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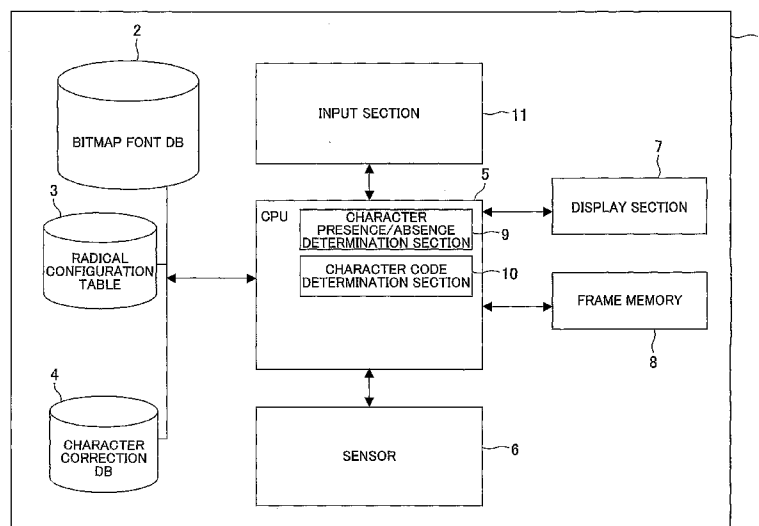
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(54) Title: DISPLAY DEVICE, VEHICLE, DISPLAY METHOD, DISPLAY PROGRAM, AND DISPLAY PROGRAM STORAGE MEDIUM



(57) Abstract: The present invention has as an object to allow a user to appropriately view various images displayed on a display screen having a non-flat surface shape. For this purpose, the present invention includes control means (5) for correcting, in accordance with a display position of an image on the display screen (7), image data based on which the image is displayed on the display screen (7). According to this arrangement, the control means (5) corrects, in accordance with a display position of an image on the display screen (7), image data based on which the image is displayed. This for example allows the user to view an image displayed on the display screen (7) having a non-flat surface shape as if viewing an image displayed on a display screen having a flat surface shape.

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DESCRIPTION

DISPLAY DEVICE, VEHICLE, DISPLAY METHOD, DISPLAY
PROGRAM, AND DISPLAY PROGRAM STORAGE MEDIUM

TECHNICAL FIELD

5 The present invention relates to a display device showing
an image on a display screen having a non-flat surface shape,
a vehicle including the same, a display method, a display
program, and a display program storage medium.

10 BACKGROUND ART

Recently, the development of a display device (curved
surface displays) having a curved display surface has been
advanced.

For example, Japanese Laid-Open Application No.
15 73148/1999 (*Tokukaihei* 11-73148; published on March 16,
1999) (Document 1) describes a light-emitting display device,
including a light-emitting sheet made of an EL
(electroluminescence) sheet, which has a curved display
surface and a method for manufacturing the light-emitting
20 display device. Further, Japanese Laid-Open Application No.
52856/2001 (*Tokukai* 2001-52856; published on February 23,
2001) (Document 2) describes a technique concerning an EL
sheet of a curved surface shape.

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Further, Japanese Laid-Open Application No. 295164/2003 (*Tokukai* 2003-295164; published on October 15, 2003) (Document 3) and Japanese Laid-Open Application No. 268270/1998 (*Tokukaihei* 10-268270; published on October 9, 1998) (Document 4) describe a technique concerning a liquid crystal panel for a curved display and a method for manufacturing the same.

Further, Japanese Laid-Open Application No. 246840/1990 (*Tokukaihei* 2-246840; published on October 2, 1990) (Document 5) discloses a head up display (HUD) having a curved surface holographic combiner.

Further, for example, Japanese Laid-Open Application No. 79837/2000 (*Tokukai* 2000-79837; published on March 21, 2000) (Document 6) discloses a display device which makes it possible to view a natural image display on a display surface in a curved state by preliminarily correcting a flat image taking into consideration an image distortion due to curvature.

However, in each of the techniques of Documents 1 to 5, a display screen has a curved surface. Therefore, depending on a relative position of a user with respect to the display screen, the user may see displayed contents in their distorted form.

Further, the technique of Patent Document 6 relates to a segment-type display element (i.e., a display element, having

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an electrode pattern arranged in a figure "8", which displays numbers). The segment display element can only show specific images, such as numbers and letters of the alphabet, which are made of combinations of segments arranged in the figure "8". Further, in a manufacturing process thereof, it is necessary to add a step of preliminarily correcting a flat image. This results in a complex manufacturing process accompanied by a cost increase.

DISCLOSURE OF INVENTION

The present invention has been completed in consideration of the foregoing problems and has as an object to provide a display device which makes it possible for a user to appropriately view various images displayed on a display screen having a non-flat surface shape, a vehicle including the same, a display method, a display program, and a display program storage medium.

A display device according to the present invention is a display device displaying an image on a display screen having a non-flat surface shape, the display device including: control means for correcting, in accordance with a display position of an image on the display screen, image data based on which the image is displayed on the display screen.

According to the foregoing arrangement, the control means corrects, in accordance with a display position of an

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image on the display screen, image data based on which the image is displayed on the display screen. This for example allows the user to view an image displayed on the display screen having a non-flat surface shape as if viewing an image displayed on a display screen having a flat surface shape.

Further, the display device according to the present invention is a display device displaying an image on a display screen having a non-flat surface shape, the display device including: control means for correcting, in accordance with a display position of a character, character data based on which the character is displayed on the display screen.

This makes it possible to correct character data on which a character is based which is liable to look distorted as compared with a figure and the like when displayed on a display device of a non-flat surface shape. Therefore, it is possible to accurately correct character data in particular need of correction so that the user can naturally view the character.

Further, the display device according to the present invention is a display device displaying an image on a display screen having a non-flat surface shape, the display device including: character presence/absence determination means for determining whether image data based on which the image is displayed on the display screen contains character data or not; and control means for at least correcting, in a case where

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the image data based on which the image is displayed contains the character data, the character data in accordance with a display position of a character based on the character data.

5 This makes it possible to determine the presence or absence of character data on which a character in particular need of correction is based. Therefore, the character can be accurately corrected according to need.

10 The display device according to the present invention may be arranged so that the control means corrects a shape of the character.

 This makes it possible to correct a shape of a character based on character data in particular need of correction, in such a way that the user can naturally view the character.

15 Furthermore, the display device according to the present invention may be arranged so that the control means corrects a relative position of one component of the character with respect to another component, the character being based on the character data contained in the image data based on
20 which the image is displayed.

 This makes it possible to correct a relative position of one component of a character with respect to another, the character being based on character data in particular need of correction, in such way as to change a vertical or horizontal
25 width of the character.

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Note that the "component of a character" refers to components obtained by dividing a character (into parts). For example, it refers to radicals (e.g., *hen*, meaning left radicals; *tsukuri*, meaning right radicals; *kammuri*, meaning top radicals of one type; *kashira*, meaning top radicals of another type; and *kamae*, meaning enclosing radicals) which form Kanji characters. More particularly, it refers to components which, when characters are classified or arranged according to character structures, serve as the basis for the classification or arrangement. These components (radicals) are often commonly used in a plurality of characters (Kanji characters). Such "components" are combined so as to express a single character (Kanji character).

Further, the display device according to the present invention may be arranged so that the control means corrects coordinate data forming an outline of the character based on the character data contained in the image data based on which the image is displayed.

Furthermore, the display device according to the present invention may be arranged so that the control means corrects a relative position of one character with respect to another character.

This for example makes it possible to correct a relative position of one character with respect to another in such a way as to change a gap between the characters.

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Furthermore, the display device according to the present invention may be arranged so that the control means corrects, in accordance with a position of a user with respect to the display screen, the image data based on which the image is displayed in each position on the display screen.

This makes it possible to correct, in accordance with a position of the user with respect to the display screen, the image data based on which the image is displayed. Therefore, even when a position of the user is changed so that that position on the display screen in which the user views the image in its distorted form is changed, it is possible to appropriately correct the image data based on which the image is displayed in each position on the display screen.

The display device according to the present invention may be arranged so as to include a detection means for detecting the position of the user with respect to the display screen.

This makes it possible to detect a position of the user with use of the detection means and appropriately correct, in accordance with the detected position of the user, the image data based on which the image is displayed. Therefore, for example, even when the position of the user with respect to the display screen is changed, an appropriate image can be displayed in accordance with the changed position.

The display device according to the present invention is

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a display device including instruction input means for receiving an instruction from the user, wherein the control means determines, in accordance with the instruction given by the user to the instruction input means, the position of the user with respect to the display screen.

This allows the control means to determine a position of the user with use of the instruction input means and appropriately correct, in accordance with the determined position of the user, the image data based on which the image is displayed.

The display device according to the present invention may be arranged so as to include a liquid crystal panel.

According to the foregoing arrangement, a display device which allows a user to appropriately view various images displayed on a display screen having a non-flat surface shape can be applied to a highly versatile thin liquid crystal panel.

A vehicle according to the present invention is arranged so as to include any one of the display devices described above.

The term vehicle encompasses various vehicles such as an automobile, a two-wheeled motor vehicle, a helicopter, an airplane, and a ship.

This makes it possible to achieve a vehicle including a display device which allows a user to appropriately view various images displayed on a display screen having a

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non-flat surface shape. Further, by mounting on each of the various vehicles a display device having a display screen of a non-flat surface shape, a design of the vehicle including the display device can be diversified. For example, interior designs of many recent automobiles are based on curved shapes. Therefore, by causing a display screen of a mounted display device to have a non-flat surface shape (e.g., a curved surface shape), it is possible to totally coordinate the interior design and mount the display device without a feeling of strangeness.

A display program according to the present invention causes a computer mounted on a display device to function as control means of any one of the display devices.

By causing such a computer as described above to read the display program, it becomes possible to achieve, with use of the computer, processing of control means of any one of the display devices.

