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(54) **DISPLAY CONTROL SYSTEM AND DISPLAY CONTROL METHOD**

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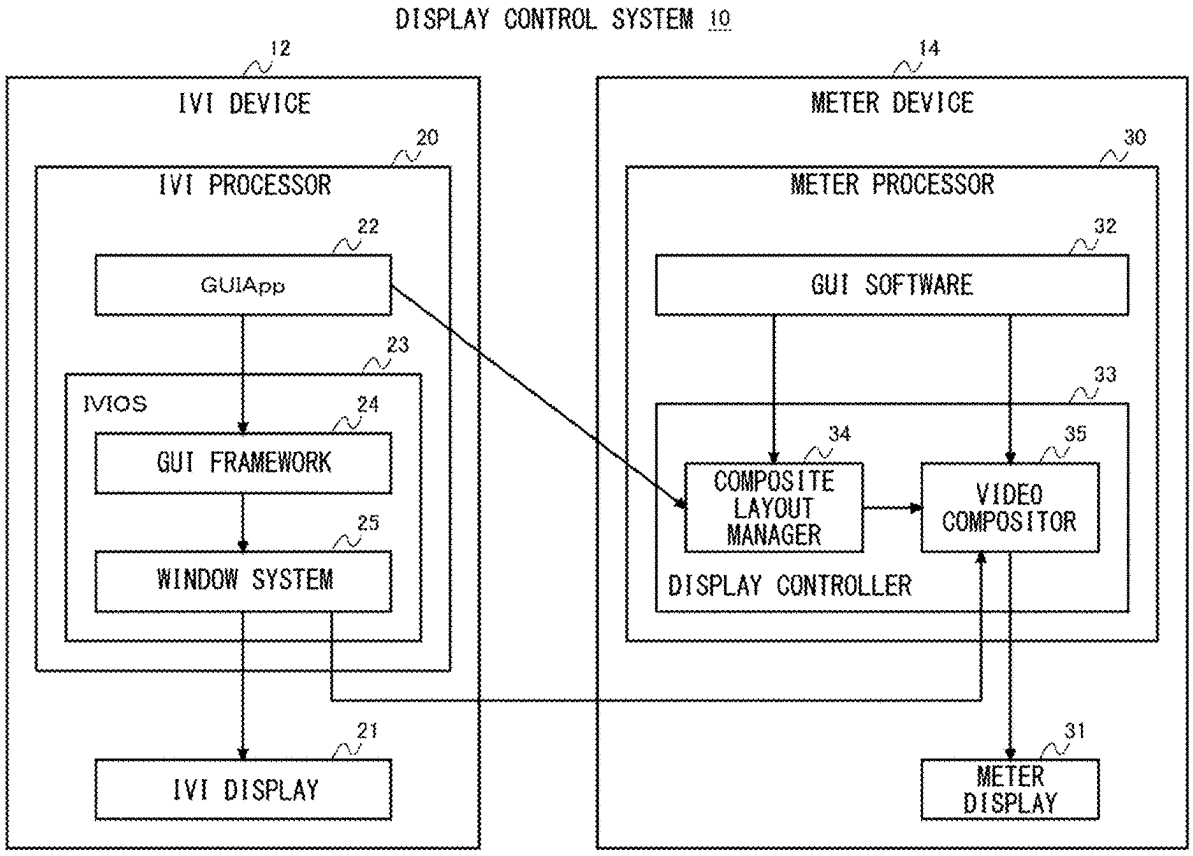
(57) **ABSTRACT**

A GUIApp of an IVI processor passes, to a GUI framework, data of a first GUI object using a GUI component prepared in advance and data of a second GUI object that designates transparency of the first GUI object to be displayed while being superimposed on a meter image. The GUI framework generates a first image that designates color information to be displayed while being superimposed on the meter image based on the data of the first GUI object, and generates a second image that designates transparency of the first image based on the data of the second GUI object. A video compositor of a meter processor generates a composite image in which the first image whose transparency is set based on the second image is superimposed on the meter image.



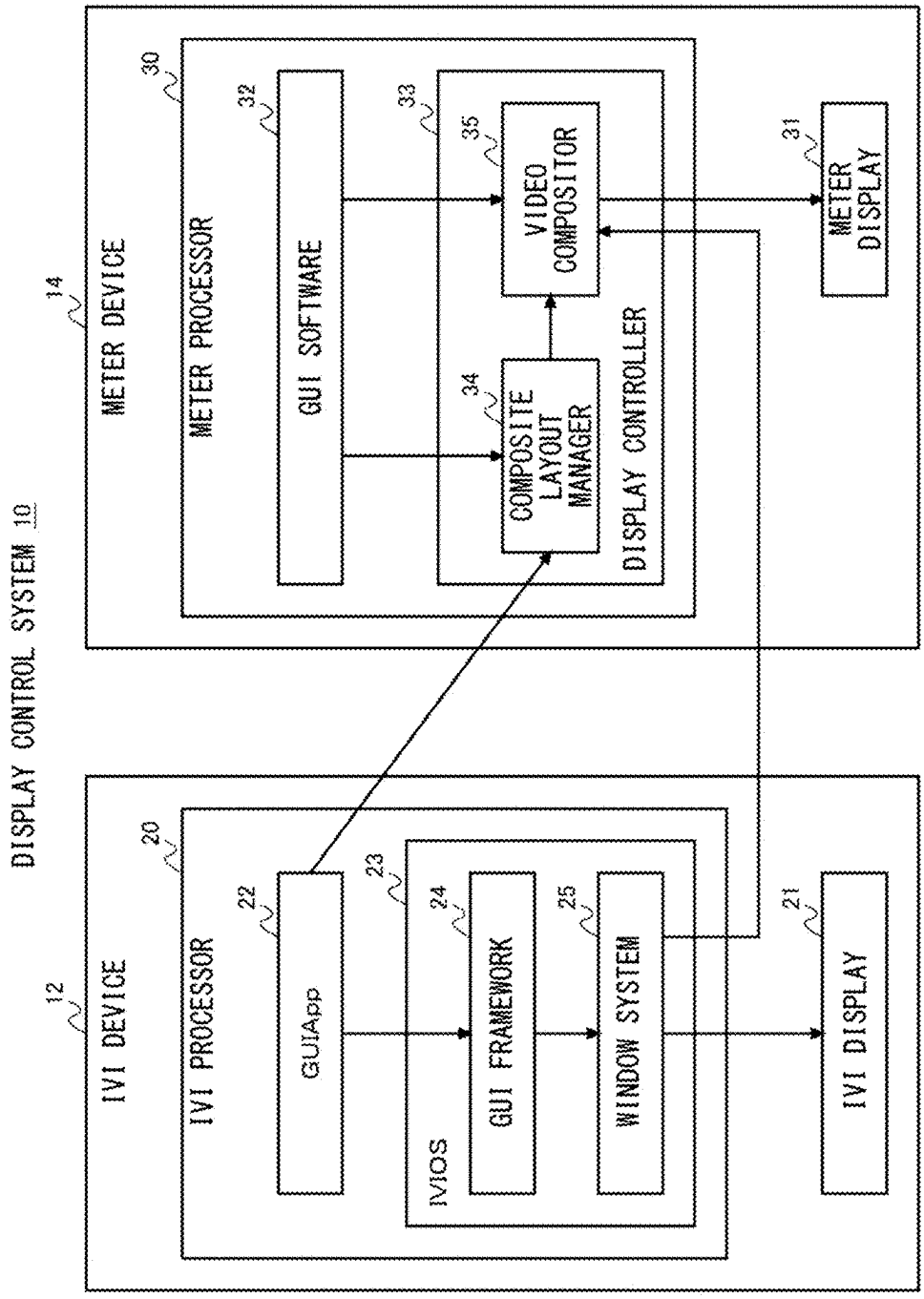

DISPLAY CONTROL SYSTEM 10
12
IVI DEVICE
20
IVI PROCESSOR
22
GUIApp
23
IVIOS
24
GUI FRAMEWORK
25
WINDOW SYSTEM
21
IVI DISPLAY
14
METER DEVICE
30
METER PROCESSOR
32
GUI SOFTWARE
33
DISPLAY CONTROLLER
34
COMPOSITE LAYOUT MANAGER
35
VIDEO COMPOSITOR
31
METER DISPLAY

