

(51) International Patent Classification:
H04N 5/74 (2006.01)(21) International Application Number:
PCT/CN2015/079933(22) International Filing Date:
27 May 2015 (27.05.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/003,260 27 May 2014 (27.05.2014) US
62/034,952 8 August 2014 (08.08.2014) US(71) Applicant: **MEDIATEK INC.** [CN/CN]; No.1, Dusing
Road 1st, Science-Based Industrial Park, Hsin-Chu,
Taiwan (CN).(72) Inventors: **LIU, Tsu-Ming**; 6F., No.6, Ln.148, Xinzhuang
St., Hsinchu City, Taiwan (CN). **CHANG, Chih-Kai**; No.
23-7, Ln. 170, Wenxin S. 2nd Rd., Nantun Dist., Taichung
City, Taiwan (CN). **JU, Chi-Cheng**; 9F.-2, No. 42, Lushui
Rd., Hsinchu City, Taiwan (CN). **WANG, Chih-Ming**;
8F., No.150, Wencai St., Zhubei City, Hsinchu County,
Taiwan (CN).(74) Agent: **BEIJING SANYOU INTELLECTUAL PROP-
ERTY AGENCY LTD.**; 16th Fl., Block A, Corporate
Square, No. 35 Jinrong Street, Beijing 100033 (CN).(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: PROJECTION PROCESSOR AND ASSOCIATED METHOD

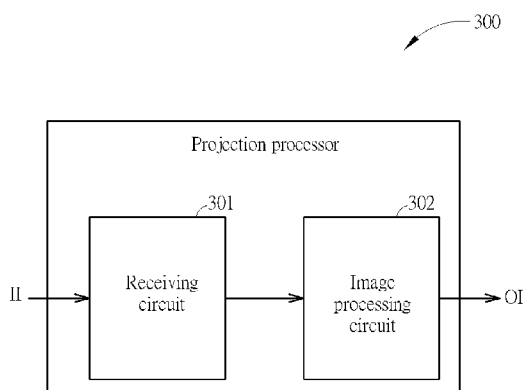


FIG. 3

(57) Abstract: A projection processor includes a receiving circuit and an image processing circuit. The receiving circuit receives an input image. The image processing circuit performs at least one predetermined image processing operation upon the input image to generate an output image, wherein a projection source is generated according to the output image. The projection source is displayed or projected by a projection source component of an electronic device, such that a first cover of a projection display component partially reflects the projection source.

PROJECTION PROCESSOR AND ASSOCIATED METHOD

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 62/003,260, filed on May 27th, 2014, and U.S. Provisional Application No. 62/034,952, filed on August 8th, 2014. The
5 entire contents of the related applications are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to image processing, and more particularly, to a projection processor and associated method.

BACKGROUND

10 Devices which can provide customers with high-quality visual effects are desirable because of the recent progress in multimedia entertainment systems. In particular, 3D display technology has been receiving more attention because of its superior visual effects and vivid images. For customers, using 3D glasses results in an uncomfortable experience, but holographic display is too expensive to be widely acceptable for most users.

SUMMARY

15 One of the objectives of the present invention is to provide a projection processor and associated method applied in the projection processor.

According to an embodiment of the present invention, an exemplary projection processor is disclosed. The exemplary projection processor includes a receiving circuit and an image processing
20 circuit. The receiving circuit is arranged to receive an input image. The image processing circuit is arranged to perform at least one predetermined image processing operation upon the input image to generate an output image, wherein a projection source is generated according to the output image. The projection source is displayed or projected by a projection source component of an electronic device, such that a first cover of a projection display component partially reflects the projection
25 source.

According to an embodiment of the present invention, an exemplary projection method employed by a projection processor is disclosed. The exemplary projection method includes: receiving an input image; and performing at least one predetermined image processing operation upon the input image to generate an output image, wherein a projection source is generated
5 according to the output image. The projection source is displayed or projected by a projection source component of an electronic device, such that a first cover of a projection display component partially reflects the projection source.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment
10 that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG.1 is a schematic illustrating a projection display component of an electronic device according to an embodiment of the present invention.

FIG. 2 is a diagram illustrating the projection display component extended for projection
15 according to an embodiment of the present invention.

FIG.3 is a diagram illustrating a projection processor of an electronic device carried by a projection display component according to an embodiment of the present invention.

FIG. 4 is a diagram illustrating the image processing circuit of the projection processor according to an embodiment of the present invention.

FIG. 5 is a diagram illustrating a working condition of an image flip engine according to an
20 embodiment of the present invention.

FIG. 6 is a flowchart illustrating an image flip operation performed by the image flip engine according to an embodiment of the present invention.

FIG. 7 is a diagram illustrating a working condition of an image distortion correction circuit
25 according to an embodiment of the present invention.

FIG. 8 is a diagram illustrating a working condition of the image distortion correction circuit according to another embodiment of the present invention.

FIG. 9 is a flowchart illustrating an image distortion correction operation performed by the image distortion correction circuit according to an embodiment of the present invention.