A storage medium according to the present invention is a storage medium storing the display program. By storing the display program in a storage medium which can be read by a computer, it becomes easy to save and distribute the display program. Furthermore, by causing to a computer to read the storage medium, the computer can be used to execute processing of control means of any one the display devices.

For a fuller understanding of the nature and advantages

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of the invention, reference should be made to the ensuing detailed description taken in conjunction with the accompanying drawings.

5 BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a block diagram showing an arrangement of a display device according to one embodiment of the present invention.

10 Fig. 2 is a block diagram showing an arrangement of a display device according to another embodiment of the present invention.

Fig. 3 is a flow chart showing a procedure for displaying an image by correcting character data with use of a bitmap font under varying correction conditions in the display device
15 of Fig. 1.

Fig. 4 is a flow chart showing a procedure for displaying an image by correcting character data with use of an outline font under varying correction conditions in the display device of Fig. 2.

20 Fig. 5 is a flow chart showing a procedure for displaying an image by correcting character data with use of a bitmap font without changing correction conditions in the display device of Fig. 1.

25 Fig. 6 is a flow chart showing a procedure for displaying an image by correcting character data with use of a bitmap

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font without changing correction conditions in the display device of Fig. 2.

Fig. 7 is a plan view, showing the display device of Fig. 1 or 2 from above, which indicates a positional relationship between a user and a display screen of the display device.

Fig. 8(a), showing an arrangement of a Kanji character "Go" displayed on the display screen of the display device of Fig. 1, is a front view showing an arrangement of the Kanji character displayed before data correction.

Fig. 8(b), showing an arrangement of a Kanji character "Go" displayed on the display screen of the display device of Fig. 1, is a front view showing an arrangement of the Kanji character displayed after data correction.

Fig. 9(a), showing an arrangement of a Kanji character "Kou" displayed on the display screen of the display device of Fig. 1, is a front view showing an arrangement of the Kanji character displayed before data correction.

Fig. 9(b), showing an arrangement of a Kanji character "Kou" displayed on the display screen of the display device of Fig. 1, is a front view showing an arrangement of the Kanji character displayed after data correction.

Fig. 10 is a block diagram showing an arrangement of a display device according to a further embodiment of the present invention.

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BEST MODE FOR CARRYING OUT THE INVENTION

A curved LCD (liquid crystal display) 1, which is one embodiment of the present invention, will be described below. Fig. 1 is a block diagram showing an arrangement of the curved LCD 1.

As shown in Fig. 1, the curved LCD 1 includes a bitmap font DB (database) 2, a radical configuration table 3, a character correction DB (database) 4, a CPU (control means) 5, a sensor (detection means) 6 for detecting a position, a display section (display means) 7, a frame memory 8, and an input section 11.

The curved LCD 1 includes a liquid crystal panel (display screen) of a curved surface shape (non-flat surface shape). Further, the curved LCD 1 is mounted on a vehicle such as an automobile so as to show navigation information, television broadcasts, and images of the surroundings around the automobile. Note in this description that the term image encompasses images of characters, those of figures, those of pictures, video images, and the like projected on a display screen.

The bitmap font DB 2 stores a bitmap font corresponding to a large number of characters. Note that the bitmap font is a type of fonts (data format) for expressing the shapes of characters, expresses characters as aggregates of small square dots, and expresses the shapes of all characters with a

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predetermined number of lattices.

The character correction DB 4 stores a large number of correction contents with respect to character codes. For example, in case of a Kanji character "Kou", a table designating which character area is enlarged and where on the matrix a dot is placed is registered, and the character is corrected with reference to the table. Alternatively, the character correction DB 4 stores corrected data corresponding to the character codes, and in accordance with a display position, the corrected data replaces the character codes so as to be displayed. Further, the radical configuration table 3 stores, as a bitmap font, a large number of radicals such as left radicals and right radicals which form Kanji characters. Kanji characters are divided into radicals (parts) such as left radicals and right radicals, and radicals are commonly used in a plurality of Kanji characters. That is, the radicals stored in the radical configuration table 3 are turned into parts, so that a plurality of Kanji characters are formed by combining these radicals turned into parts.

The display section 7 has a display screen of a horizontally curved shape. Note that the display screen is a concave display screen which is curved away from a user's side. Further, when that area of the display screen which is located on the right side of the user is a rightward area, that area of the display screen which is located in the center with

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respect to the user is a center area, and that area of the display screen which is located on the left side of the user is a leftward area, the central area is a flat area whose curvature is smaller than those of the leftward and rightward areas. Further, the display device 7 is a dot-matrix display panel which displays characters and figures by turning on and off pixels (display units) arranged in a matrix manner.

Note that the display section 7 may be an active-matrix display panel each of whose pixels includes an active element so as to drive the active element. (The active element is individually connected to an electrode so as to individually retain a voltage. When a current flows through the active element, the active element individually turns on the pixel to which it is connected.) Alternatively, the display section 7 may be a simple-matrix display panel which interposes a liquid crystal layer between crossed electrodes so as to drive the liquid crystal layer.

Further, the display screen of the display section 7 is a flat display screen, having an oblong shape at an aspect ratio (horizontal to vertical ratio) of 7:3, which is curved in a horizontal direction so that a central portion is curved away from the user. That is, in this description, the aspect ratio means a ratio of a horizontal length along with a curved surface to a vertical length of the display screen.

The frame memory 8 stores image data to be displayed in

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the display section 7.

The input section 11 includes an interface (not shown) to which a navigation system, a television receiver, a camera, and the like are connected. Inputted from these external devices is image data such as navigation information, television broadcasts, and images of the surroundings around the automobile, and the input information is transmitted to the CPU 5.

The sensor 6 detects a position of the user (whether the user is in front of the leftward area, the center area, or the rightward area of the display screen). An arrangement of the sensor 6 is not particularly limited. For example, the sensor 6 may detect a position of the user with use of infrared. Alternatively, the sensor 6 may include a camera for capturing images in the direction of display, so that a position of the user is detected from the image captured by the camera.

The CPU 5 includes a character presence/absence determination section 9 for determining the presence or absence of a character. The character presence/absence determination section 9 determines whether character data is contained in image data inputted from outside. The CPU also includes a character code determination section 10 for determining a character code. A character code is a unique number, such as a JIS (Japanese Industrial Standards) code,

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allotted to each character or symbol, which is designed to encode the character or symbol so as to send and receive the character or symbol through computers.

Further, the CPU 5 corrects image data according to need so as to display an image on the display screen so that the user can suitably view an image displayed based on the image data in each position on the display screen.

Further, the CPU 5, based on a detection result yielded by the sensor 6, determines a position of the user with respect to the display screen and changes correction conditions in each position of the user with respect to the display screen. That is, when a character is displayed on the display screen in a curved state, the correction conditions are changed so that the character can be seen with a normal character width from a position in which the user is seated.

Described in the following is a method for changing conditions under which image data displayed by the CPU 5 is corrected in accordance with a change in a position of the user with respect to the display screen. Fig. 7 is a plan view schematically showing a relationship between the display screen of the curved LCD 1 and a position of the user. It is supposed that a character is displayed on the display screen of the curved LCD 1, and the user is seated in an area, indicated by A in Fig. 7, which is in front of the left area of the display screen. A front area of the display device means

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an area, being in front of the display screen, where the user can see a displayed image.

In an example shown in Fig. 7, a character displayed in the center area of the display screen looks normal (natural) to the user. That is, the character displayed in the center area looks approximately as wide as the image which is actually displayed. Further, a character displayed in the right area of the display screen looks normal to the user.

However, under such conditions that an image is displayed without correcting character data, a character displayed in the left area looks vertically long to the user. That is, the width of the character looks narrower than the image which is actually displayed.

For this reason, when the CPU 5 determines by a detection result of the sensor 6 that the user is in front of the left area of the display screen, the CPU 5 allows a character finished with data correction as described later to be displayed in the left area of the display screen and allows a character without data correction to be displayed in the center and right areas.

Thus, character data which has been corrected is displayed in the left area of the display screen, so that the user in front of the left area of the display screen is allowed to view, with a normal character width, a character displayed in the left area as if viewing a character displayed on a screen

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having a flat shape.

Similarly, when the CPU 5 determines by a detection result of the sensor 6 that the user is in front of the right area of the display screen, the CPU 5 allows a character finished with data correction as described later to be displayed in the right area of the display screen and allows a character without data correction to be displayed in the center and left areas.

Furthermore, when the CPU 5 determines by a detection result of the sensor 6 that the user is in front of the center area of the display screen, the CPU 5 allows a character without data correction to be displayed in all the areas of the display screen.

Described in the following is a process by which the CPU 5 corrects character data made of a bitmap font. Kanji characters "Go" and "Kou" which are displayed without data correction are shown in Figs. 8(a) and 9(a), respectively. As shown in Figs. 8(a) and 9(a), each of the Kanji characters has a normal width.

Correspondingly, Kanji characters "Go" and "Kou," finished with data correction, which are displayed in the left area of the display screen when the user is in front of the left area of the display screen, are shown in Figs. 8(b) and 9(b), respectively. As shown in Figs. 8(b) and 9(b), the CPU 5 performs data correction so that each of the Kanji characters

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is displayed wider than it normally is.

The CPU 5 refers to the radical configuration table 3 so as to divide the Kanji character "Go" into a left radical "Gon" (B) and a right radical "Ware" (B') and performs data
5 correction so that the Kanji character "Go" is displayed with a wide space between the left radical and the right radical. That is, as for dots (pixels) which indicate the Kanji character, the number of rows of dots interposed between the left radical and the right radical is increased so that the Kanji character
10 is displayed. Note at this time that it is preferable that the total number of dots within a character display area (i.e., a number of dots used for displaying the character) should not change per se.

In other words, as shown in Fig. 8(a), the CPU 5 divides
15 the Kanji character "Go (B+B')" into components B and B' (components of the character). Moreover, the CPU 5 performs data correction so that the components B and B' are displayed with a wide space therebetween. That is, as for dots (pixels) which indicate the Kanji character, the number of rows of
20 dots interposed between the components B and B' is increased so as to display the Kanji character. Note that the components B and B' are not limited to those shown in Figs. 8(a) and 8(b) but may be components which can be divided into components of characters (or turned into parts).