FIG. 1

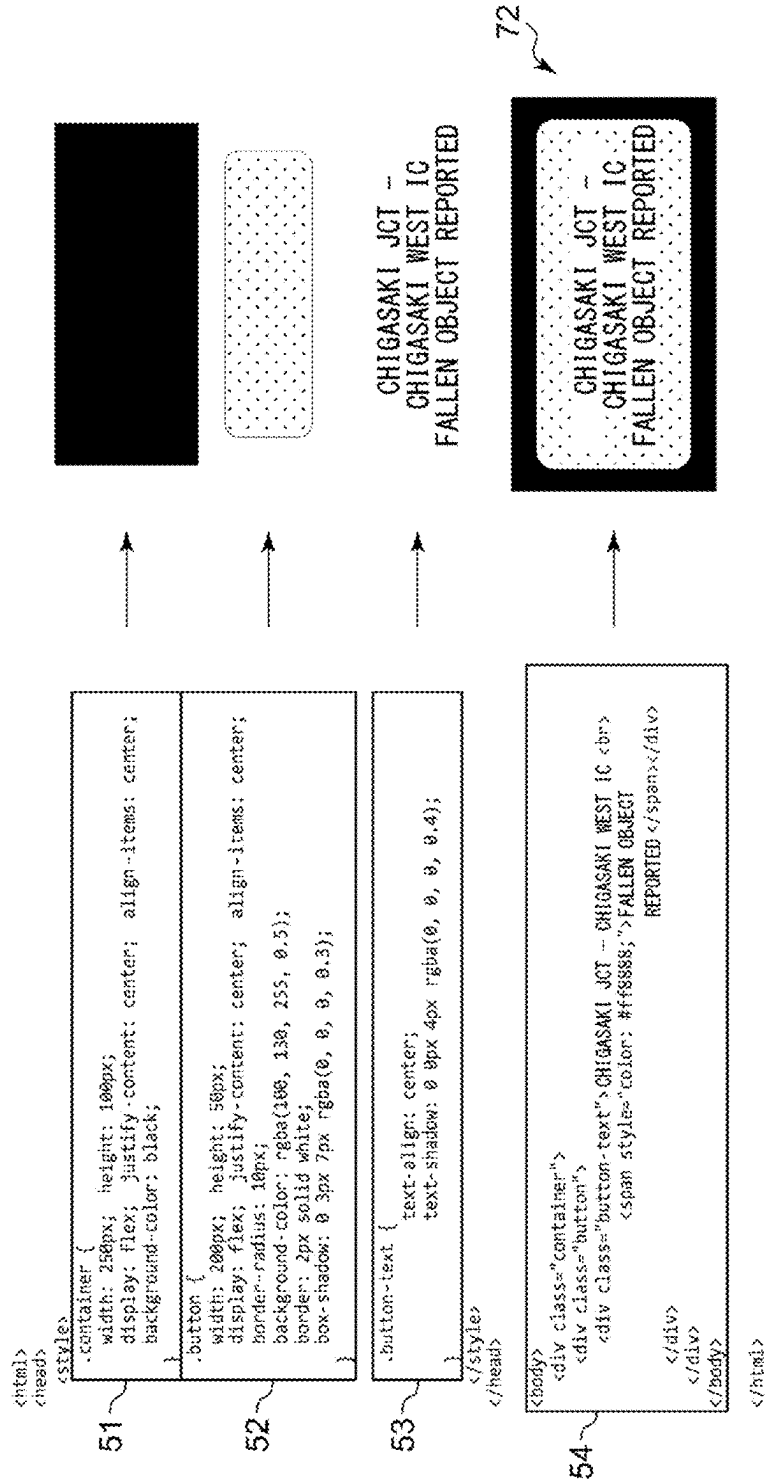

50
GUI DATA
CORRESPONDING GUI IMAGE
72
CHIGASAKI JCT –
CHIGASAKI WEST IC
FALLEN OBJECT REPORTED
51
52
53
54

FIG. 2

FIG. 3

```
"IVI_Information_Layout" : {
 "Source": { 0, 0, 250, 100 }
          // IVI→DESIGNATE WHICH PART OF IMAGE TRANSMITTED FROM IVI
                TO METER IS TO BE CLIPPED:
          //UPPER LEFT END IS (0,0) AND SIZE IS (250 X 100)
 "Destination": { 500, 300, 250, 100 }
          //DESIGNATE POSITION AND SIZE FOR COMBINING CLIPPED PORTION IN :
            METER IMAGE:
          //UPPER LEFT END IS (500,300) AND SIZE IS (250 X 100)
}
```

FIG. 4

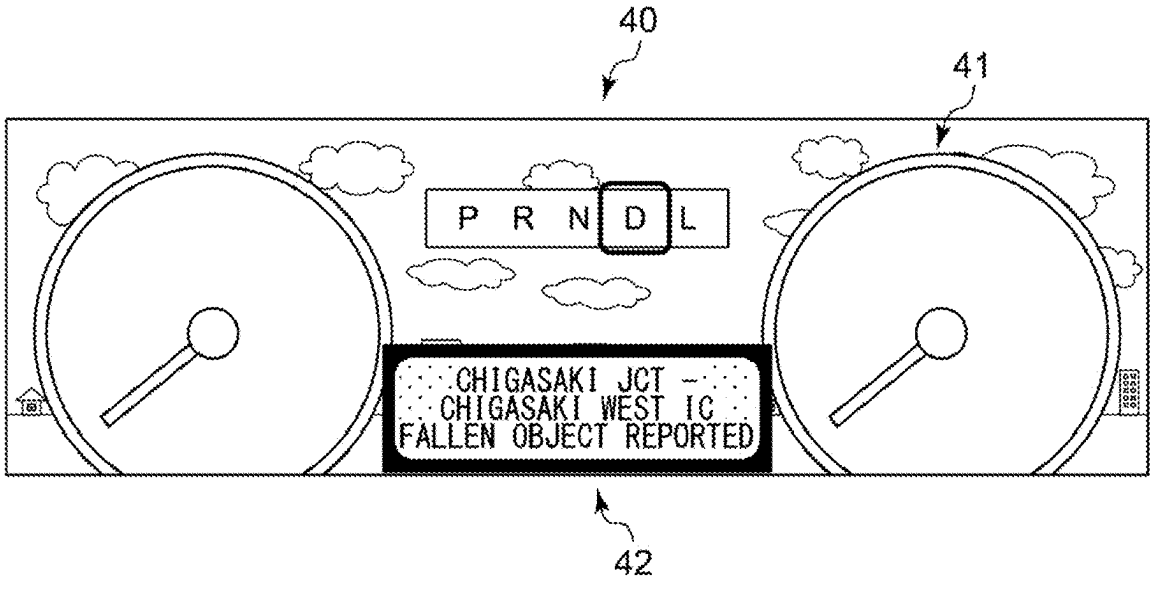


FIG. 5

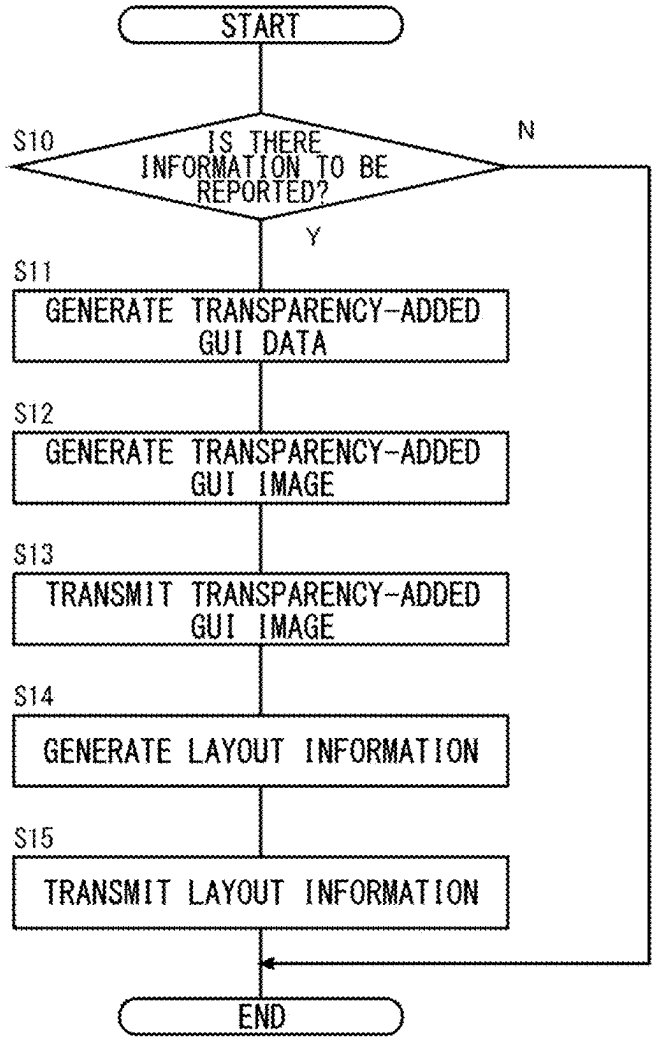
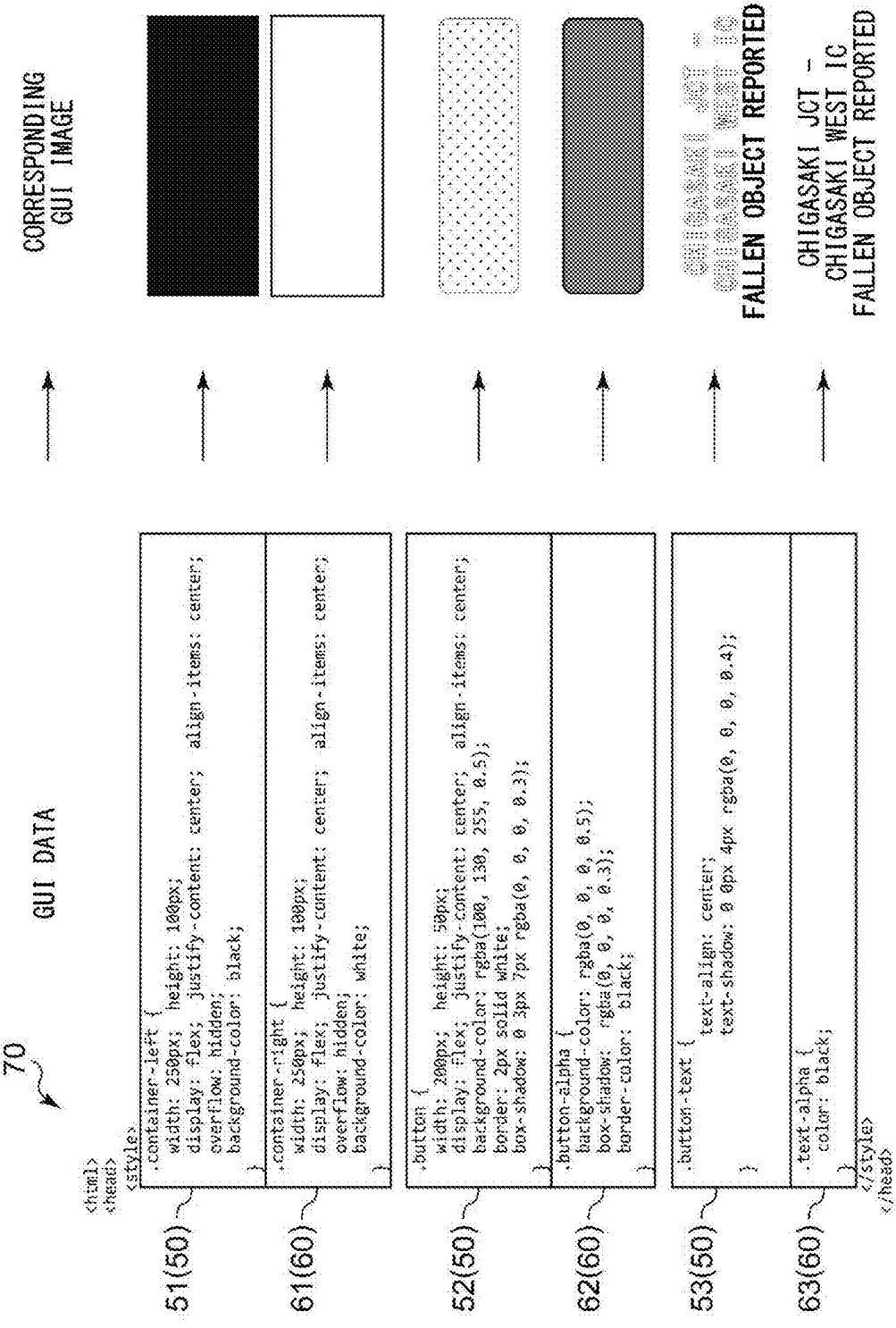

