There has also been an approach such as attempting to separate information quickly with use of an existing typical receiver although some deterioration is seen in video.

[Citation List]

[Patent Literature]

[0006]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2007-43706

[PTL 2] Japanese Unexamined Patent Application Publication No. 2009-212768

[Summary of Invention]

[Technical Problem]

[0007]

However, the conventional video display methods have a problem that signals for visible light communication cannot be appropriately transmitted.

[Solution to Problem]

[0008]

~~A video display method in the present disclosure~~Disclosed herein is a video display method of, when displaying an image in a video signal on a per frame basis, representing a tone of the image using a plurality of sub-frames, and includes: generating a visible light communication image by encoding a visible light communication signal, the visible light communication image being an image having a stripe pattern for visible light communication; calculating average luminance of the visible light communication image; superimposing the visible light communication image only on, among one or more sub-images included in the image of the video signal that is displayed in the frame, a sub-image that is displayed in a specific sub-frame among one or more sub-frames in each of which a corresponding one of the one or more sub-images is displayed, to generate a visible light superimposition image, the specific sub-frame being a sub-frame for representing the average luminance calculated; and displaying the visible light superimposition image in the specific sub-frame included in the frame.

According to a first aspect of the present invention, there is provided a video display method of, when displaying an image in a video signal on a per frame basis, representing a tone of the image by displaying a plurality of sub-frames each in a different weighted display period, the video display method comprising: determining a tone value of a visible light communication image; generating a first visible light communication image and a second visible light communication image by encoding a visible light communication signal, the first visible light communication image being an image having a stripe pattern in which a value obtained by converting brightness of a high-luminance part into a tone is the determined tone value, the second visible light communication image having a brightness-inverted form of the first visible light communication image; dividing a first sub-frame into two or more second sub-frames, the first sub-frame corresponding to the determined tone value; and superimposing, in each of the second sub-frames, the first visible light communication image and the second visible light communication image alternately on a high-luminance part of the image of the video signal that is displayed on the each of the second sub-frames.

According to the second aspect of the present invention, there is provided a video display apparatus which, when displaying an image in a video signal on a per frame basis, represents a tone of the image by displaying a plurality of sub-frames each in a different weighted display period, the video display apparatus comprising: a determination unit configured to determine a tone value of a visible light communication image; a visible light communication image generation unit configured to generate a first visible light communication image and a second visible light communication image by encoding a visible light communication signal, the first visible light communication image being an image having a stripe pattern in which a value obtained by converting brightness of a high-luminance part into a tone is the determined tone value, the second visible light communication image having a brightness-inverted form of the first visible light communication image; a division unit configured to divide a first

sub-frame into two or more second sub-frames, the first sub-frame corresponding to the determined tone value; and a superimposition and display unit configured to superimpose, in each of the second sub-frames, the first visible light communication image and the second visible light communication image alternately on a high-luminance part of the image of the video signal that is displayed on the each of the second sub-frames.

According to the third aspect of the present invention, there is provided a program for controlling a video display apparatus which, when displaying an image in a video signal on a per frame basis, represents a tone of the image by displaying a plurality of sub-frames each in a different weighted display period, the program causing a computer of the video display apparatus to execute the steps of: determining a tone value of a visible light communication image; generating a first visible light communication image and a second visible light communication image by encoding a visible light communication signal, the first visible light communication image being an image having a stripe pattern in which a value obtained by converting brightness of a high-luminance part into a tone is the determined tone value, the second visible light communication image having a brightness-inverted form of the first visible light communication image; dividing a first sub-frame into two or more second sub-frames, the first sub-frame corresponding to the determined tone value; and superimposing, in each of the second sub-frames, the first visible light communication image and the second visible light communication image alternately on a high-luminance part of the image of the video signal that is displayed on the each of the second sub-frames.

[Advantageous Effects of Invention]

[0009]

According to embodiments of the present ~~disclosure~~invention, signals for visible light communication can be appropriately transmitted.

[Brief Description of Drawings]

[0010]

[FIG. 1] FIG. 1 schematically illustrates an example of a visible light communication system according to Embodiment 1.