25 Further, the CPU 5 refers to the radical configuration

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table 3 so as to determine that the Kanji character "Kou" is not a combination of a left radical and a right radical, and the CPU 5 refers to the character correction DB 4 so as to perform correction so that the character is displayed partially wider without dividing character data. That is, the number of rows of dots indicating the left portion of the character is increased so that the character is displayed.

Similarly, when the user is in front of the rightward area of the display screen and the Kanji character "Kou" is displayed in the rightward area of the display screen, the CPU 5 increases the number of rows of dots indicating the right portion of the character and performs correction so that the character is displayed partially wider. As for the Kanji character "Go," the number of rows of dots between the left radical and the right radical is increased so that the character is displayed.

Described in the following is a procedure by which character data made of a bitmap font is corrected in the curved LCD 1 so that an image is displayed on the display screen. Fig. 3 is a flow chart showing a procedure for displaying an image in the curved LCD 1 of Fig. 1.

As shown in Fig. 3, the CPU 5 determines by the character presence/absence determination section 9 whether character data is contained in image data inputted from outside into the input section 11 (S1).

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When the CPU 5 determines by the character presence/absence determination section 9 that the image data does not contain character data (S1, NO), the CPU 5 allows the image data to be stored temporarily in the frame memory 8 without correcting the image data (S14). Thereafter, the CPU 5 takes the image data out of the frame memory 8 and displays an image on the display screen (S15). Thus, the CPU 5 terminates display processing (END).

When the CPU 5 determines by the character presence/absence determination section 9 that the image data contains character data (S1, YES), the character code determination section 10 determines a character code (S2), so that character data is extracted (S3). That is, the character code determination section 10 determines a character code of character data inputted from outside and decodes encoded character data.

Furthermore, with reference to the bitmap font DB 2 (S4), the CPU 5 forms the decoded character data as a bitmap font.

Further, the CPU 5 determines whether or not the character data contained in the input image data is to be displayed in the center area (flat area) of the display screen (S5).

When the CPU 5 determines that the character data contained in the input image data is image data to be displayed in the center area (flat area) (S5, YES), the CPU 5

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combines the character data with the image data other than the character data without correcting the character data and allows the combined data to be stored temporarily in the frame memory 8 (S13).

5 Meanwhile, when the CPU 5 determines that the character data contained in the input image data is to be displayed in a position other than the center area (S5, NO), the CPU 5 causes the sensor 6 to detect a position of the user (S6). Furthermore, the CPU 5 determines whether the
10 character is an image to be displayed in an area of the display screen on the user's side (an area of the user closest to the display screen) (S7).

 Moreover, when the CPU 5 determines that the character data contained in the image data is an image to be displayed
15 in an area on a side without the user (an area other than an area on the user's side) (S7, NO), the CPU 5 combines the character data with the image data other than the character data without correcting the character data and allows the combined data to be stored temporarily in the frame memory
20 8 (S13).

 Further, when the CPU 5 determines that the character data contained in the image data is an image to be displayed in an area on the user's side (S7, YES), the CPU 5 refers to the radical configuration table 3 (S8) so as to determine
25 whether or not the character data is a combination of radicals

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such as a left radical and a right radical stored in the radical configuration table 3 (S9).

When the CPU 5 determines that the character data is a combination of a left radical and a right radical stored in the radical configuration table 3 (S9, YES), the CPU 5 corrects, based on the curvature of the display screen, a position in which the left radical and the right radical of the character data are combined (S10). The CPU 5 combines the corrected character data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S13).

When that the CPU 5 determines that the character data is not a combination of a left radical and a right radical stored in the radical configuration table 3 (S9, NO), the CPU 5 refers to the character correction DB 4 (S11) so as to correct the character (S12).

Then, the CPU 5 combines the corrected character data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S13).

The CPU 5 takes, out of the frame memory 8, the combined data stored in the frame memory 8 in S13 and instructs the display section 7 to display the data. This allows the display section 7 to display an image (S15), so that the CPU 5 terminates display processing (END).

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As described above, in accordance with a position of the user with respect to the display screen, the CPU 5 of the curved LCD 1 corrects and displays a character on the curved display screen in such a way that the character is seen with a normal character width from a position of the user. This enables the user to view the displayed character with the same character width regardless of where the user sees the character. Further, this enables the user to naturally view an image displayed on a display screen having a curved shape as if viewing an image on a display screen having a flat shape.

Further, unlike a segment-type display panel using a process by which an electrode pattern arranged in a figure "8" so that numbers are displayed as described in Patent Document 6, the curved LCD 1 is a dot-matrix display panel including the CPU 5 (control circuit), enlarging and reducing image data, which directly corrects image data to be displayed.

For this reason, image data can be corrected under varying conditions, so that various characters can be corrected so as to be displayed. That is, in accordance with a character (image) to be displayed and a position of the user with respect to the display screen, conditions under which image data is corrected are varied. This allows the user to view the image more naturally.

Further, as described above, the curved LCD 1 corrects

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the width of a character so as to display the character. Generally speaking, a character displayed on a curved display screen is liable to look distorted as compared with other figures and the like. On this account, the curved LCD 1
5 accurately corrects a character in particular need of correction so that the user can view the character with a normal character width.

Further, the curved LCD 1 prestores display data elements and replaces one display data element with another
10 depending on a position of the user and a display position so as to display the display data element. That is, the curved LCD 1 stores left radicals and right radicals as separate data elements and combines the data elements in each case depending on a display position so as to display the combined
15 data elements. This makes it possible to accurately correct a character made of a left radical and a right radical so that the user can view the character with a normal character width.

Further, in the curved LCD 1, the CPU 5 corrects a position in which a left radical and a right radical of
20 character data are combined. That is, the CPU 5 corrects, as a minimum unit, a relative position of a left radical with respect to a right radical, the left radical and the right radical being stored for example in the radical configuration table 3 and serving as components of a character. For this reason, by
25 correcting a relative position of one radical with respect to

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another or correcting a position of one character with respect to another, the character data can be corrected more accurately. That is, because of a data structure which divides character data into a left radical and a right radical, a position in which a left radical and a right radical are combined can be changed according to a display position of the character on the curved LCD 1. This allows the user to perceive the character to be displayed with the same character width regardless of where the user sees the character.

Further, in the curved LCD 1, based on a result of detecting a position of the user with use of the sensor 6, image data to be displayed is corrected under correction conditions in accordance with a position of the user with respect to the display screen. Therefore, even when a position of the user is changed so that a position of the display screen in which the user views an image in its distorted form is changed, it is possible to appropriately correct the image data in each position on the display screen.

Further, the curved LCD 1 is arranged so that the CPU 5 corrects a relative position of one component of a character with respect to another, the character being based on character data contained in image data to be displayed. However, the curved LCD 1 is not so limited but may be arranged so that the CPU 5 corrects a relative position of a

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character with respect to another, the character being based on character data contained in image data to be displayed. This makes it possible to correct a relative position of a character with respect to another in such a way that a gap
5 between the characters is changed.

Further, in the foregoing, an arrangement is described in which a bitmap font is used to correct character data with a component of a character serving as a minimum unit. However, this is not for the purpose of limitation. For example,
10 a vector font (e.g., an outline font or a skeleton font) may be used to correct character data. Note that an outline font is a type of font (data format) for expressing a shape of a character. The outline font draws a line expressing an outline of a character. The line is drawn according to a calculating
15 formula with use of peak coordinate data and function data expressing a straight line and a curved line. The outline is filled, and the shape of the character is displayed. Further, a skeleton font is a font which is created by combining data expressing a skeleton of a character with data expressing an
20 outline which physicalizes the skeleton.

Described in the following is an arrangement in which character data is corrected with use of an outline font so that an image is displayed. Although a skeleton font is not described, the same arrangement can be used for the skeleton
25 font too. Fig. 2 is a block diagram showing an arrangement of

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a curved LCD 1 which corrects character data with use of an outline font so as to display the character data.

The curved LCD 1 includes a CPU 5, a sensor 6, a display section 7, a frame memory 8, an input section 11, and an outline DB 13.

The outline DB 13 stores peak coordinate data, which forms an outline of a character, and function coordinate data, which indicates a straight line and a curved line.

The CPU (control means) 5 includes a character width/height correction section 12, a character presence/absence determination section 9, and a character code determination section 10. The character width/height correction section 12 refers to the outline DB 13 so as to correct a character width and height of character data.

Described in the following is a procedure for displaying an image by correcting character data with use of an outline font. Fig. 4 is a flow chart showing a procedure for displaying an image on the curved LCD 1 of Fig. 2.

As shown in Fig. 4, the CPU 5 determines by the character presence/absence determination section 9 whether or not character data is contained in image data inputted from outside into the input section 11 (S21).

When the CPU 5 determines that the image data does not contain character data (S21, NO), the CPU 5 causes the image data to be stored temporarily in the frame memory 8 without

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correcting the image data (S30). Thereafter, the CPU 5 takes the image data out of the frame memory 8 and displays an image on the display screen (S31). Thus, the CPU 5 terminates display processing (END).

5 Meanwhile, when the CPU 5 determines that the image data contains character data (S21, YES), the character code determination section 10 determines a character code (S22), so that character data is extracted (character data is decoded) (S23). Further, the CPU 5 refers to the outline DB 13 (S24) so
10 as to form the decoded character data as an outline font.

 Further, the CPU 5 determines whether or not the character data is to be displayed in a flat area of the display section 7 (S25). When the CPU 5 determines that the character data is an image to be displayed in the flat area
15 (S25, YES), the CPU 5 combines the character data with the image data other than the character data without correcting the character data and causes the combined data to be stored temporarily in the frame memory 8 (S29).

 When the CPU 5 determines that the character data is
20 an image to be displayed in a position other than the flat area (S25, NO), the CPU 5 determines a position of the user with respect to the display screen (S26). Furthermore, the CPU 5 determines whether or not the character is an image to be displayed in an area of the display screen on the user's side
25 (S27).