START
S10
IS THERE INFORMATION TO BE REPORTED?
N
Y
S11
GENERATE TRANSPARENCY-ADDED GUI DATA
S12
GENERATE TRANSPARENCY-ADDED GUI IMAGE
S13
TRANSMIT TRANSPARENCY-ADDED GUI IMAGE
S14
GENERATE LAYOUT INFORMATION
S15
TRANSMIT LAYOUT INFORMATION
END

FIG. 6


70
GUI DATA
CORRESPONDING GUI IMAGE
51(50)
61(60)
52(50)
62(60)
53(50)
63(60)
CHIGASAKI JCT – CHIGASAKI WEST IC FALLEN OBJECT REPORTED
CHIGASAKI JCT – CHIGASAKI WEST IC FALLEN OBJECT REPORTED

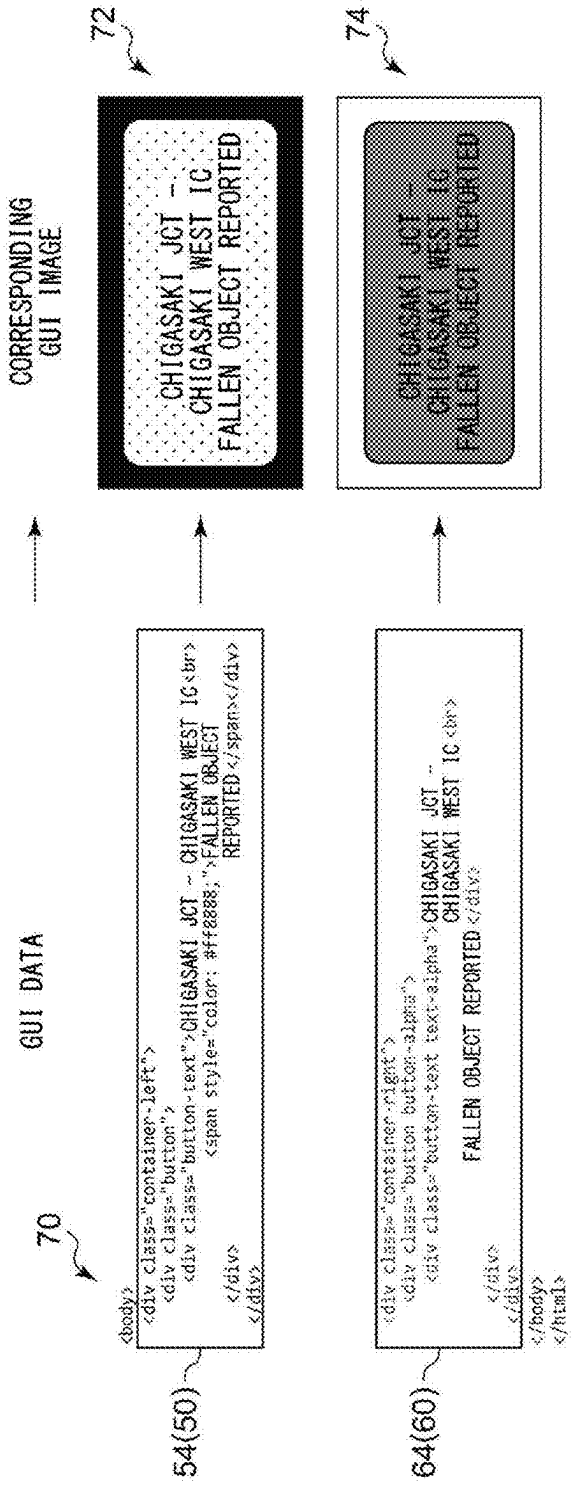

CORRESPONDING GUI IMAGE
72
74
CHIGASAKI JCT ~ CHIGASAKI WEST IC FALLEN OBJECT REPORTED
CHIGASAKI JCT ~ CHIGASAKI WEST IC FALLEN OBJECT REPORTED
GUI DATA
70
54(50)
64(60)

FIG. 7

FIG. 8

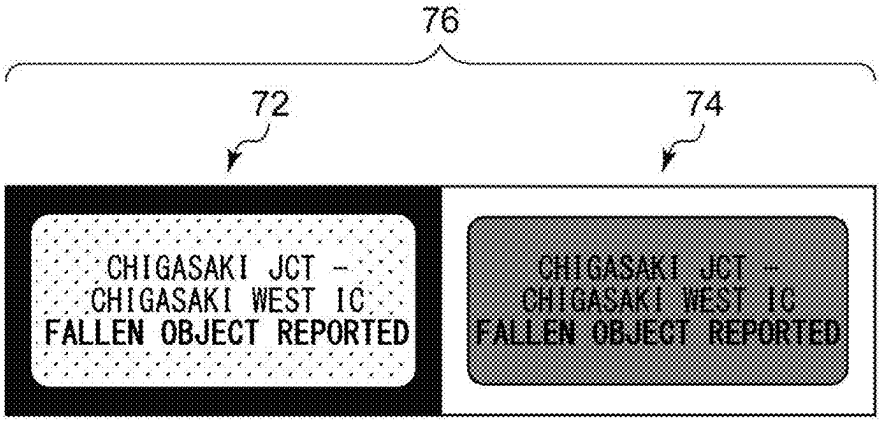


FIG. 9

```
"IVI_Information_Layout" : {
 "Source": { 0, 0, 250, 100 }
          // IVI→ DESIGNATE WHICH PART OF IMAGE TRANSMITTED FROM IVI TO
                  METER IS TO BE CLIPPED:
          // UPPER LEFT END IS (0,0) AND SIZE IS (250 X 100)
 "Destination": { 500, 300, 250, 100 }
          // DESIGNATE POSITION AND SIZE FOR COMBINING CLIPPED PORTION
             IN METER IMAGE:
          // UPPER LEFT END IS (500,300) AND SIZE IS (250 X 100)
 "TransparentOptions" : { 250, 0, 250, 100 }
          // POSITION OF IMAGE STORING TRANSPARENCY INFORMATION WHEN :
             COMBINING IMAGES:
          // UPPER LEFT END IS (250,0) AND SIZE IS (250 X 100)
}
```