[FIG. 2] FIG. 2 is a block diagram illustrating a schematic configuration of the video display apparatus according to Embodiment 1.

[FIG. 3] FIG. 3 is a block diagram illustrating a schematic configuration of a reception device according to Embodiment 1.

[FIG. 4] FIG. 4 schematically illustrates an example of a visible light communication image and encoded images.

[FIG. 5] FIG. 5 explains an example of an operation of the video display apparatus according to Embodiment 1 which mixes a visible light communication image into normal video and displays resultant video.

[FIG. 6A] FIG. 6A explains an operation of the video display apparatus and the reception device according to Embodiment 1.

[FIG. 6B] FIG. 6B explains an operation of the video display apparatus and the reception device according to Embodiment 1.

[FIG. 7] FIG. 7 illustrates an example of an angle between the visible light communication image and the reception device, and an imaging error occurrence probability.

[FIG. 8A] FIG. 8A explains another example of an operation of the video display apparatus according to Embodiment 1 which mixes a visible light communication image into normal video and displays resultant video.

[FIG. 8B] FIG. 8B explains another example of an operation of the video display apparatus according to Embodiment 1 which mixes a visible light communication image into normal video and displays resultant video.

[FIG. 9] FIG. 9 illustrates other generation examples of the visible

CLAIMS:

[Claim 1]

A video display method of, when displaying an image in a video signal on a per frame basis, representing a tone of the image by displaying a plurality of sub-frames each in a different weighted display period, the video display method comprising:

determining a tone value of a visible light communication image;

generating a first visible light communication image and a second visible light communication image by encoding a visible light communication signal, the first visible light communication image being an image having a stripe pattern in which a value obtained by converting brightness of a high-luminance part into a tone is the determined tone value, the second visible light communication image having a brightness-inverted form of the first visible light communication image;

dividing a first sub-frame into two or more second sub-frames, the first sub-frame corresponding to the determined tone value; and

superimposing, in each of the second sub-frames, the first visible light communication image and the second visible light communication image alternately on a high-luminance part of the image of the video signal that is displayed on the each of the second sub-frames.

[Claim 2]

The video display method according to Claim 1,

wherein the image of the video signal that is displayed in the each of the second sub-frames is an image binary in each color for display use.

[Claim 3]

The video display method according to Claim 1 or 2,

wherein the tone value determined in the determining is not greater than 2% of a maximum tone value.

[Claim 4]

A video display apparatus which, when displaying an image in a video signal on a per frame basis, represents a tone of the image by displaying a plurality of sub-frames each in a different weighted display period, the video display apparatus comprising:

a determination unit configured to determine a tone value of a visible light communication image;

a visible light communication image generation unit configured to generate a first visible light communication image and a second visible light communication image by encoding a visible light communication signal, the first visible light communication image being an image having a stripe pattern in which a value obtained by converting brightness of a high-luminance part into a tone is the determined tone value, the second visible light communication image having a brightness-inverted form of the first visible light communication image;

a division unit configured to divide a first sub-frame into two or more second sub-frames, the first sub-frame corresponding to the determined tone value; and

a superimposition and display unit configured to superimpose, in each of the second sub-frames, the first visible light communication image and the second visible light communication image alternately on a high-luminance part of the image of the video signal that is displayed on the each of the second sub-frames.

[Claim 5]

A program for controlling a video display apparatus which, when displaying an image in a video signal on a per frame basis, represents a tone of the image by displaying a plurality of sub-frames each in a different weighted display period, the program causing a computer of the video display apparatus to execute the steps of:

determining a tone value of a visible light communication image;

generating a first visible light communication image and a second visible light communication image by encoding a visible light communication signal, the first visible light communication image

being an image having a stripe pattern in which a value obtained by converting brightness of a high-luminance part into a tone is the determined tone value, the second visible light communication image having a brightness-inverted form of the first visible light communication image;

dividing a first sub-frame into two or more second sub-frames, the first sub-frame corresponding to the determined tone value; and

superimposing, in each of the second sub-frames, the first visible light communication image and the second visible light communication image alternately on a high-luminance part of the image of the video signal that is displayed on the each of the second sub-frames.