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When the CPU 5 determines that the character is an image to be displayed in an area on a side without the user (S27, NO), the CPU 5 combines the uncorrected character data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S29).

When the CPU 5 determines that the character is an image to be displayed in an area on the user's side (S27, YES), the CPU 5 corrects, based on the curvature of the display screen, the shape of the character (e.g., at least one of the height and width of the character) by correcting coordinate data which forms the outline of the character (S28). Further, at this time, the CPU 5 changes, in accordance with a change in a position of the user with respect to the display screen, correction conditions in each position on the display screen.

The CPU 5 combines the corrected character data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S29).

The CPU 5 takes out of the frame memory 8 the combined data stored in the frame memory 8 in S29 and instructs the display section 7 to display the data. This allows the display section 7 to display an image (S15), so that the CPU 5 terminates display processing (END).

Thus, by correcting the character, its height, and/or its

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width, based on the character data, with use of coordinate data which forms the outline of the character, the character can be corrected in detail. This allows the user to view the character more naturally.

5 Further, in the foregoing, the CPU 5 is arranged so as to change correction conditions in each position on the display screen in accordance with a result of detecting a position of the user with respect to the display screen with use of the sensor 6.

10 However, the CPU 5 is not so limited but may be for example arranged so as not to change correction conditions. A procedure for displaying an image according to such a method will be described below.

15 Fig. 5 is a flow chart showing a procedure for displaying an image on the curved LCD 1 with use of a bitmap font without changing correction conditions. Note that the steps S41 through S45, S52, and S53 correspond to the steps S1 through S5, S14, and S15 (see Fig. 3), respectively, and explanations thereof are omitted.

20 When the CPU 5 determines that character data is an image to be displayed in the flat area (S45, YES), the CPU 5 combines the character data with the image data other than the character data without correcting the character data and causes the combined data to be stored temporarily in the
25 frame memory 8 (S51).

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Meanwhile, when the CPU 5 determines that the character data is an image to be displayed in a position other than the flat area (S45, NO), the CPU 5 refers to the radical configuration table 3 (S46) so as to determine whether or not the character data is a combination of radicals such as a left radical and a right radical stored in the radical configuration table 3 (S47).

When the CPU 5 determines that the character data is not a combination of a left radical and a right radical stored in the radical configuration table 3 (S47, NO), the CPU 5 refers to the character correction DB 4 (S49) so as to correct the character (S50). Moreover, the CPU 5 combines the corrected character data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S51).

Meanwhile, when the CPU 5 determines that the character data is a combination of a left radical and a right radical stored in the radical configuration table 3 (S47, YES), the CPU 5 corrects, based on the curvature of the display screen, a position in which the left radical and the right radical of the character data are combined (S48). Moreover, the CPU 5 combines the corrected character data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S51).

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Then, the CPU 5 takes out of the frame memory 8 the combined data stored in the frame memory 8 in S51 and causes the display section 7 to display the data (S53). This causes the CPU 5 to terminate display processing (END).

5 Further, in an example of Fig. 5, a display is performed with use of a bitmap font without changing correction conditions. However, this is not for the purpose of limitation. For example, an arrangement may be such that character data is corrected with use of an outline font without changing
10 correction conditions so that an image is displayed. A procedure for displaying an image according to such an arrangement will be described below.

Fig. 6 is a flow chart showing a procedure for displaying an image on the curved LCD 1 by correcting the character data without changing correction conditions. Suppose that
15 image data is inputted from outside into the input section 11. The steps S61 through S65, S68, and S69 correspond to the steps of the steps S21 through S25, S30, and S31 (see Fig. 4), respectively, and explanations thereof are omitted.

20 When the CPU 5 determines that the character data is to be displayed in the flat area (S65, YES), the CPU 5 combines the character data with the image data other than the character data without correcting the character data and causes the combined data to be stored temporarily in the
25 frame memory 8 (S67).

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Meanwhile, when the CPU 5 determines that the character data is to be displayed in a position other than the flat panel (S65, NO), the CPU 5 corrects, based on the curvature of the display screen, the character width and height of the character data (S66). Moreover, the CPU 5 combines the corrected data with the image data other than the character data and causes the combined data to be stored temporarily in the frame memory 8 (S67).

Then, the CPU 5 takes out of the frame memory 8 the combined data stored temporarily in the frame memory 8 in S67 and causes the display section 7 to display the data (S69). Moreover, the CPU 5 terminates display processing (END).

Further, in the foregoing, the CPU 5 is arranged so as to change correction conditions in each position on the display screen in accordance with a result of detecting a position of the user with respect to the display screen with use of the sensor 6.

However, a method for detecting a position of the user is not so limited. For example, as shown in Fig. 10, an arrangement may be such that the curved LCD 1 includes an instruction input section (instruction input means) 14, which receives an instruction from the user, and the CPU 5 determines a position of the user with respect to the display screen in accordance with the instruction given by the user to the instruction input section.

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Alternatively, the instruction input section 14 may be arranged so as to include a wireless transmitting section, such as a remote controller, and a wireless receiving section. The wireless transmitting section includes an input section,
5 into which the user inputs an instruction, and a transmitting section, which wirelessly transmits information inputted by the user. The wireless receiving section receives information transmitted by the wireless transmitting section.

Further, in the foregoing, an arrangement is such that
10 only the character data out of the image data is corrected. However, the arrangement is not so limited but may be such that image data containing a figure is corrected. For example, the arrangement may be such that the number of rows and lines of dots which form image data is increased or decreased,
15 so that the width and height of an image become wide or narrow. Thus, the CPU 5 changes, at any time, displayed contents in accordance with a display position of the contents, and this allows the user to view the contents as if viewing the contents displayed in a normal position.

Further, in the foregoing arrangement, the CPU 5 uses a
20 bitmap font to correct a position in which a left radical and a right radical of the character data are combined. However, the arrangement is not so limited but may be such that a bitmap font is used for example to correct the "widths" of a left
25 radical and a right radical.

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Alternatively, an arrangement may be such that the CPU
5 uses a bitmap font to correct a position in which various radicals (e.g., *kammuri*, *kashira* and *kamae*) of the character data are combined.

5 Alternatively, an arrangement may be such that a position in which one character based on the character data are combined with another is corrected in such a way that a gap between the characters is adjusted.

10 Further, in the foregoing arrangement, the display device is the curved LCD 1. However, the display device is not so limited but may be a display, such as an organic EL display, an inorganic EL display, a head up display, or a plasma display, which has a display screen of a curved surface shape.

15 Further, in the foregoing arrangement, the display device is mounted on a vehicle such as an automobile so as to show navigation information, television broadcasts, and images of the surroundings around the automobile. However, an application of the display device is not so limited. For example, the display device may be a television display device
20 which is connected to a television receiving device so as to show an received image. Alternatively, the display device may be connected to a VCR (video cartridge recorder), a PC (personal computer), a DVD player or the like so as to show image data outputted from these devices. Alternatively, the
25 display device may be integrated into these devices.

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Further, for example, the display device may be provided as an automobile instrument panel so as to display instruments such as a speedometer, a tachometer, a water temperature gauge, and an oil pressure gauge. Further, the display device may simultaneously or selectively show instruments such as a speedometer, navigation information, television broadcasts, and images of the surroundings around the automobile. Further, the display device may be mounted not only on an automobile but also on various vehicles such as a two-wheeled motor vehicle, a bicycle, an airplane, a helicopter, and a ship so as to show instruments, navigation information, television broadcasts, radar, and the like. Further, the display device may be mounted not only on a vehicle but also on devices such as a mobile phone, a PHS (Personal Handyphone System, registered trademark), a PDA (personal digital assistant), a laptop computer, and a clock.

Further, in the foregoing arrangement, the display screen has a horizontally curved shape. However, a shape of the display screen is not so limited, and the display screen only needs to have a non-flat surface shape. For example, the display screen may have a shape which is curved up and down. Alternatively, the display screen may have a shape which is curved from right to left and up and down, e.g., a spherical surface shape. Furthermore, the curvature of a curved portion of the display screen may vary by position on

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the display screen or may be constant. Further, the display screen may be a plurality of flat surface shapes combined in a curved surface manner or a combination of a flat surface shape and a curved surface shape.

5 Further, in case of a display device having a shape which is curved from right to left and up and down, a single character may be corrected so that a ratio of width between an upper part and a lower part of the character is different, or a ratio of height between a left part and a right part of the
10 character is different. For example, plural characters may be corrected so that a ratio of width between an upper part and a lower part of one character differs from a ratio of width between an upper part and a lower part of another character, or a ratio of height between a left part and a right part of one
15 character differs from a ratio of height between a left part and a right part of another character.

 Further, the display screen of the display section 7 is a concave display screen whose center portion is curved away from the user. However, the display screen is not so limited.
20 For example, the display screen may be a convex display screen whose center portion is curved closer to the user.

 Further, in the foregoing arrangement, the display screen is a super-wide screen at an aspect ratio (horizontal to vertical ratio) of 7:3 or more. However, an aspect ratio of the
25 display screen is not so limited but may be 4:3, like that of a

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conventional television, or 15:9, like that of a wide-screen television.

Further, a shape of the display screen is not particularly limited. For example, the display screen may have a circular
5 or elliptical flat surface which is curved concavely and convexly. Further, the display screen needs to be neither diphyccercal nor symmetrical.

Further, in the foregoing description, all processes in the curved LCD 1 are executed under the control of the CPU 5.
10 However, this is not for the purpose of limitation. A program for executing these processes may be stored in a storage medium, and an information apparatus capable of reading out the program may be used instead of the CPU 5.

According to this arrangement, an operational device
15 (CPU or MPU) of an information processing apparatus reads out a program from a storage medium so as to execute a process. Therefore, it can be said that the program per se achieves the process.

Used as the information processing apparatus are a
20 general computer (i.e., a workstation and a personal computer) and a function enhancement board or unit connected to a computer.

Further, the program means a software program code (e.g., an executable format program, an intermediate code
25 program, and a source program) which achieves a process.