FIG. 10

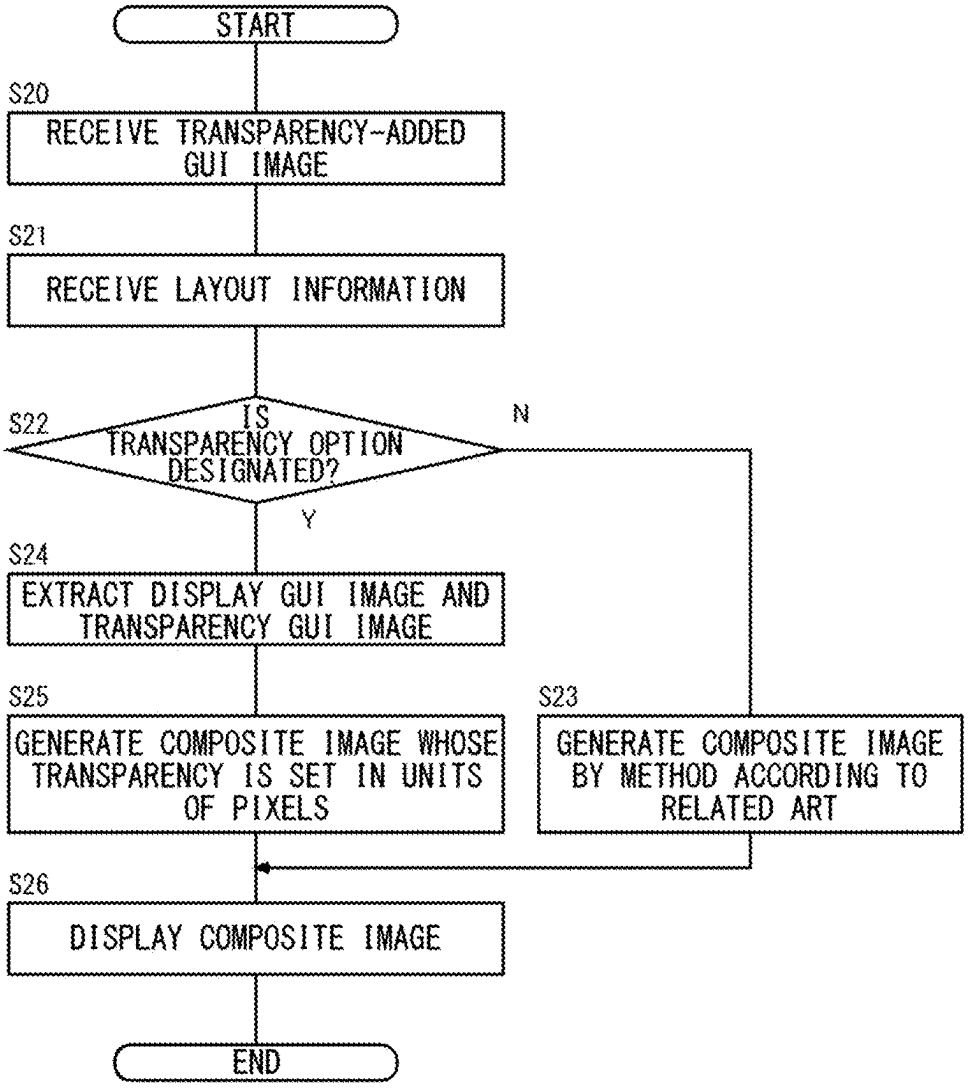

START
S20
RECEIVE TRANSPARENCY-ADDED GUI IMAGE
S21
RECEIVE LAYOUT INFORMATION
S22
IS TRANSPARENCY OPTION DESIGNATED?
N
Y
S24
EXTRACT DISPLAY GUI IMAGE AND TRANSPARENCY GUI IMAGE
S25
GENERATE COMPOSITE IMAGE WHOSE TRANSPARENCY IS SET IN UNITS OF PIXELS
S23
GENERATE COMPOSITE IMAGE BY METHOD ACCORDING TO RELATED ART
S26
DISPLAY COMPOSITE IMAGE
END

FIG. 11

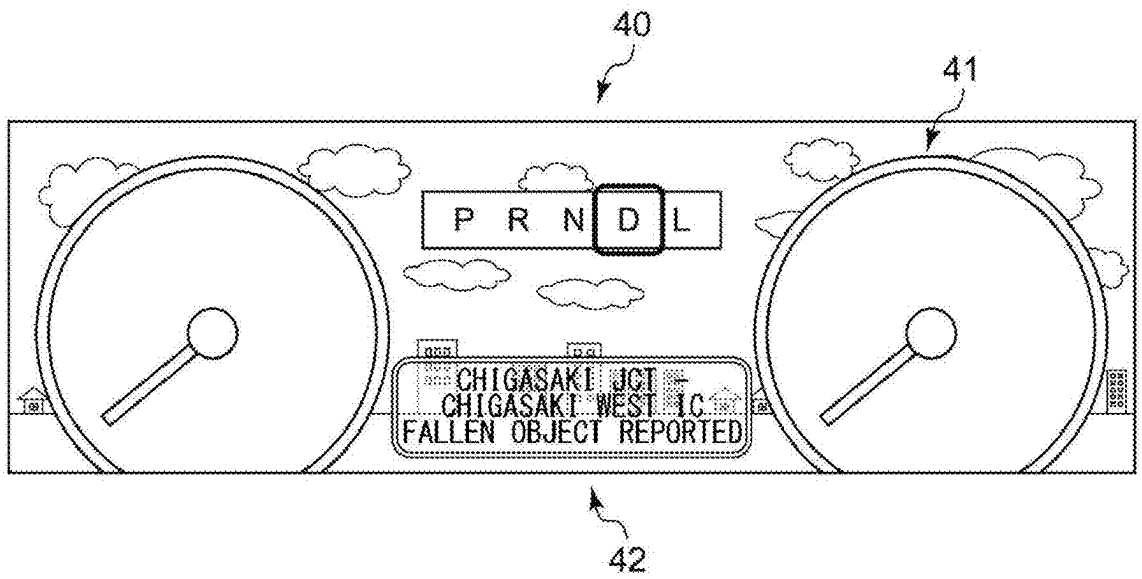
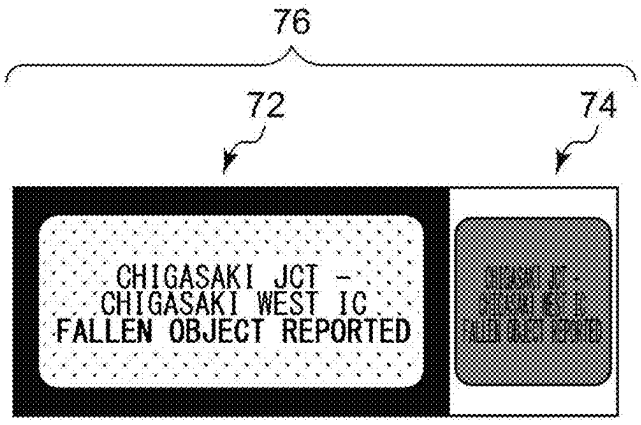

40
41
P R N D L
CHIGASAKI JCT –
CHIGASAKI WEST IC
FALLEN OBJECT REPORTED
42

FIG. 12


76
72
74
CHIGASAKI JCT –
CHIGASAKI WEST IC
FALLEN OBJECT REPORTED

DISPLAY CONTROL SYSTEM AND DISPLAY CONTROL METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2024-023771, filed on Feb. 20, 2024, the entire contents of which are incorporated herein by reference.

BACKGROUND

1. Field

[0002] The present disclosure relates to a data processing technology, and more particularly, to a display control system and a display control method.

2. Description of the Related Art

[0003] The patent document 1 below describes an image integration unit that combines images generated by a plurality of application units and outputs the composite image to a plurality of displays. The image integration unit includes a controller that controls which screen of an application unit is displayed on each display. Each application unit generates pieces of screen data of two or more display modes (such as a normal mode and a simple mode). The controller selectively combines the pieces of screen data according to characteristics of each display, and outputs a combination result to each display.

[0004] [patent document 1] WO 2014/118943 A

[0005] In a graphical user interface (GUI) framework and a window system generally used in the application unit, setting of outputting transparency information for an output image is limited. Therefore, in a case of combining the output images in the image integration unit, expressiveness of the images to be combined is limited.

SUMMARY

[0006] One object of the present disclosure is to provide a technology for improving expressiveness of a composite image in a system using an application unit in which output of transparency information is limited.

[0007] In order to solve the above problem, a display control system according to one aspect of the present disclosure includes: a renderer that generates a first image that designates color information to be displayed while being superimposed on a predetermined image, and a second image that designates transparency of the first image; and a compositor. The renderer generates a first image based on data of a first GUI object using a GUI component prepared in advance, and generates a second image based on data of a second GUI object that outputs an image that designates transparency of the first GUI object, and the compositor generates a composite image in which the first image whose transparency is set based on the second image is superimposed on a predetermined image.

[0008] Another aspect of the present disclosure is a display control method. The method is executed by a computer and includes: first processing of generating a first image that designates color information to be displayed while being superimposed on a predetermined image and a second image that designates transparency of the first image; and second processing of generating a composite image in which the first image whose transparency is set based on the second image is superimposed on the predetermined image, in which in the first processing, the first image is generated based on data of a first GUI object using a GUI component prepared in advance, and the second image is generated based on data of a second GUI object that outputs an image that designates transparency of the first GUI object.

[0009] Note that arbitrary combinations of the above constituent elements and modifications of the expressions of the present disclosure in apparatuses, computer programs, recording media recording computer programs, and the like are also effective as aspects of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a block diagram illustrating functional blocks of a display control system according to an embodiment;

[0011] FIG. **2** is a diagram illustrating an example of display graphical user interface (GUI) data;

[0012] FIG. **3** is a diagram illustrating an example of layout information;

[0013] FIG. **4** is a diagram illustrating an example of a composite image according to a related art;

[0014] FIG. **5** is a flowchart illustrating an operation of an in-vehicle infotainment (IVI) device;

[0015] FIG. **6** is a diagram illustrating an example of transparency-added GUI data;

[0016] FIG. **7** is a diagram illustrating the example of the transparency-added GUI data;

[0017] FIG. **8** is a diagram illustrating an example of a transparency-added GUI image;

[0018] FIG. **9** is a diagram illustrating an example of the layout information;

[0019] FIG. **10** is a flowchart illustrating an operation of a meter device;

[0020] FIG. **11** is a diagram illustrating an example of a composite image according to the embodiment; and

[0021] FIG. **12** is a diagram illustrating an example of a transparency-added GUI image according to a modified example.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0022] The invention will now be described by reference to the preferred embodiments. This does not intend to limit the scope of the present invention, but to exemplify the invention.

