color as the center and is an image representing the surface of an ice block. Also, for the second texture, dark It is an image created mainly in blue and purple of , and it is an image that expresses the inside of the ice block that can be seen through Suppose there is In addition, in FIGS. 14 to 19, for the portion related to the second texture, the mesh Shown in hanging pattern. [0042] 14 to 16, the virtual camera approaches the part related to the second texture. Although the image appears to be magnified due to the It is an expression that does not exist. On the other hand, in FIGS. 17 to 19, the virtual turtle 30 Along with the movement of the roller, the change in the shape itself (especially the width) is greater than in the case of FIGS. 14 to 16. It's getting In other words, for the image inside the ice (second texture), the movement of the virtual camera It moves out of sync with the expression change (movement) of the ice surface (first texture) accompanying the It is expressed as Therefore, the surface of the ice can be seen through (pretending to be) For the part related to the second texture, the shape (display range) is changed according to the movement of the virtual camera etc. can be expressed as changing. This makes the ice (inside) more three-dimensional. Such an expression can be realized, and by extension, a richer expression of transparency can be achieved. [0043] By the way, in the above pillar object, if there is no irregularity on the surface other than the opening, Assuming that the above height map is set to the same value uniformly, it is assumed that Become. As a result, the shift amount is uniform. On the other hand, the surface has unevenness ( ), the above shift amount can vary from pixel to pixel. . For example, in the ice block object example above, assuming that the surface of the ice is uneven, do. In this case, a height map is prepared that corresponds to the unevenness of the ice surface. That is, the

For the second texture coordinates (shift coordinates) acquired as two colors, the unevenness of the ice surface is considered (reflected). Therefore, the shift amount is not uniform, and the pixel can be different. As a result, in the above FIGS. 17 to 19, the outer circumference of the shaded portion , It is expressed as if there is a step according to the unevenness (height) of the surface of the ice block object . 50 (11) JP 2023-11505 A 2023.1.24

Thus, in this embodiment, the color of the second texture is blended with the color of the first texture. to express transparent objects. At this time, only the parallax of the second texture After applying the mapping technique and shifting the texture coordinates referred to as the second color, determines the drawing color. This allows the inside of the object to change as the virtual camera moves. It is possible to make it appear that the appearance of the image corresponding to the part changes stereoscopically. As a result, transparent It is possible to express the three-dimensional effect inside the object that is visible (it looks like it is), and it is more transparent. Representation of bright objects can be realized with a small processing load. [0045] [Details of processing in this embodiment] Next, the processing of this embodiment will be described in more detail with reference to FIGS. 20 to 22. FIG. In addition, Honjo 10 It is assumed that the processing is executed as part of game processing, for example, but in the following explanation, the above Only the processing related to drawing objects as described above will be explained, and other game processing A detailed description of is omitted. [0046] [About data used] First, various data used in the processing according to this embodiment will be described. Figure 20 shows An example of programs and data stored in the storage unit 84 of the game device 2 is shown. Record The storage unit 84 stores a game program 301, object data 302, first texture data. data 303, second texture data 304, third texture data 305, virtual camera system Use data 306, light source data 307, etc. are stored. 20 [0047] The game program 301 executes a game including object drawing processing according to this embodiment. It is a program for running [0048] The object data 302 is data relating to an object to be rendered. tool Specifically, the object data 302 includes polygon data of the object. ing. In addition, in the object data 302, in the virtual space of the object It also includes position information and attitude information indicating the arrangement position. [0049] First texture data 303, second texture data 304, third texture data 330 05 are the image data of the first texture, the second texture, and the third texture, respectively; is. These texture data are prepared for each object. [0050] The virtual camera control data 306 is for controlling the movement of the virtual camera in the virtual space. data. The virtual camera control data 306 includes the position of the virtual camera, the line-of-sight direction (image image direction), angle of view, and the like. [0051] The light source data 307 is data that defines the position of the light source in the virtual space and the intensity of the light. be. 40 In addition, various data necessary for object drawing processing are appropriately stored in the storage unit 84 as needed. stored as appropriate. [0053] [Details of rendering process] Next, details of the processing according to the present embodiment will be described with

reference to flowcharts. This embodiment state, one or more processors read the program stored in one or more memories, By executing it, the flowchart shown below is realized. In addition, the flowchart is just one example of the process. So if you get similar results, The processing order of each step may be changed. In addition, the values of variables and the values used in decision steps The threshold value is also merely an example, and other values may be adopted as necessary. 50 (12) JP 2023-11505 A 2023.1.24