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The program may be used individually or in combination with another program (e.g., OS). Further, the program may be read out from a storage medium, stored temporarily in a memory (e.g., RAM) in the information processing apparatus, and re-read out so as to be executed.

Further, a storage medium in which the program is stored may be easily separated from the information processing apparatus or may be fixed to (mounted on) the information processing apparatus. Furthermore, the storage medium may be connected as an external storage device to the information processing apparatus.

Used as such a storage medium are a magnetic tape (e.g., a videotape and a cassette tape), a magnetic disk (e.g., a floppy (registered trademark) disk and a hard disk), an optical disk (a magneto-optical disk) (e.g., a CD-ROM, a MO, a MD, a DVD, and a CD-R), a memory card (e.g., an IC card and an optical card), and a semiconductor memory (e.g., a mask ROM, an EPROM, an EEPROM, and a flash ROM).

Further, it is also possible to use a storage medium which is connected to the information processing apparatus through a network (i.e., an intranet or the Internet). In this case, the information processing apparatus downloads the program through the network so as to acquire the program. That is, the program may be acquired through a transmission medium (a medium which retains the program in a flowing

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manner) such as a network (connected to a wireless line or a wired line). Note that it is preferable that a download program be prestored in the information processing apparatus (or a transmitting device or a receiving device).

5 The present invention is not limited to those embodiments described above but can be varied in many ways within the scope of the following claims. That is, embodiments obtained by combining the technical means appropriately varied within the scope of the following claims are also
10 included in the technical scope of the present invention.

 A display device according to the present invention is a display device displaying an image on a display screen having a non-flat surface shape, the display device including: control means for correcting, in accordance with a display position of
15 an image on the display screen, image data based on which the image is displayed on the display screen.

 According to the foregoing arrangement, the control means corrects, in accordance with a display position of an image on the display screen, image data based on which the
20 image is displayed on the display screen. This for example allows the user to view an image displayed on the display screen having a non-flat surface shape as if viewing an image displayed on a display screen having a flat surface shape.

 The invention being thus described, it will be obvious
25 that the same way may be varied in many ways. Such

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variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

5

INDUSTRIAL APPLICABILITY

The present invention can be applied to a display device in general whose display screen has a non-flat surface shape. For example, the present invention can be applied to an EL display, an LCD, a plasma display, and the like. Further, a display device of the present invention can serve various uses for an image display device (e.g., a television set and a monitor) and an OA device (e.g., a word processor and a personal computer) or an image display device mounted on an information terminal (e.g., a video camera, a digital camera, and a mobile phone), a clock, and the like. Further, it may be mounted on a vehicle such as an automobile.

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CLAIMS

1. A display device displaying an image on a display screen having a non-flat surface shape, the display device comprising:

control means for correcting, in accordance with a display position of an image on the display screen, image data based on which the image is displayed on the display screen.

2. A display device displaying an image on a display screen having a non-flat surface shape, the display device comprising:

control means for correcting, in accordance with a display position of a character, character data based on which the character is displayed on the display screen.

3. A display device displaying an image on a display screen having a non-flat surface shape, the display device comprising:

character presence/absence determination means for determining whether image data based on which the image is displayed on the display screen contains character data or not; and

control means for at least correcting, in a case where the image data based on which the image is displayed contains

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the character data, the character data in accordance with a display position of a character based on the character data.

4. The display device according to Claim 2 or 3, wherein
5 the control means corrects a shape of the character.

5. The display device according to Claim 2 or 3, wherein
the control means corrects a relative position of one
component of the character with respect to another
10 component, the character being based on the character data
contained in the image data based on which the image is
displayed.

6. The display device according to Claim 2 or 3, wherein
15 the control means corrects coordinate data forming an outline
of the character based on the character data contained in the
image data based on which the image is displayed.

7. The display device according to Claim 2 or 3, wherein
20 the control means corrects a relative position of one character
with respect to another character.

8. The display device according to Claim 1, wherein the
control means corrects, in accordance with a position of a
25 user with respect to the display screen, the image data based

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on which the image is displayed in each position on the display screen.

5 9. The display device according to Claim 8, further comprising a detection means for detecting the position of the user with respect to the display screen.

10 10. The display device according to Claim 8, further comprising instruction input means for receiving an instruction from the user, wherein

the control means determines, in accordance with the instruction given by the user to the instruction input means, the position of the user with respect to the display screen.

15 11. The display device according to Claim 1, wherein the display screen includes a liquid crystal panel.

20 12. A vehicle comprising a display device according to Claim 1.

25 13. A method for displaying an image on a display screen having a non-flat surface shape, the method comprising the step of:

correcting, in accordance with a display position of an image on the display screen, image data based on which the

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image is displayed on the display screen.

5 14. A display program causing a computer mounted on a display device to function as control means of the display device according to Claim 1.

 15. A storage medium storing the display program according to Claim 14.

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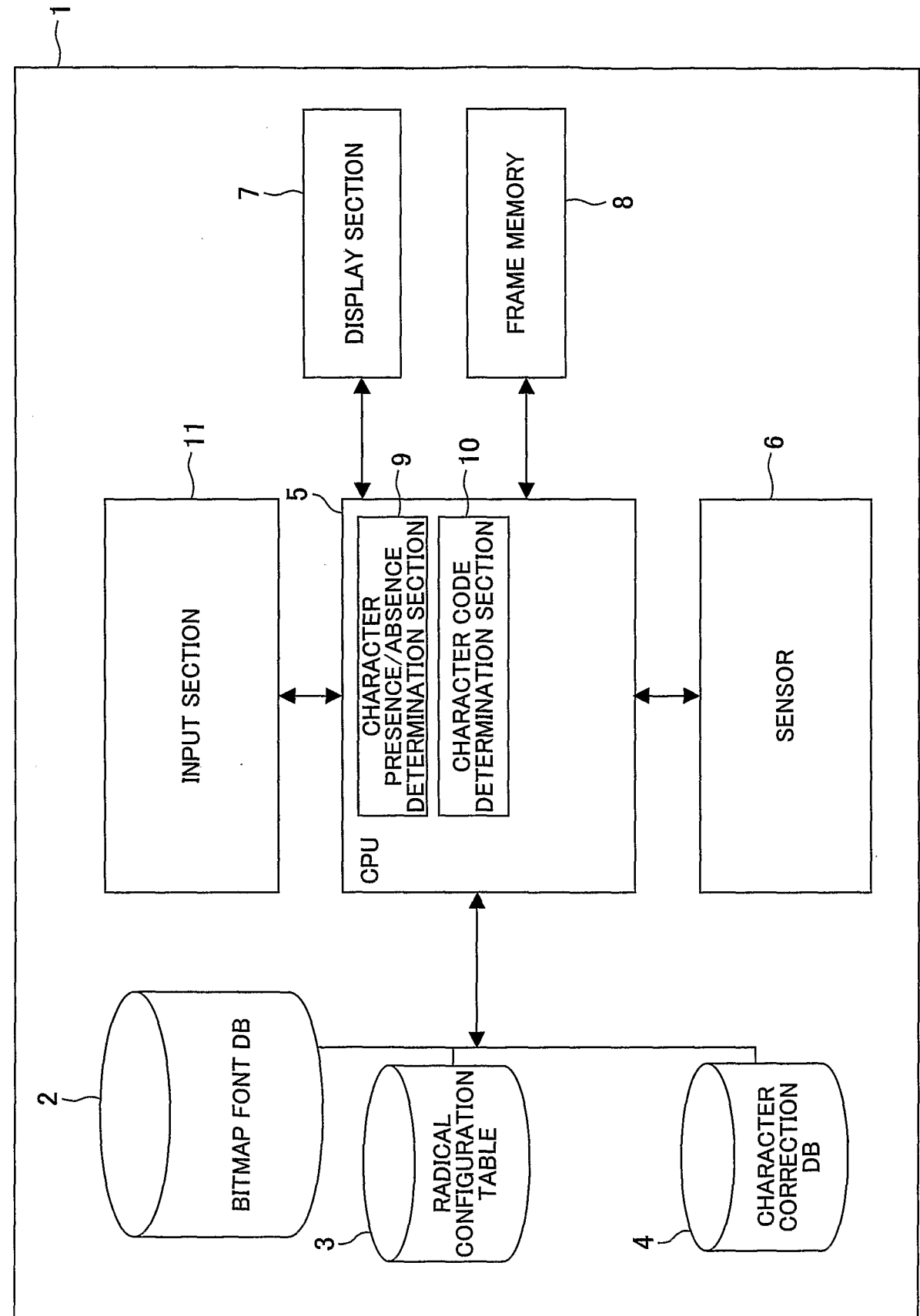