[0023] A subject of an apparatus or method in the present disclosure includes a computer. The computer executes a program, thereby implementing functions of the subject of the apparatus or method in the present disclosure. The computer includes a processor that operates according to the program as a main hardware configuration. A type of the processor is not limited as long as the processor can implement the functions by executing the program. The processor includes one or more electronic circuits including a semiconductor integrated circuit (IC) or a large scale integration (LSI). Although the electronic circuits are referred to as the IC or the LSI here, the terms vary depending on the degree of integration, and may be referred to as a system LSI, a very large scale integration (VLSI), or an ultra large scale integration (ULSI). A field programmable gate array (FPGA), which is programmed after manufacturing of the LSI, or a

reconfigurable logic device capable of reconfiguring a bonding relationship inside the LSI or setting up a circuit section inside the LSI can also be used for the same purpose. The plurality of electronic circuits may be integrated on one chip or may be provided on a plurality of chips. The plurality of chips may be integrated into one apparatus or may be provided in a plurality of apparatuses. The program may be recorded in a non-transitory recording medium such as a computer-readable read only memory (ROM), an optical disk, or a hard disk drive, or may be recorded in a transitory storage medium such as a computer-readable random access memory (RAM). The program may be stored in advance in a recording medium, or may be supplied to a recording medium or a storage medium via a wide area communication network including the Internet or the like.

[0024] A display control system according to an embodiment is a system including two or more processors mounted on physically different units. The two or more processors include an in-vehicle infotainment (IVI) side processor and a meter side processor. The IVI side processor includes a general operating system (OS) for IVI and a graphical user interface (GUI) application that operates on the OS. The OS includes a GUI framework and a window system. The GUI application uses the GUI framework and the window system to generate an IVI image (for example, an image indicating navigation information) to be displayed on a display of a meter. The window system transmits the IVI image to a meter side.

[0025] The IVI image according to the embodiment includes a color information region (a display GUI image described below) in which color information of a GUI object is rendered and a transparency region (a transparency GUI image described below) in which transparency is rendered as color information. The meter side processor combines an image of the color information region whose transparency is set based on the color information of the transparency region with an image of the meter. The "image" in the embodiment includes one or both of a video (moving image) and a still image.

[0026] FIG. **1** is a block diagram illustrating functional blocks of a display control system **10** according to the embodiment. Each block illustrated in the block diagram according to the present disclosure can be implemented by an element such as a central processing unit (CPU) or a memory of a computer or a mechanical apparatus in terms of hardware, and is implemented by a computer program or the like in terms of software, but here, functional blocks implemented by a combination thereof are illustrated. It is understood by those skilled in the art that the functional blocks can be implemented in various forms by a combination of hardware and software.

[0027] The display control system **10** is a data processing system constructed in a vehicle. The display control system **10** includes an IVI device **12** and a meter device **14**. The IVI device **12** is an in-vehicle information device that executes processing such as navigation, streaming of a moving image, and music reproduction. The meter device **14** is a device that executes processing related to display of the meter of the vehicle, such as a speedometer or an engine tachometer. The IVI device **12** and the meter device **14** have different safety requirements. That is, the meter device **14** is required to have higher safety than the IVI device **12**. Safety refers to not only security but also robustness or accuracy of information.

[0028] The IVI device **12** and the meter device **14** transmit and receive a video signal by using a general-purpose video transmission interface such as a gigabit video interface (GVIF) (registered trademark), a high-definition multimedia interface (HDMI) (registered trademark), or a gigabit multimedia serial link (GMSL). The IVI device **12** and the meter device **14** transmit and receive a message (for example, layout information) by using a data transmission interface such as TCP/IP different from the video transmission interface.

[0029] The IVI device **12** includes an IVI processor **20** and an IVI display **21**. The IVI processor **20** executes various types of data processing in the IVI device **12**. The IVI processor **20** includes a CPU and a memory. The IVI processor **20** may be implemented as an electronic control unit (ECU) or a system on a chip (SoC). The IVI display **21** displays the IVI image output from the IVI processor **20**. The IVI image may include, for example, a navigation image or a streamed video.

[0030] The IVI processor **20** includes a GUIApp **22** and an IVIOS **23**. A function of each functional block in the IVI processor **20** may be implemented in a computer program. The IVI processor **20** may perform the function of each functional block by executing the computer program.

[0031] The IVIOS **23** is a general OS (in other words, system software) introduced into the IVI processor **20**. The IVIOS **23** includes a GUI framework **24** and a window system **25**. The GUIApp **22** is a GUI application that operates on the IVIOS **23** and generates an image related to IVI. The IVIOS **23** (GUI framework **24**) does not store transparency information in rendering data. In addition, since the IVIOS **23** is a ready-made product, it is not possible to add a new function such as storing the transparency information in the rendering data.

[0032] The meter device **14** includes a meter processor **30** and a meter display **31**. The meter processor **30** executes various types of data processing in the meter device **14**. The meter processor **30** includes a CPU and a memory. The meter processor **30** may be implemented as an ECU or an SoC. The meter display **31** displays images of various meters output from the meter processor **30**.

[0033] The meter processor **30** includes a GUI software **32** and a display controller **33**. A function of each functional block in the meter processor **30** may be implemented in a computer program. The meter processor **30** may perform the function of each functional block by executing the computer program.

[0034] The GUI software **32** generates the images of various meters. The images of the meters include, for example, an image of the speedometer and an image of the engine tachometer. The GUI software **32** may include a GUI application, a GUI framework, and a window system. The display controller **33** controls display contents of the meter display **31**. The display controller **33** causes the meter display **31** to display a meter image output from the GUI software **32**.

[0035] The display control system **10** according to the embodiment causes the meter display **31** to display a composite image obtained by combining a GUI image for IVI generated by the IVI processor **20** with the meter image generated by the meter processor **30**. First, a configuration related to display of a composite image according to a related art will be described.

[0036] The GUIApp **22** of the IVI processor **20** as a generator generates data of the GUI object related to IVI to be displayed while being superimposed on the meter image (hereinafter, also referred to as "display GUI data"). The display GUI data is data of the GUI object using a GUI component prepared in advance. In the embodiment, the GUI component prepared in advance is a GUI component defined in hypertext markup language (HTML). The display GUI data according to the embodiment is data using one or more GUI components (for example, a container and a button) selected by a developer (a screen designer or the like) from among a plurality of GUI components defined by HTML. The display GUI data may be an HTML document. The GUIApp **22** outputs the display GUI data to the GUI framework **24**.

[0037] The GUI framework **24** of the IVI processor **20** as a renderer generates data of the display GUI image based on the display GUI data output from the GUIApp **22**. The GUI framework **24** includes, for example, an HTML rendering engine. The display GUI image is an image to be combined with the meter image, and includes the GUI object indicating information regarding IVI. The data of the display GUI image includes a pixel value of the GUI object.

[0038] FIG. **2** illustrates an example of the display GUI data. Display GUI data **50** includes container style data **51**, button style data **52**, text style data **53**, and content data **54**. The container style data **51** is data that defines a style of a container object. The button style data **52** is data that defines a style of a button object. The text style data **53** is data that defines a style of text. The content data **54** is data that designates a content to be displayed on a screen (that is, a display GUI image **72**).

[0039] Returning to FIG. **1**, the window system **25** of the IVI processor **20** includes a frame buffer that temporarily stores image data. The GUI framework **24** stores the generated data of the display GUI image in the frame buffer. The window system **25** transmits the data of the display GUI image stored in the frame buffer to the meter device **14** via the video transmission interface.

[0040] In addition, the GUIApp **22** of the IVI processor **20** further generates the layout information that designates a display mode of the display GUI image on the meter display **31**. The GUIApp **22** transmits the layout information to the meter device **14** via the data transmission interface different from the video transmission interface.

[0041] FIG. **3** illustrates an example of the layout information. The layout information includes a source attribute and a destination attribute. The source attribute is information that designates a position of a clipping region. For example, the source attribute includes a horizontal coordinate and a vertical coordinate of an upper left end of the display GUI image in the image data input from the IVI device **12** to the meter device **14**, and a size (a horizontal width and a vertical width) of the display GUI image. The destination attribute is information that designates a position to be combined. For example, the destination attribute includes a horizontal coordinate and a vertical coordinate of an upper left end of a region to be combined with the IVI image in the meter image, and a size (a horizontal width and a vertical width) of the region to be combined.

[0042] The GUI software **32** of the meter device **14** generates images of various meters. The GUI software **32** further generates layout information that defines a display mode of the meter image. The display controller **33** of the meter device **14** includes a composite layout manager **34** and a video compositor **35**. The GUI software **32** outputs data of the meter image to the video compositor **35** and outputs the layout information to the composite layout manager **34**.

[0043] The composite layout manager **34** acquires the layout information of the IVI image transmitted from the IVI processor **20** via the data transmission interface. In addition, the composite layout manager **34** acquires the layout information of the meter image output from the GUI software **32**. The composite layout manager **34** inputs the layout information of the IVI image and the layout information of the meter image to the video compositor **35**.