[CLAIMS]

[Claim 1]

A video display method of, when displaying an image in a video signal on a per frame basis, representing a tone of the image using a plurality of sub-frames, the video display method comprising:

generating a visible light communication image by encoding a visible light communication signal, the visible light communication image being an image having a stripe pattern for visible light communication;

calculating average luminance of the visible light communication image; superimposing the visible light communication image only on, among one or more sub-images included in the image of the video signal that is displayed in the frame, a sub-image that is displayed in a specific sub-frame among one or more sub-frames in each of which a corresponding one of the one or more sub-images is displayed, to generate a visible light superimposition image, the specific sub-frame being a sub-frame for representing the average luminance calculated; and

displaying the visible light superimposition image in the specific sub-frame included in the frame.

[Claim 2]

The video display method according to Claim 1,

wherein in the superimposing,

assuming that, out of two different luminance values included in each of the sub-image and the visible light communication image, a lower luminance value is 0 and a higher luminance value is 1, a logical sum or a logical product of the luminance values in the sub-image and the visible light communication image is calculated to generate the visible light superimposition image.

[Claim 3] The video display method according to Claim 2, further comprising,

when the visible light superimposition image is generated using the logical product,

adding, to the frame, an additional sub-frame that is a sub-frame having a length of time identical to a length of time of the

specific sub-frame, and displaying an other visible light superimposition image in the additional sub-frame.

[Claim 4]

The video display method according to Claim 3,

wherein in the adding, a reversed image is displayed as the other visible light superimposition image, the reversed image being generated by calculating a logical product using luminance values in the sub-image and an image obtained by switching between two different luminance values included in the visible light communication image.

[Claim 5]

The video display method according to Claim 2, further comprising,

when the visible light superimposition image is generated using the logical sum, dividing the specific sub-frame and displaying an other visible light superimposition image in one of two division sub-frames generated by the dividing,

wherein in the displaying, the visible light superimposition image is displayed in the other of the two division sub-frames.

[Claim 6]

The video display method according to Claim 5,

wherein in the dividing,

a reversed image is displayed as the other visible light superimposition image, the reversed image being generated by calculating a logical sum using luminance values in the sub-image and an image obtained by switching between two different luminance values included in the visible light communication image generated in the generating.

[Claim 7]

The video display method according to Claim 1, comprising:

displaying the sub-image in a sub-frame among the one or more sub-frames that is other than the specific sub-frame; and

displaying, in at least either before or after the visible light superimposition image is displayed in the frame, an identification image that is an image having luminance uniformly lower than

average luminance of the sub-image.

[Claim 8]

The video display method according to Claim 7, further comprising:

generating a reversed visible light superimposition image by calculating a logical product or a logical sum using luminance values in the sub-image and an image obtained by switching between two different luminance values included in the visible light communication image; and

displaying the reversed visible light superimposition image after sequentially displaying the visible light superimposition image and the identification image in the frame.

[Claim 9]

The video display method according to any one of Claims 1 to 8,

wherein in the displaying,

the visible light superimposition image is displayed for a duration of not more than 0.2 milliseconds.

[Claim 10]

A video display apparatus which, when displaying an image in a video signal on a per frame basis, represents a tone of the image using a plurality of sub-frames, the video display apparatus comprising:

a visible light communication image generation unit configured to generate a visible light communication image by encoding a visible light communication signal, the visible light communication image being an image having a stripe pattern for visible light communication;

a luminance calculation unit configured to calculate average luminance of the visible light communication image;

a superimposition unit configured to superimpose the visible light communication image only on, among one or more sub-images included in the image of the video signal that is displayed in the frame, a sub-image that is displayed in a specific sub-frame among one or more sub-frames in each of which a corresponding one of the

one or more sub-images is displayed, to generate a visible light superimposition image, the specific sub-frame being a sub-frame for representing the average luminance calculated; and

an image display unit configured to display the visible light superimposition image in the specific sub-frame included in the frame.