FIG. 1

FIG. 2

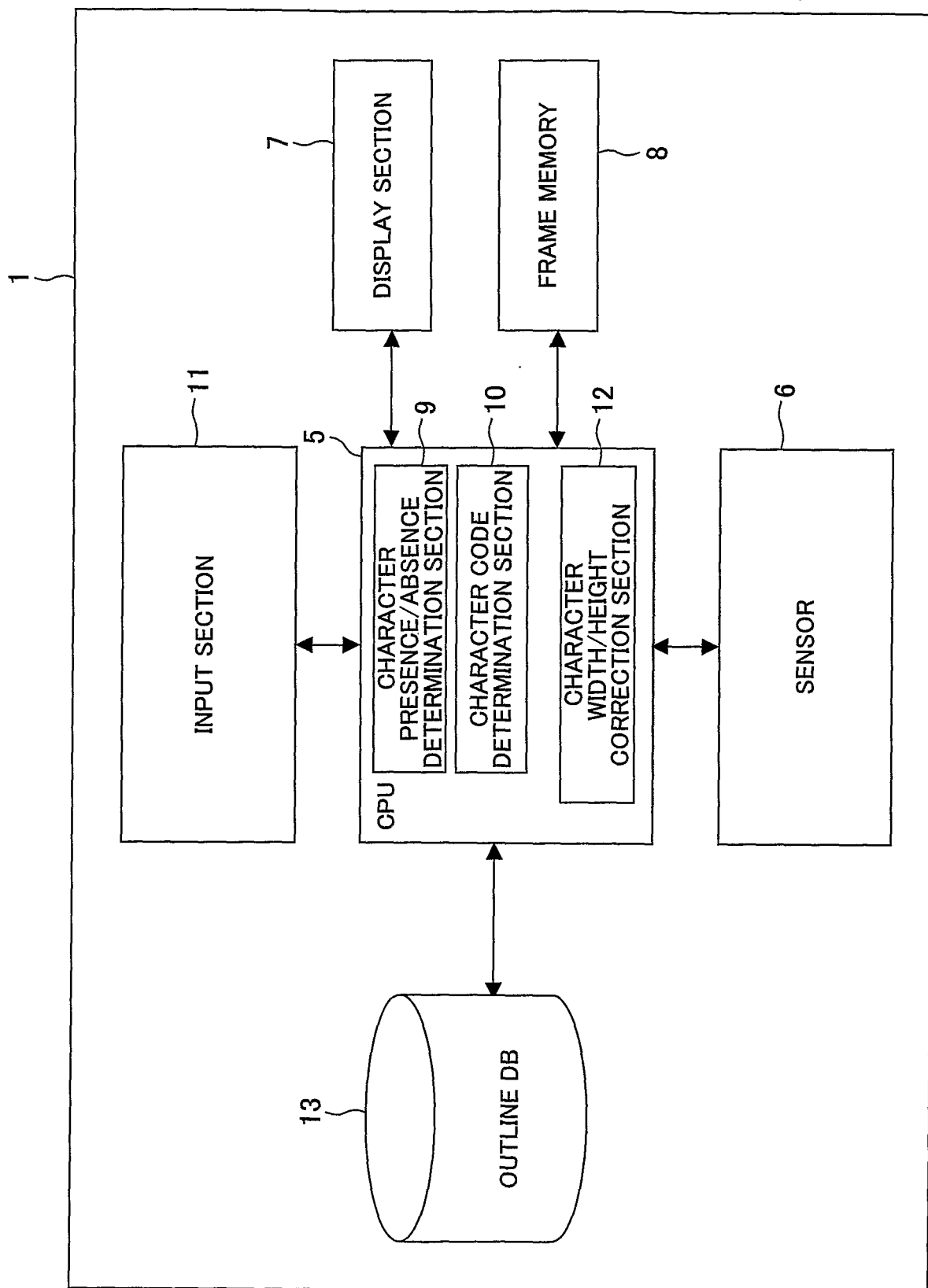
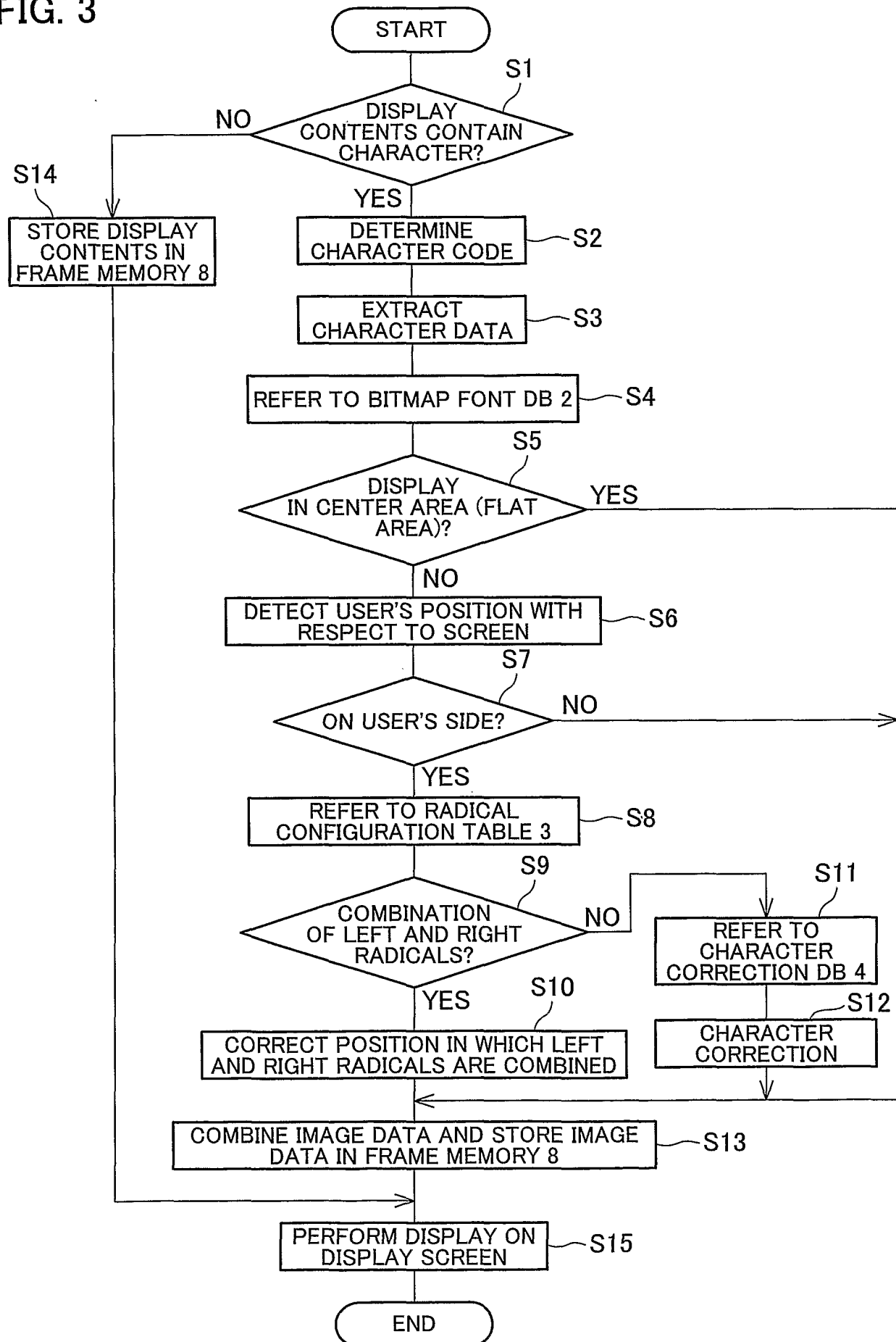