[0044] The video compositor **35** as a compositor generates data of the composite image in which the IVI image (for example, the display GUI image **72**) transmitted from the IVI processor **20** via the video transmission interface is superimposed on the meter image output from the GUI software **32**. The video compositor **35** may generate the composite image by using a known alpha blend. The video compositor **35** outputs data of the composite image to the meter display **31**, and displays the composite image on the meter display **31**.

[0045] FIG. **4** illustrates an example of a composite image according to a related technology. A composite image **40** includes a meter image **41** and an IVI image **42**. The IVI image **42** corresponds to the display GUI image **72** of FIG. **2**. In the related technology, it is difficult to set transparency for the IVI image **42**, and there is a limitation on expressiveness of the composite image **40**. As described above, the IVIOS **23**, which is an OS generally used in the IVI device **12**, does not store the transparency information in the rendering data. Therefore, the video compositor **35** has to combine the opaque IVI image **42** with the meter image **41**. In addition, even in a case where the transparency can be set for the entire IVI image **42**, the transparency cannot be set in units of pixels, and thus, the expressiveness of the composite image **40** is insufficient.

[0046] Therefore, in the embodiment, a technology for improving the expressiveness of the composite image in a case of using a system (for example, the IVIOS **23**) in which the setting of the transparency is limited is proposed. Referring back to FIG. **1**, features of each functional block in the display control system **10** according to the embodiment will be described.

[0047] The GUIApp **22** of the IVI processor **20** holds data of a first GUI object related to IVI to be displayed while being superimposed on the meter image (hereinafter, also referred to as "display GUI data"). At the same time, the GUIApp **22** also holds data of a second GUI object that designates transparency of the first GUI object (hereinafter, also referred to as "transparency GUI data"). Both the display GUI data and the transparency GUI data are data of the GUI objects using the GUI components (for example, the container and the button) prepared in advance by HTML. In the embodiment, the display GUI data and the transparency GUI data use GUI components of the same type. As a modified example, the display GUI data and the transparency GUI data may use different types of GUI components. The transparency GUI data may designate the transparency of the first GUI object indicated by the display GUI data by using the GUI component different from the GUI component used by the display GUI data. In addition, in the IVI processor **20**, another GUI component used by the transparency GUI data may be prepared and stored separately from

the GUI component used by the display GUI data. The transparency GUI data may designate the transparency of the first GUI object indicated by the display GUI data by using another GUI component.

[0048] The data of the first GUI object (display GUI data) and the data of the second GUI object (transparency GUI data) may be stored in advance in the GUIApp **22**. In addition, the GUIApp **22** may dynamically generate the display GUI data and the transparency GUI data according to an operation state of the IVI device **12**. The transparency designated by the transparency GUI data can be said to be the transparency of the first GUI object (in other words, the IVI image) when the first GUI object (in other words, the IVI image) is superimposed on the meter image.

[0049] The GUI framework **24** of the IVI processor **20** generates an image of the first GUI object (hereinafter, also referred to as "display GUI image") based on the display GUI data. The display GUI image is a first image that designates color information to be displayed while being superimposed on a superimposition target image (the meter image in the embodiment). The GUI framework **24** further generates an image of the second GUI object (hereinafter, also referred to as "transparency GUI image") based on the transparency GUI data. The transparency GUI image is a second image that designates transparency of the display GUI image when the display GUI image is superimposed on the meter image. The video compositor **35** of the meter processor **30** generates a composite image in which the display GUI image whose transparency is set based on the image of the transparency GUI image is superimposed on the meter image.

[0050] In the embodiment, the GUIApp **22** generates data of a third GUI object including the display GUI data and the transparency GUI data (hereinafter, also referred to as "transparency-added GUI data"). The GUIApp **22** further generates layout information including a position of the second GUI object (transparency GUI image) in the third GUI object (transparency-added GUI image described below).

[0051] The GUI framework **24** generates an image of the third GUI object (hereinafter, also referred to as "transparency-added GUI image") based on the transparency-added GUI data. The transparency-added GUI image is one image obtained by integrating the display GUI image and the transparency GUI image, and is one image in which the display GUI image and the transparency GUI image are disposed in different regions. The video compositor **35** extracts the display GUI image and the transparency GUI image from the transparency-added GUI image based on the layout information.

[0052] An operation of the display control system **10** having the above configuration will be described.

[0053] FIG. **5** is a flowchart illustrating an operation of the IVI device **12**. In a case where information (for example, navigation information) to be reported to an occupant of the vehicle by being displayed on the meter display **31** is generated (Y in S**10**), the GUIApp **22** of the IVI processor **20** generates the transparency-added GUI data (S**11**).

[0054] FIGS. **6** and **7** illustrate an example of the transparency-added GUI data. FIG. **6** illustrates a header portion of an HTML document as the transparency-added GUI data, and FIG. **7** illustrates a body portion of the HTML document as the transparency-added GUI data. Transparency-added GUI data **70** includes the display GUI data **50** (the container style data **51**, the button style data **52**, the text style data **53**, and the content data **54**) described above with reference to FIG. **2**. The information to be reported to the occupant of the vehicle is set in the content data **54**.

[0055] Further, the transparency-added GUI data **70** further includes transparency GUI data **60**. The transparency GUI data **60** includes container style data **61** corresponding to the container style data **51**, button style data **62** corresponding to the button style data **52**, text style data **63** corresponding to the text style data **53**, and content data **64** corresponding to the content data **54**. A black outer frame is drawn in a GUI image corresponding to the container style data **61**, but there is actually no outer frame. The content data **64** is data for setting an image (that is, transparency GUI image **74**) that designates transparency of the display GUI image **72**.

[0056] The transparency GUI data **60** according to the embodiment is a GUI object having the same shape as the GUI object of the display GUI data **50**, and is data that defines a monochrome GUI object. In the embodiment, the GUI object of the transparency GUI data **60** is set such that the lower the transparency of the GUI object of the corresponding display GUI data **50**, the darker the color becomes. In other words, the GUI object of the transparency GUI data **60** is set such that the higher the transparency of the GUI object of the corresponding display GUI data **50**, the whiter the color becomes. As a modified example, contrary to the embodiment, the GUI object of the transparency GUI data **60** may be set such that the lower the transparency of the GUI object of the corresponding display GUI data **50**, the whiter the color becomes.

[0057] In the example of FIG. **6**, "background-color" of the container style data **61** is set to white in order to transparently display the container object defined by the container style data **51**. Furthermore, an a value is set to 0.5 in "background-color" of the button style data **62** in order to translucently display the button object defined by the button style data **52**. In the embodiment, the GUIApp **22** is implemented so as to generate the transparency GUI image **74** reflecting the transparency to be set for the display GUI image **72** from the viewpoint of design.

[0058] Returning to FIG. **5**, the GUI framework **24** of the IVI processor **20** analyzes the HTML document as the transparency-added GUI data, and generates the transparency-added GUI image which is an image based on the transparency-added GUI data (S**12**). The window system **25** of the IVI processor **20** transmits the transparency-added GUI image to the meter device **14** via the video transmission interface (S**13**).

[0059] FIG. **8** illustrates an example of the transparency-added GUI image. A transparency-added GUI image **76** includes the display GUI image **72** and the transparency GUI image **74**. The transparency-added GUI image **76** in the embodiment is an image in which the display GUI image **72** and the transparency GUI image **74** are arranged side by side. In the example of FIG. **8**, an outer edge portion of the display GUI image **72** is black, and an outer edge portion of the transparency GUI image **74** is white. Therefore, the outer edge portion of the display GUI image **72** is displayed with high transparency, and is treated as being transparent, for example.

[0060] Returning to FIG. **5**, the GUIApp **22** of the IVI processor **20** generates layout information related to the transparency-added GUI data (transparency-added GUI

image) (S**14**). The GUIApp **22** transmits the layout information generated in S**14** to the meter device **14** via the data transmission interface different from the video transmission interface (S**15**). In a case where the information to be reported to the occupant of the vehicle by being displayed on the meter display **31** is not generated (N in S**10**), the processing after S**11** is skipped. The IVI device **12** repeatedly executes the processing illustrated in FIG. **5**. The processing of S**11** to S**13** and the processing of S**14** to S**15** may be executed in parallel.

[0061] FIG. **9** illustrates an example of the layout information. The layout information related to the transparency-added GUI data (transparency-added GUI image) includes a transparency option attribute (TransparentOptions) in addition to the source attribute and the destination attribute illustrated in the layout information of FIG. **3**. The transparency option attribute includes a horizontal coordinate and a vertical coordinate of an upper left end of the transparency GUI image in the transparency-added GUI image, and a size (a horizontal width and a vertical width) of the transparency GUI image. The layout information added with the transparency option attribute can also be said to be information indicating that an image added with the transparency information (transparency GUI image) is transmitted.

[0062] FIG. **10** is a flowchart illustrating an operation of the meter device **14**. The video compositor **35** of the meter processor **30** acquires the meter image generated by the GUI software **32** of the meter processor **30**. Further, the video compositor **35** receives the transparency-added GUI image transmitted from the IVI device **12** via the video transmission interface (S**20**).

[0063] The composite layout manager **34** of the meter processor **30** acquires the layout information generated by the GUI software **32** of the meter processor **30**. In addition, the composite layout manager **34** receives the layout information transmitted from the IVI device **12** via the data transmission interface (S**21**). The composite layout manager **34** passes the acquired or received layout information to the video compositor **35**.