[0054] FIG. 21 is a flowchart showing details of processing according to this embodiment. In addition, in FIG. A processing loop of steps S4 to S7 is repeatedly executed for each frame. [0055] In FIG. 21, first, in step S1, the processor 81 draws an object to be drawn. Place the object in the virtual space. The processor 81 also arranges the light source in the virtual space. be. Furthermore, at step S2, the processor 81 places the virtual camera in the virtual space. [0056] Next, at step S3, the processor 81 extracts polygon data from the object data 302. read out data. Furthermore, the first texture data 10 associated with the object Data 303, second texture data 304, and third texture data 305 are read. Also At this time, the basic correspondence definition described above is set. That is, the surface of the object and the is set to correspond to the texture coordinates of each texture. [0057] Next, in step S4, the processor 81 controls the virtual camera. i.e. virtual Camera movement and line-of-sight direction (imaging direction) are set. The control is sent to the controller 4 It may be control to move the virtual camera based on the user's operation on the It may be controlled to move automatically without any operation. [0058] Next, in step S5, the processor 81 executes object drawing processing. Figure 22 20 4 is a flowchart showing the details of the object rendering process. In FIG. 22, First, in step S21, the processor 81 extracts all the points that make up the drawing target object. It is determined whether or not the rigon has been drawn. If not all drawing has been done yet (step S 21 NO), in step S22, the processor 81 draws polygons from polygons that have not yet been drawn. , and then select a polygon to be drawn. [0059] Next, in step S23, the processor 81 draws the current polygon to be drawn. It is determined whether or not all pixels corresponding to the polygon have been drawn. result of the decision As a result, if all pixels related to the polygon to be drawn have been drawn (YES in step S23), Returning to step S21, the process is repeated. On the other hand, we have not yet drawn all the pixels 30 If not (NO in step S23), in step S24, the processor 81 A drawing target pixel to be the next drawing target is selected from the element. [0060] Next, in step S25, the processor 81 creates an object based on the basic correspondence definition. A first texture coordinate corresponding to a pixel to be drawn based on the correspondence relationship between the surface and the first texture. First color information indicating the color of the mark is obtained. [0061] Next, in step S26, the processor 81 processes the object based on the basic correspondence definition. Based on the correspondence relationship between the surface and the third texture (height map), the third 3 Get the height information of texture coordinates. 40 [0062] Next, in step S27, the processor 81 uses the above parallax mapping technique to

Second color information, which is information of the second color, is obtained from the second texture. Specifically, first , the processor 81 determines the relationship between the object surface and the second texture based on the basic correspondence definition. A second texture coordinate corresponding to the drawing target pixel is specified based on the correspondence. Furthermore, the above The shift amount is calculated based on the height information and the position/direction of the virtual camera. the shift The amount is calculated by, for example, the following formula. Second texture coordinates-(XY components of line-of-sight direction vector×height×predetermined coefficient) Equation 1 Then, the processor 81 determines the second texture coordinates shifted by the calculated shift amount. Color information is acquired as second color information. 50 (13) JP 2023-11505 A 2023.1.24