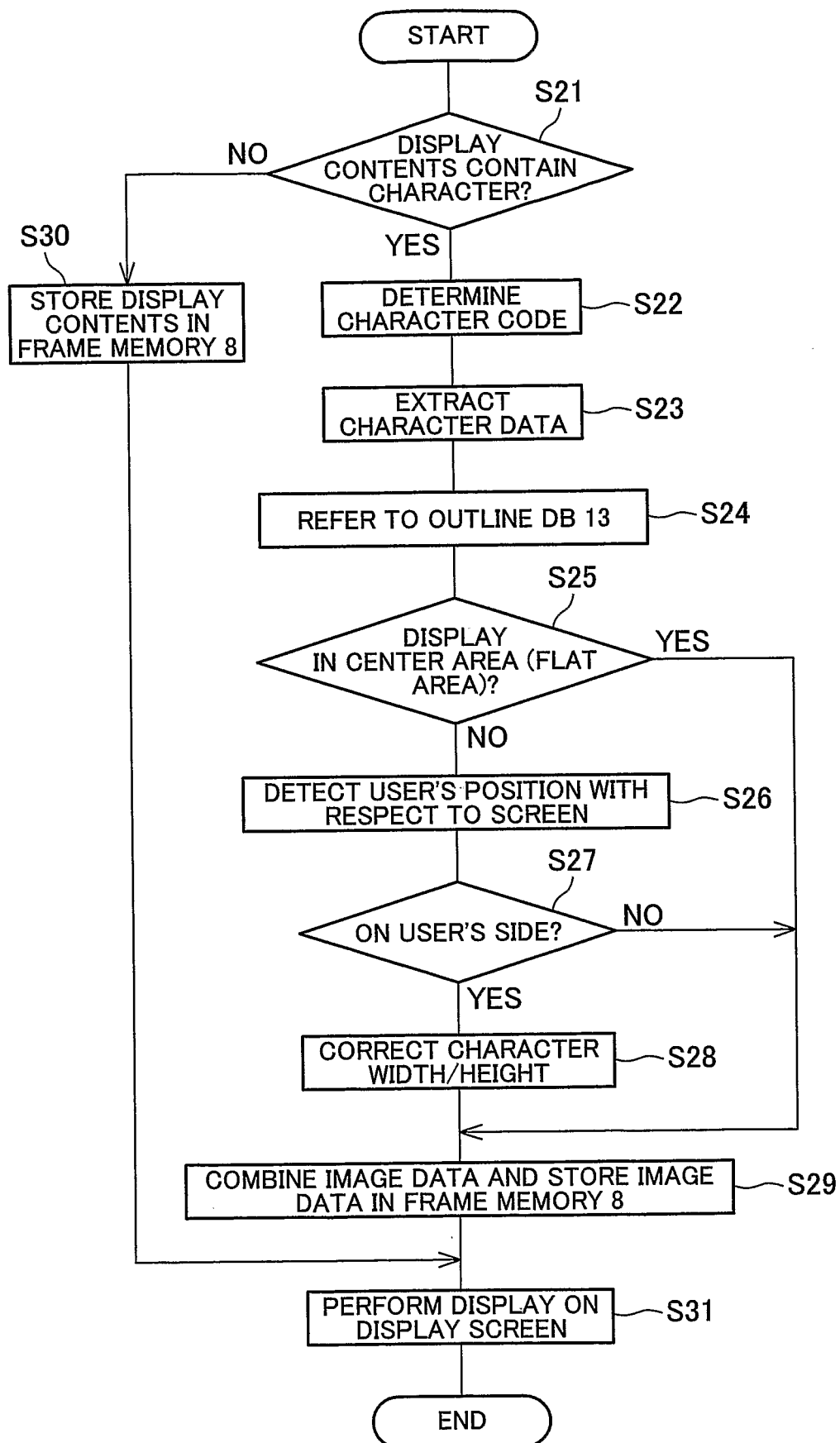
FIG. 3

3/10



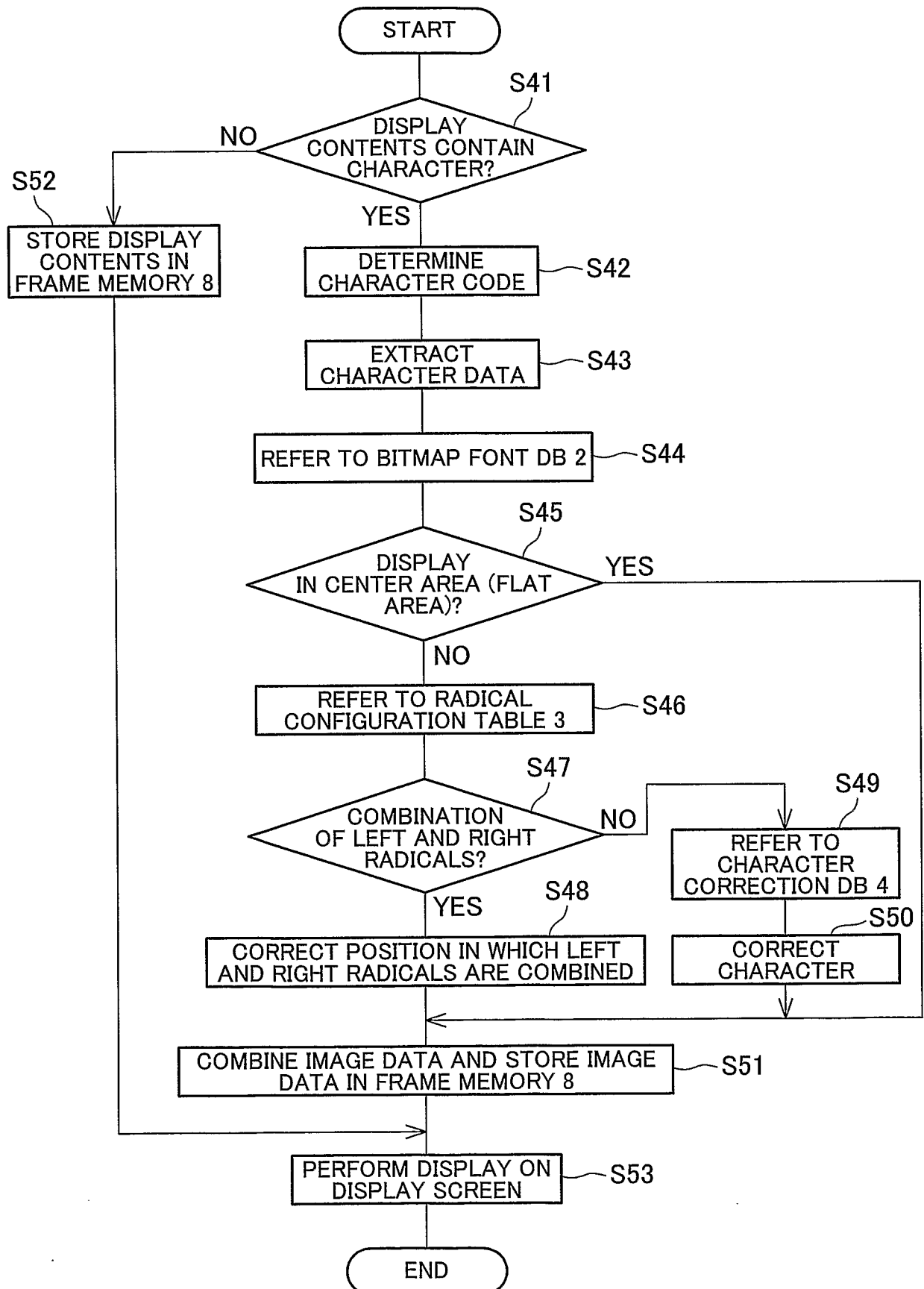
4/10

FIG. 4



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FIG. 5



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FIG. 6

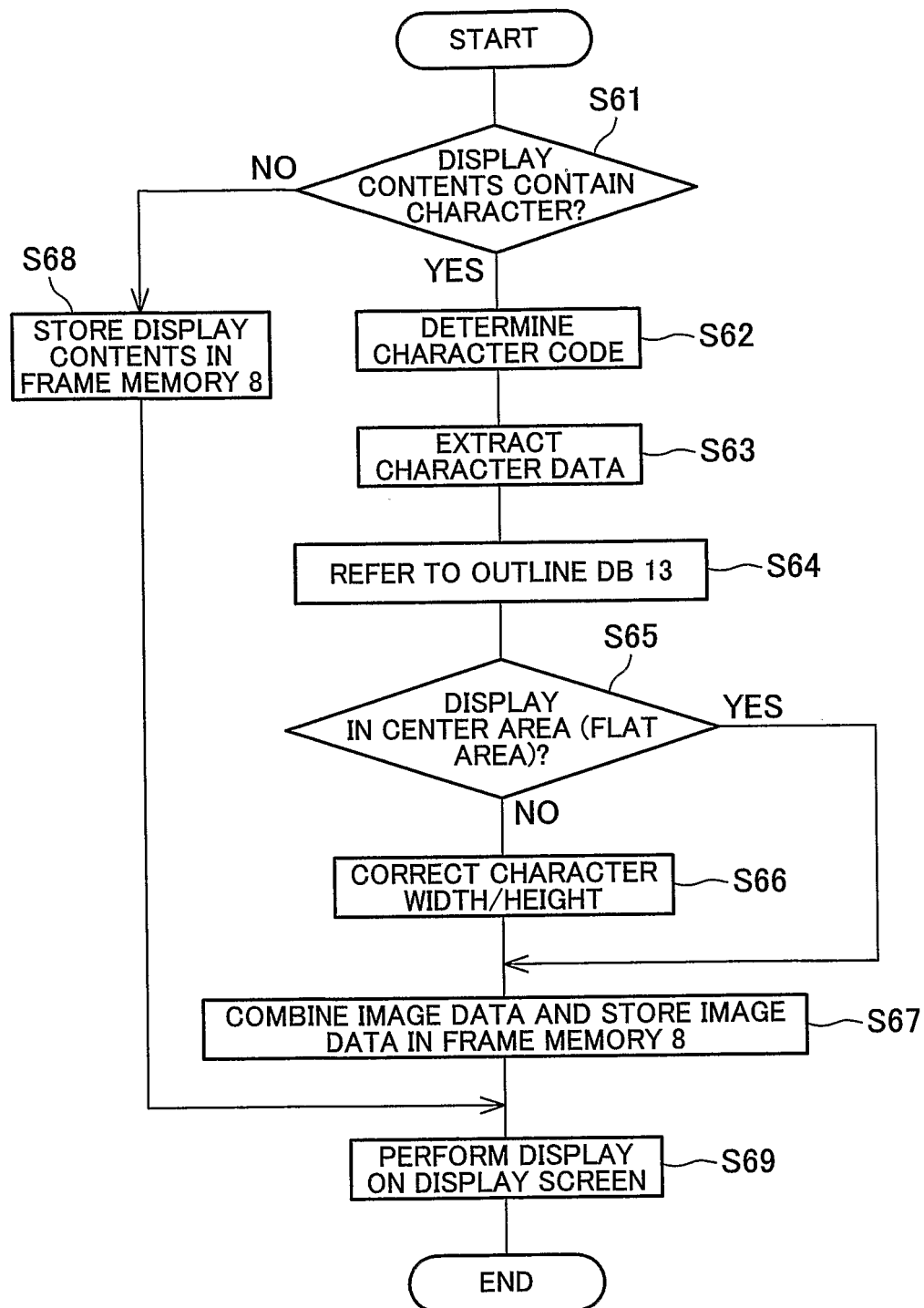
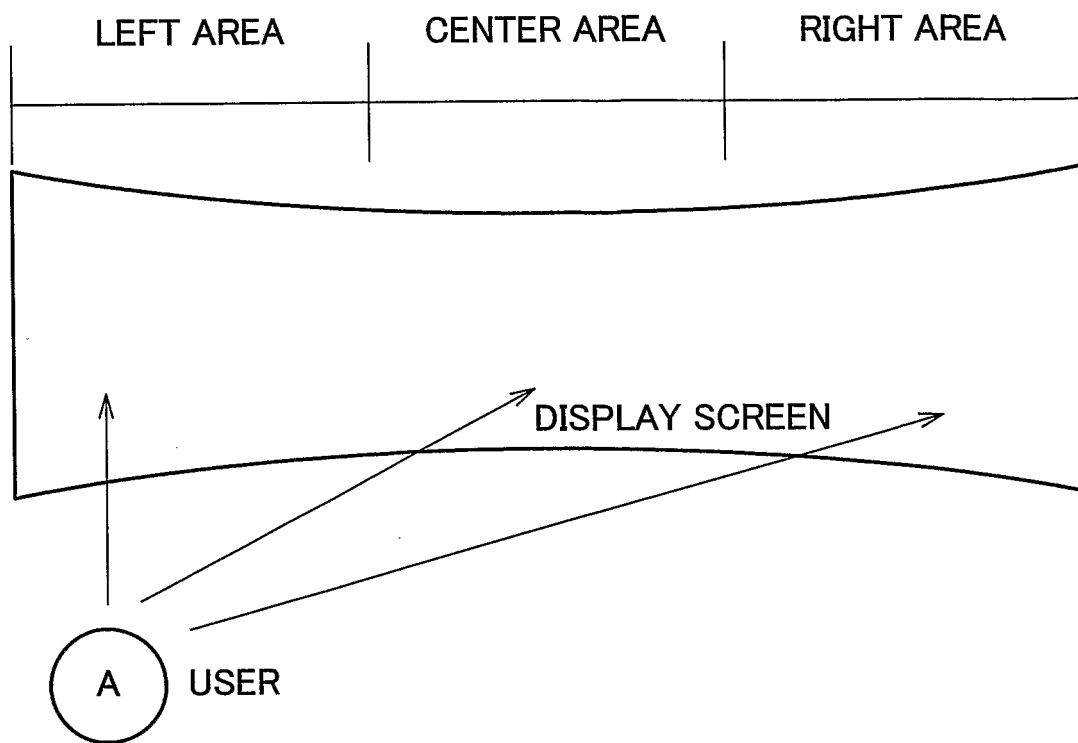