[0064] In a case where the transparency option attribute is designated in the layout information transmitted from the IVI device **12**, the video compositor **35** detects the designation. In a case where the transparency option attribute is not designated in the layout information transmitted from the IVI device **12** (N in S**22**), the video compositor **35** generates the composite image obtained by combining the IVI image transmitted from the IVI device **12** with the meter image by a method according to the related art (S**23**). Specifically, the video compositor **35** extracts the display GUI image from the image data transmitted from the IVI device **12** based on the source attribute of the layout information. The video compositor **35** generates the composite image obtained by combining the display GUI image with a region of the meter image indicated by the destination attribute of the layout information. The video compositor **35** displays the composite image on the meter display **31** (S**26**).

[0065] In a case where the transparency option attribute is designated in the layout information transmitted from the IVI device **12** (Y in S**22**), the video compositor **35** extracts the display GUI image from the transparency-added GUI image based on the source attribute of the layout information. At the same time, the video compositor **35** extracts the transparency GUI image from the transparency-added GUI image based on the transparency option attribute of the layout information (S**24**).

[0066] The video compositor **35** generates the composite image obtained by combining the display GUI image whose transparency is set in units of pixels based on the transparency GUI image with the region of the meter image indicated by the destination attribute of the layout information (S**25**). The video compositor **35** displays the composite image on the meter display **31** (S**26**).

[0067] The processing in the video compositor **35** in S**25** will be described in detail. Here, RGB pixel values of corresponding pixels between the display GUI image, the transparency GUI image, and the meter image to be combined (the region designated by the destination attribute) are expressed as follows.

[0068] RGB pixel values of display GUI image: (S1r, S1g, and S1b)

[0069] RGB pixel values of transparency GUI image: (S2r, S2g, and S2b)

[0070] RGB pixel values of meter image: (S3r, S3g, and S3b)

[0071] RGB pixel values of composite image: (Dr, Dg, and Db)

[0072] Transparency α for each pixel is $\alpha=1-S2r$. Therefore, the video compositor **35** calculates the RGB pixel values of the composite image as follows.

$$Dr = S3r \times (1-\alpha) + S1r = S3r \times S2r + S1r$$

$$Dg = S3g \times (1-\alpha) + S1g = S3g \times S2r + S1g$$

$$Db = S3b \times (1-\alpha) + S1b = S3b \times S2r + S1b$$

[0073] Here, formulas in which the pixel value is expressed by 0 to 1 (the closer the pixel value to 0, the darker the color, and the closer the pixel value to 1, the whiter the color) is shown, but as a modified example, the pixel values may be expressed by 0 to 255 (the closer the pixel value to 0, the darker the color, and the closer the pixel value to 255, the whiter the color). The video compositor **35** performs the above calculation on all the pixels to be combined, and calculates each pixel value of the composite image.

[0074] In the embodiment, a pixel value multiplied by the transparency in advance is stored in the display GUI image as illustrated in FIG. **6**. That is, in the embodiment, in a case where the transparency is designated for the first GUI object in the display GUI data, the GUI framework **24** of the IVI processor **20** generates the display GUI image indicating a color obtained by multiplying a color designated for the first GUI object in the display GUI data by the transparency designated in the display GUI data. As a modified example, a pixel value for which the transparency is not set may be stored in the display GUI image. In this case, the video compositor **35** may calculate the RGB pixel values of the composite image as follows.

$$Dr = S3r \times (1 - \alpha) + S1r \times \alpha = S3r \times S2r + S1r \times (1 - S2r)$$

$$Dg = S3g \times (1 - \alpha) + S1g \times \alpha = S3g \times S2r + S1g \times (1 - S2r)$$

$$Db = S3b \times (1 - \alpha) + S1b \times \alpha = S3b \times S2r + S1b \times (1 - S2r)$$

[0075] FIG. **11** illustrates an example of the composite image according to the embodiment. The composite image **40** according to the embodiment includes the IVI image **42** (the above composite image) whose transparency is set. For example, in the IVI image **42**, the transparency is set for a container image and a button image, and the meter image **41** as a background can be seen through. On the other hand, frames of text and the button image are displayed in an opaque manner.

[0076] With the display control system **10** according to the embodiment, it is possible to improve the expressiveness of the composite image to be displayed on the meter display **31** even in a case of using the IVIOS **23** (GUI framework **24**) in which the setting of the transparency is limited. In the display control system **10**, the transparency of the composite image can be designated in units of pixels, and the transparency can be set only for a part of the composite image. Furthermore, in the display control system **10**, the transparency can also be set for a non-rectangular object such as a rounded square.

[0077] In addition, with the display control system **10** according to the embodiment, in a case where the processor of the meter device **14** having a relatively high safety requirement combines the image generated by the processor of the IVI device **12** having a relatively low safety requirement with the meter image, the expressiveness of the composite image can be improved. In addition, with the display control system **10**, the display GUI image and the transparency GUI image can be extracted from the transparency-added GUI image for IVI by using an existing mechanism of generating the composite image based on the layout information.

[0078] The present disclosure has been described above based on the embodiment. It is to be understood by those skilled in the art that the embodiment is an example, various modified examples can be made for combinations of the constituent elements or processing processes of the embodiment, and such modified examples are also within the scope of the present disclosure.

[0079] A first modified example will be described. The GUI framework **24** of the IVI device **12** according to the embodiment includes the HTML rendering engine. As a modified example, the GUI framework **24** may include other types of rendering engines. For example, the GUI framework **24** may include a Flutter (trade mark or registered trademark) rendering engine or may include an Android (trade mark or registered trademark) rendering engine. The GUIApp **22** of the IVI processor **20** may generate the transparency-added GUI data in a format corresponding to a type of rendering engine used by the GUI framework **24**.

[0080] A second modified example will be described. In the embodiment, the display GUI image and the transparency GUI image use the same plurality of GUI components. As a modified example, the display GUI image and the transparency GUI image may have different configurations of GUI components. The GUIApp **22** of the IVI processor **20** may generate the transparency GUI data in which some GUI components that are not related to the transparency among the plurality of GUI components used by the display GUI image are not set in the transparency GUI image.

[0081] For example, in a case where there is an opaque frame object (a button or the like) and characters are displayed without transparency inside the frame object, it is not necessary to reflect, in the transparency GUI image, the transparency of the characters inside the frame object. In this case, it is sufficient if a black frame object (that is, an object instructed to be opaque) is set in the transparency GUI image. According to the modified example, it is possible to reduce a load of processing of generating the transparency GUI image in the IVI processor **20**.

[0082] A third modified example will be described. In the embodiment, the GUIApp **22** of the IVI processor **20** is implemented to generate the transparency-added GUI data including the display GUI data and the transparency GUI data corresponding to the display GUI data. As a modified example, the GUIApp **22** may have a function of automatically generating at least a part of the transparency GUI data based on the display GUI data (here, referred to as an "additional data setter").

[0083] The additional data setter may generate the transparency GUI data including data of the same GUI component as a GUI component (a container, a button, or the like) set in the display GUI data. At that time, the a value of "background-color" of the corresponding GUI component of the display GUI data may be set as "background-color" of the GUI component of the transparency GUI data. According to the modified example, it is possible to reduce a burden on the developer of the GUIApp **22** to manually implement the GUIApp **22** so as to generate the transparency GUI data corresponding to the display GUI data. The developer may add attribute information indicating whether or not each GUI component needs to be reflected in the transparency GUI data to the display GUI data such that the additional data setter can identify a GUI component desired to be reflected in the transparency GUI data and a GUI component that is not desired to be reflected in the transparency GUI data.

[0084] A fourth modified example will be described. In the embodiment, the layout information is described in a Javascript Object Notation (JSON) format ("JavaScript" is a trademark or a registered trademark), but the layout information may be described in another format. Furthermore, in the layout information according to the embodiment, the position and size of the IVI image are designated in units of pixels in the meter device **14**. However, the position and size of the IVI image may be designated with more abstract values. For example, in the layout information, designation such as displaying a percentage position at which the IVI image is to be displayed on a screen (or on the meter image) may be made. Further, the composite layout manager **34** of the meter processor **30** may be configured to calculate a specific display position of the IVI image.

[0085] A fifth modified example will be described. In the embodiment, the display GUI image and the transparency GUI image have the same resolution. On the other hand, the transparency information is lower in importance than the color information, and thus, the resolution of the transparency GUI image may be lower than the resolution of the display GUI image. In other words, the GUIApp **22** of the IVI processor **20** may generate the transparency-added GUI data including the transparency GUI data for generating the

transparency GUI image having a lower resolution than the display GUI image. According to the modified example, an amount of image data transferred from the IVI processor **20** to the meter processor **30** can be reduced.

[0086] FIG. **12** illustrates an example of the transparency-added GUI image according to the modified example. FIG. **12** illustrates an example in which a horizontal resolution of the transparency GUI image **74** is set to ¼ of a horizontal resolution of the display GUI image **72**. A vertical resolution of the transparency GUI image **74** is the same as a vertical resolution of the display GUI image **72**. In the modified example, the video compositor **35** of the meter processor **30** may associate one pixel of the transparency GUI image **74** with a plurality of pixels of the display GUI image **72**. In the example of FIG. **12**, the video compositor **35** may associate one pixel of the transparency GUI image **74** in a horizontal direction with four pixels of the display GUI image **72** in the horizontal direction.

[0087] A sixth modified example will be described. The GUIApp **22** of the IVI processor **20** may generate the transparency-added GUI data including the transparency GUI data for generating the transparency GUI images with chromatic colors other than black and white. As a result, it is possible to obtain a composite image with an effect similar to applying a color filter, which cannot be obtained using the transparency GUI image with colors of only black and white. For example, it is possible to apply a bluish tint to the composite image by using the transparency GUI image filled with blue. In addition, it is possible to apply a reddish tint to the composite image by using the transparency GUI image filled with red.