[0063] Next, at step S28, processor 81 blends the first color with the second color to obtain the current Determines the drawing color of the pixel to be drawn. At this time, the processor 81 based on the light source data 307 Considering the positional relationship between the object to be drawn and the light source, the blend of the first color and the second color Decide on a percentage. In this embodiment, this ratio is calculated as a blend ratio. As described above , if the positional relationship is front lighting, the blend ratio is set so that the ratio of the first color is higher than that of the second color is calculated. Also, in the case of a backlit positional relationship, the ratio of the second color is higher than that of the first color. The blend ratio is calculated as follows. Then, the processor 81 adds The drawing color is determined by blending the first color and the second color based on the above. and the decision Draw the current target pixel with the selected drawing color (e.g., writing to the framebuffer is 10 done). After that, the process returns to step S23 and the process is repeated. [0064] On the other hand, as a result of the determination in step S21, all poly If the drawing of the gon is finished (YES in step S21), the object is drawn. Processing ends. [0065] Returning to FIG. 21, after the object drawing process, in step S6, the processor 81 An image reflecting the above processing is output to the display unit 5 . [0066] Next, in step S7, the processor 81 determines that the condition for ending the processing according to the present embodiment is satisfied. It is determined whether or not the If not satisfied (NO in step S7), the above step Returning to step S4, the process is repeated. If satisfied (YES in step S7), the program The processor 81 ends the processing according to this embodiment. [0067] This concludes the detailed description of the processing according to the present embodiment. [0068] In this way, in this embodiment, the colors of the first texture and the second texture are blended to create an orange color. Apply the technique of parallax mapping only to the secondary texture when drawing the object, The coordinates of the texture that acquires the second color are shifted. Therefore, the image related to the second texture About the image part, the unevenness of the object surface and the positional relationship with the virtual camera are taken into account, and Images with a three-dimensional effect and a sense of depth can be expressed. This makes it appear as if the object's internals are It is possible to express a

transparent object that seems to be seen through, and the three-dimensional effect inside it. - Expression that emphasizes the sense of depth is possible. Moreover, such a process is a so-called Since it is done at the fragment/pixel shader stage, the processing load is relatively light. It has become. Therefore, for example, it can be expressed by conventional transparency processing using the α-blending method. Objects with a sense of transparency can be represented with a lower processing load than when [0069] [Modification] It should be noted that in the above-described embodiment, the texture inside the object is used as the second texture. 40 An example to use is shown. In addition, as mentioned above, information indicating the brightness and depth of color, for example, The second texture may be an image in RGB format. Second text in this case Char conceptually defines the amount of light that passes through the object surface (transmittance) corresponding to each pixel. (However, like the above process, it does not actually perform the process of making it transparent. Absent). When using such a second texture, for example, the above parallax mapping technique "Brightness information" of the second color from the second texture coordinates (shift coordinates) determined using the method to get Then, by multiplying the "brightness information" by a predetermined color to be expressed, Two colors should be decided. Also, even if two or more colors are multiplied as the number of colors to be multiplied, good. 50 (14) JP 2023-11505 A 2023.1.24

In addition to the above albedo map, the above first texture may be a normal map or a rough map. The processing may be performed using a ness map or the like in combination. This gives us more information about the surface of the object. Objects with transparency can be expressed while performing various expressions. [0071] Also, regarding the blending of the first color and the second color, the above example is an example of calculating the blend ratio However, if the parameter can specify the ratio of both, it is not limited to the blend ratio, and other parameters parameter may be used. [0072] Further, in the above embodiment, the height information is stored as a height map (third texture) was using In another embodiment, the height information is stored in image data in RGBa format, for example. By embedding it in the value of α in the may be configured. In this case, only two textures are used. [0073] Further, in the above embodiment, when the above series of processes are executed in a single device , but in another embodiment, the series of processes is performed by a plurality of information processing devices. It may be executed in an information processing system. For example, a terminal-side device and the terminal-side device In an information processing system including a server-side device that can communicate via a network, A part of the series of processes may be executed by the server-side device. Furthermore, terminal Information including a side device and a server side device that can communicate with the terminal side device via a network In the processing system, the main processing in the above series of processing is executed by the server-side device 20 and part of the processing may be executed in the terminal-side device. In addition, the above information processing system , the server-side system is composed of a plurality of information processing devices, and is executed on the server

side. A plurality of information processing apparatuses may share the processing to be executed. [0074] In addition, a so-called cloud gaming configuration may be employed. For example, game device 2 sends operation data indicating the user's operation to a predetermined server, and performs various processing on the server. is executed, and the execution result is streamed to the game device 2 as video and audio. It is good also as a structure. [Description of symbols] 30 2 game device 4 controller 5 Display 81 processor 84 storage unit 87 Image/audio output unit (15) JP 2023-11505 A 2023.1.24