FIG. 7



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FIG. 8 (a)

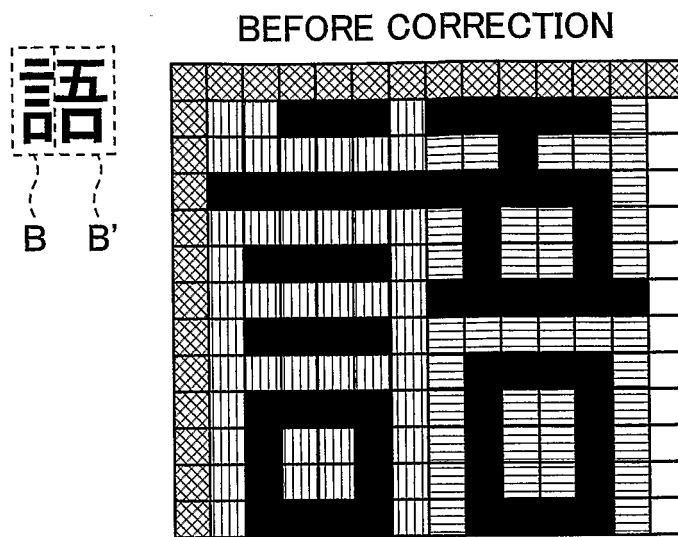
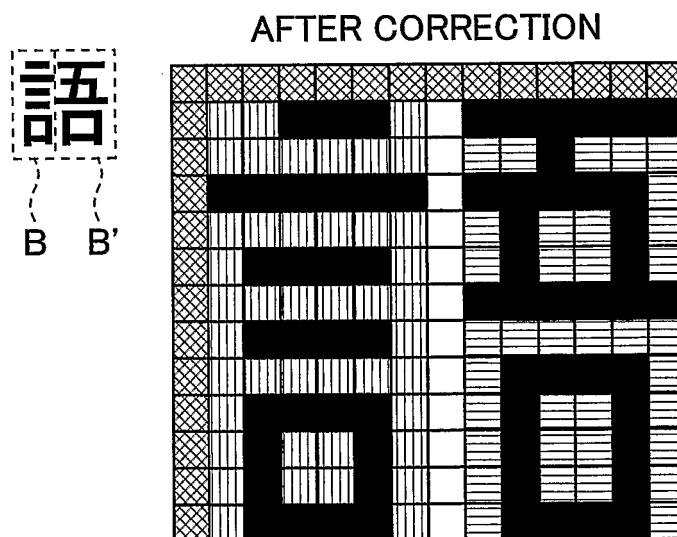


FIG. 8 (b)



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FIG. 9 (a)

高

BEFORE CORRECTION

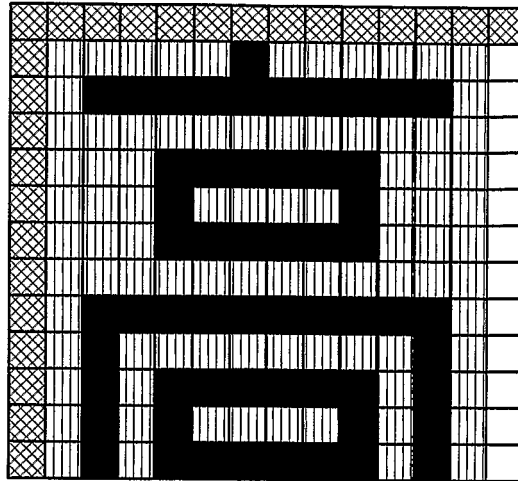


FIG. 9 (b)

高

AFTER CORRECTION

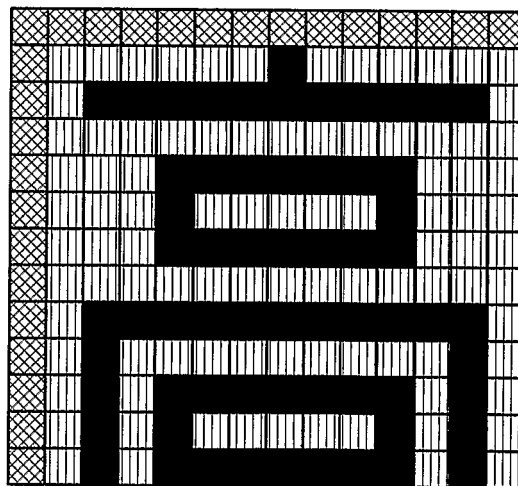
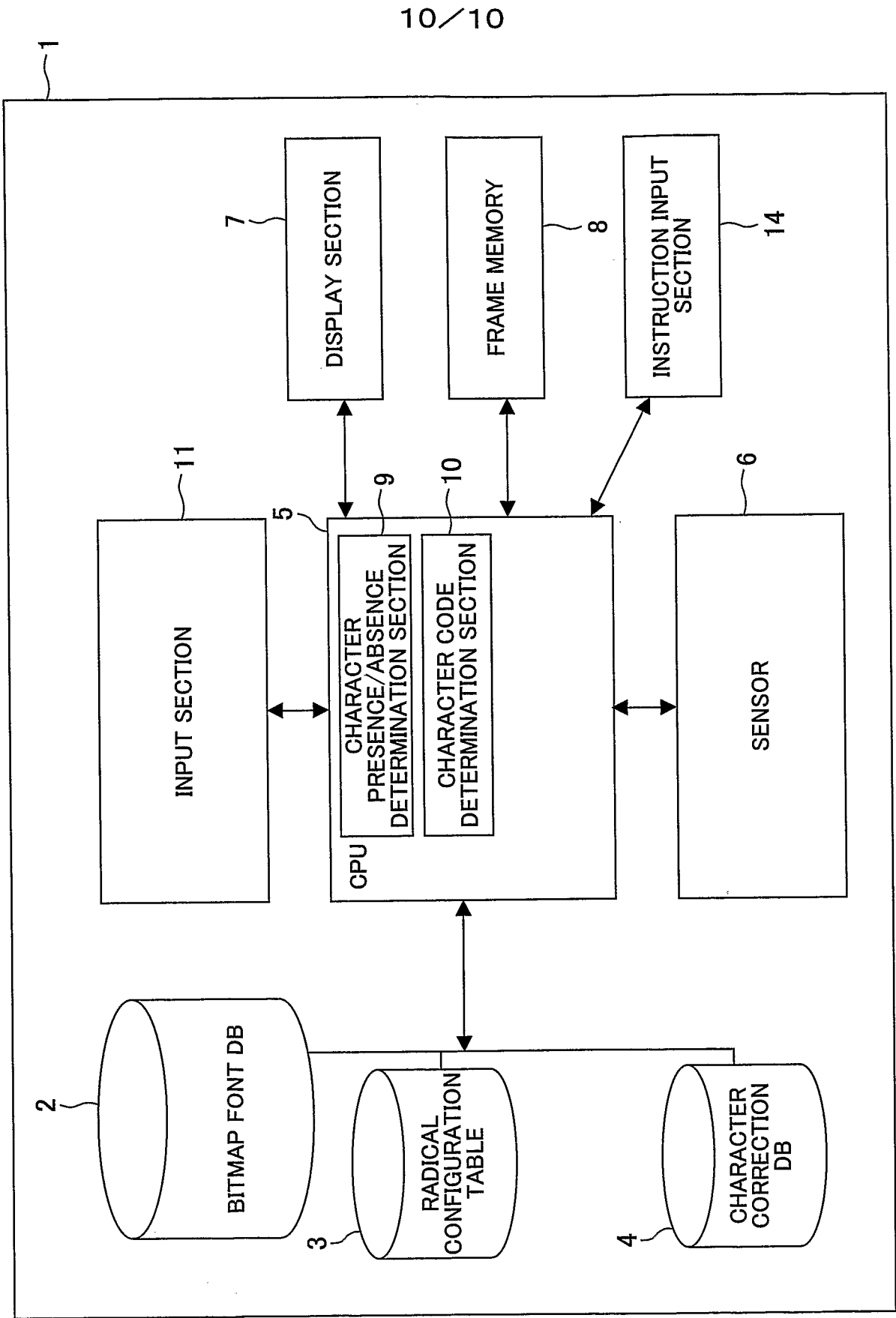


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/012979

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl.⁷ G09G5/00, 5/24, 3/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl.⁷ G09G1/00-5/42

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2005
 Registered utility model specifications of Japan 1996-2005
 Published registered utility model applications of Japan 1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2002-6797 A (MINOLTA CO LTD) 2002.01.11	1-2, 4, 6, 11, 13-15
Y	claim 14, [0064]-[0080], Fig. 5 to Fig. 8	8-10, 12
A	(Family: none)	3, 5, 7
Y	JP 10-28232 A (HITACHI LTD) 1998.01.27 claim 1-3, [0004]-[0009], [0028]-[0029], Fig. 1, Fig. 6 (Family: none)	8-10
Y	US 2002/0039229 A1 (NISSAN MOTOR CO LTD) 2002.04.04 [0003], [0033]-[0036], Fig. 7A, 7B &JP 2002-104024 A &EP 1195637 A1	12

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

07.09.2005

Date of mailing of the international search report

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INTERNATIONALSEARCHREPORT

International application No.

PCT/JP2005/012979

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-78121 (SHARP KABUSHIKI KAISHA) 2004.03.11 see whole document (Family: none)	1-15
A	JP 57-2082 A (CASIO COMPUTER CO LTD) 1982.01.07 see whole document (Family: none)	1-2, 13-15
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