[0088] In the embodiment, the video compositor **35** of the meter processor **30** uses a pixel value (S2r) of an R channel of the transparency GUI image as transparency of a composite of all the RGB channels. In the present modified example, as in the following formula, the RGB pixel values (S2r, S2g, and S2b) of the transparency GUI image may be used as the transparency of the composite of the respective channels.

$$Dr = S3r \times (1-\alpha) + S1r = S3r \times S2r + S1r$$

$$Dg = S3g \times (1-\alpha) + S1g = S3g \times S2g + S1g$$

$$Db = S3b \times (1-\alpha) + S1b = S3b \times S2b + S1b$$

[0089] A seventh modified example will be described. In the embodiment, the video compositor **35** of the meter processor **30** calculates the RGB pixel values (Dr, Dg, and Db) of the composite image as follows.

$$Dr = S3r \times S2r + S1r$$

$$Dg = S3g \times S2r + S1g$$

$$Db = S3b \times S2r + S1b$$

[0090] In the calculation, in a case where a calculation result of each channel exceeds 1 (also referred to as maximum pixel value), processing (also referred to as saturation computation) of setting the result to 1 may be executed.

[0091] In the modified example, the IVI processor **20** can transmit the transparency-added GUI image including the display GUI image and the transparency GUI image in which the RGB pixel values after the combination exceed 1 to the meter processor **30**. In a typical transparency GUI image in the modified example, the value of S2r is set to 1. According to the modified example, the composite image obtained by adding light to the meter image can be obtained.

[0092] An eighth modified example will be described. In the embodiment, a first processor (that is, the IVI processor **20**) that generates the first image to be combined and a second processor (that is, the meter processor **30**) that generates the second image to be combined are stored in separate units. As a modified example, the IVI processor **20** and the meter processor **30** may be stored in a single unit. In this case, the image data and the layout information may be transmitted and received between the IVI processor **20** and the meter processor **30** by sharing a memory space between the IVI processor **20** and the meter processor **30**.

[0093] In addition, both the IVI processor **20** and the meter processor **30** may be virtual processors. A single physical processor may execute both the processing in the IVI processor **20** and the processing in the meter processor **30**. In other words, the functions of the IVI processor **20** (for example, the GUIApp **22**, the GUI framework **24**, and the window system **25**) and the functions of the meter processor **30** (for example, the GUI software **32**, the composite layout manager **34**, and the video compositor **35**) may be implemented in a single physical processor. The single physical processor may include a first OS (here, referred to as "IVIOS") on which the functions of the IVI processor **20** operate, and a second OS (here, referred to as "meter OS") on which the functions of the meter processor **30** operate. The meter OS typically has a different safety requirement than that of the IVIOS, and specifically has a higher safety requirement than that of the IVIOS. In this case, a memory shared by multiple virtual processors may be used to transmit and receive the image data and the layout information between the IVI processor **20** and the meter processor **30**.

[0094] Any combination of the plurality of embodiments and the plurality of modified examples described above is also useful as an embodiment of the present disclosure. A new embodiment generated by the combination has the effect of each of the combined embodiments and modified examples. In addition, it will be understood by those skilled in the art that the functions to be performed by the constituent elements described in the claims are implemented by a single constituent element or cooperation of the constituent elements described in the embodiments and the modified examples.

Supplementary Note

[0095] The following technologies are disclosed by the description of the above embodiments and modified examples.

[Technology 1]

[0096] A display control system including:

[0097] a renderer structured to generate a first image that designates color information to be displayed while being superimposed on a predetermined image and a second image that designates transparency of the first image; and

[0098] a compositor, in which

[0099] the renderer generates the first image based on data of a first graphical user interface (GUI) object using a GUI component prepared in advance, and generates the second image based on data of a second GUI object that outputs an image that designates transparency of the first GUI object, and

[0100] the compositor generates a composite image in which the first image whose transparency is set based on the second image is superimposed on the predetermined image.

[0101] With the display control system, the expressiveness of the composite image can be improved in a system using an application unit (for example, the renderer) in which output of the transparency information is limited.

[Technology 2]

[0102] The display control system according to Technology 1, in which the renderer generates the first image indicating a color obtained by multiplying a color designated for the first GUI object by predetermined transparency.

[0103] With the display control system, the expressiveness of the composite image can be further improved.

[Technology 3]

[0104] The display control system according to Technology 1 or 2, in which the renderer generates one image in which the first image and the second image are disposed in different regions as one image to be transmitted to the compositor.

[0105] With the display control system, the number of times image transmission/reception is performed between the processor on the renderer side (for example, the IVI processor **20**) and the processor on the compositor side (for example, the meter processor **30**) can be reduced.

[Technology 4]

[0106] The display control system according to Technology 3, further including a generator structured to generate layout information including a position of the second image in the one image,

[0107] in which the compositor extracts the first image and the second image from the one image based on the layout information.

[0108] With the display control system, the first image and the second image can be extracted from the one image by using an existing mechanism for generating the composite image based on the layout information.

[Technology 5]

[0109] The display control system according to any one of Technologies 1 to 4, in which

[0110] the renderer is implemented in a first processor, and

[0111] the compositor is implemented in a second processor having a safety requirement different from a safety requirement of the first processor.

[0112] With the display control system, in a case where the second processor having a safety requirement different from that of the first processor generates the composite image by using the image generated by the first processor, the expressiveness of the composite image can be improved.

[Technology 6]

[0113] The display control system according to any one of Technologies 1 to 4, in which

[0114] the renderer and the compositor are implemented in a single processor,

[0115] the single processor includes a first operating system (OS) on which the renderer operates and a second OS on which the compositor operates, and

[0116] the second OS has a safety requirement different from a safety requirement of the first OS.

[0117] With the display control system, in a case where the compositor operating on the second OS having a safety requirement different from that of the first OS generates the composite image by using the image generated by the renderer operating on the first OS, the expressiveness of the composite image can be improved.

[Technology 7]

[0118] The display control system according to any one of Technologies 1 to 4, in which

[0119] the renderer is implemented in a processor of an information device mounted on a vehicle, and

[0120] the compositor is implemented in a processor of a meter device mounted on the vehicle.

[0121] With the display control system, in a case where the processor of the meter device generates the composite image by using the image generated by the processor of the information device, the expressiveness of the composite image can be improved.

[Technology 8]

[0122] A display control method executed by a computer, the display control method including:

[0123] first processing of generating a first image that designates color information to be displayed while being superimposed on a predetermined image and a second image that designates transparency of the first image; and

[0124] second processing of generating a composite image in which the first image whose transparency is set based on the second image is superimposed on the predetermined image,

[0125] in which in the first processing, the first image is generated based on data of a first GUI object using a GUI component prepared in advance, and the second image is generated based on data of a second GUI object that outputs an image that designates transparency of the first GUI object.

[0126] With the display control method, the expressiveness of the composite image can be improved in the system using the application unit in which the output of the transparency information is limited.

[0127] While various embodiments have been described herein above, it is to be appreciated that various changes in form and detail may be made without departing from the spirit and scope of the invention(s) presently or hereafter claimed.

CROSS-REFERENCE TO RELATED APPLICATION

[0128] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application

No. 2024-023771, filed on Feb. 20, 2024, the entire contents of which are incorporated herein by reference.

What is claimed is:

1. A display control system comprising:

a renderer structured to generate a first image that designates color information to be displayed while being superimposed on a predetermined image and a second image that designates transparency of the first image; and

a compositor, wherein

the renderer generates the first image based on data of a first graphical user interface (GUI) object using a GUI component prepared in advance, and generates the second image based on data of a second GUI object that outputs an image that designates transparency of the first GUI object, and

the compositor generates a composite image in which the first image whose transparency is set based on the second image is superimposed on the predetermined image.

2. The display control system according to claim **1**, wherein the renderer generates the first image indicating a color obtained by multiplying a color designated for the first GUI object by predetermined transparency.

3. The display control system according to claim **1**, wherein the renderer generates one image in which the first image and the second image are disposed in different regions as one image to be transmitted to the compositor.

4. The display control system according to claim **3**, further comprising a generator structured to generate layout information including a position of the second image in the one image,

wherein the compositor extracts the first image and the second image from the one image based on the layout information.

5. The display control system according to claim **1**, wherein

the renderer is implemented in a first processor, and

the compositor is implemented in a second processor having a safety requirement different from a safety requirement of the first processor.

6. The display control system according to claim **1**, wherein

the renderer and the compositor are implemented in a single processor,

the single processor includes a first operating system (OS) on which the renderer operates and a second OS on which the compositor operates, and

the second OS has a safety requirement different from a safety requirement of the first OS.

7. The display control system according to claim **1**, wherein

the renderer is implemented in a processor of an information device mounted on a vehicle, and

the compositor is implemented in a processor of a meter device mounted on the vehicle.

8. A display control method executed by a computer, the display control method comprising:

first processing of generating a first image that designates color information to be displayed while being superimposed on a predetermined image and a second image that designates transparency of the first image; and

second processing of generating a composite image in which the first image whose transparency is set based on the second image is superimposed on the predetermined image,

wherein in the first processing, the first image is generated based on data of a first GUI object using a GUI component prepared in advance, and the second image is generated based on data of a second GUI object that outputs an image that designates transparency of the first GUI object.

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