FIG. 10 is a diagram illustrating a working condition of an image segmentation engine
30 according to an embodiment of the present invention.

FIG. 11 is a diagram illustrating a working condition of the image segmentation engine according to another embodiment of the present invention.

FIG. 12 is a flowchart illustrating an image segmentation operation performed by the image segmentation engine according to an embodiment of the present invention.

FIG. 13 is a flowchart illustrating an image enhancement operation performed by the image enhancement engine according to an embodiment of the present invention.

FIG. 14 is a diagram illustrating a data processing system employing the projection processor according to an embodiment of the present invention.

FIG. 15 is a diagram illustrating a photograph application for the projection processor installed
10 in the data processing system according to the embodiment of FIG. 14.

FIG. 16 is a diagram illustrating a recording application for the projection processor installed in the data processing system according to the embodiment of FIG. 14.

FIG. 17 is a diagram illustrating a video playback application for the projection processor installed in the data processing system according to the embodiment of FIG. 14.

FIG. 18 is a diagram illustrating a gaming application for the projection processor installed in the data processing system according to the embodiment of FIG. 14.

FIG. 19 is a diagram illustrating a gallery application for the projection processor installed in the data processing system according to the embodiment of FIG. 14.

DETAILED DESCRIPTION

Certain terms are used throughout the following description and claims, which refer to particular components. As one skilled in the art will appreciate, electronic equipment manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not in function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to ...". Also, the term "couple" is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is coupled to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections.

30 Refer to FIG. 1 and FIG. 2. FIG. 1 is a schematic illustrating a projection display component
100 for an electronic device 101 according to an embodiment of the present invention. The sub-
diagram (A) of FIG. 1 shows a perspective view of the electronic device 101 carried by the

projection display component 100. The sub-diagram (B) of FIG. 1 shows a sectional view along line X-X' of the electronic device 101 and the projection display component 100 shown in sub-diagram (A). FIG. 2 is a diagram illustrating the projection display component 100 unfolded for projection according to an embodiment of the present invention. It should be noted that the electronic device 101 may be integrated with the projection display component 100. However, it is not a limitation of the present invention. In other embodiments, the electronic device 101 may be detachably placed onto a carrier of the projection display component 100 via physical connection, where the carrier is arranged to carry the electronic device. The carrier may be part of the electronic device 101 or an independent structure other than the electronic device 101. To put it simply, the present invention has no limitation on the engagement or integration of the electronic device 101 and the projection display component 100. Any electronic device using the proposed projection display component falls within the scope of the present invention.

As shown in FIG. 1 and FIG. 2, the projection display component 100 is arranged to place the electronic device 101 and is also a projection set when it is unfolded. The projection display component 100 may comprise at least one of a carrier CA, a first cover C1, a second cover C2, a base plate BP and an optical set OS. When the projection display component 100 is unfolded for projection, as shown in FIG. 2, the first cover C1 is arranged to partially reflect an image of a projection source PS generated from the electronic device 101, such that a projected image PI may be shown through the first cover C1. In detail, some intensity of the projected image PI may be projected through the first cover C1, and some other intensity of the projected image PI may be reflected by the first cover C1, such that the first cover C1 partially reflects the image of the projection source PS. As a result, a user may see the projected image displayed on the first cover C1 or floating behind the first cover C1. In some embodiments, a display panel of the electronic device 101, such as an LCD panel or any other passive or active display panel, may be taken as a projection source component PSC to display the image. In some other embodiments, a solid-state (laser or LED) light or any other type of light source may be taken as a projection source component PSC to project the image. Accordingly, a user may see the projected image PI displayed on or behind the first cover C1. The second cover C2 is arranged to adjust an angle between the second cover C2 and the electronic device 101, such that a projection direction of the projected image PI from the projection source PS to the first cover C1 may be adjusted. The base plate BP is arranged to adjust a distance between the first cover C1 and the electronic device 101, wherein the base plate BP is detachable, foldable or extendible. The optical set OS may be placed between the first cover C1 and the electronic device 101. For example, the optical set OS is arranged to redirect a projected direction of the projected image, such that a user may see the projected image PI with

adjusted size displayed on or behind the first cover C1. It should be noted that the projection display component 100 shown in FIG. 1 is only an example.

In the embodiment of FIG. 2, the first cover C1, the second cover C2, and the optical set OS may be respectively attached to the base plate BP via a first hinge set HS1 (which may include one or more hinge mechanisms), a second hinge set HS2 (which may include one or more hinge mechanisms), and a third hinge set HS3 (which may include one or more hinge mechanisms). Therefore, a first angle between the base plate BP and the first cover C1, a second angle between the base plate BP and the second cover C2, or the angle between the second cover C2 and the electronic device 101 may be adjustable. In some embodiments, but not limitation, the first hinge set HS1, the second hinge set HS2 or the third hinge set HS3 may be implemented using magnetic hinge sets, so that the first cover C1, second cover C2 or the optical set may be detachable. In some other embodiments, the first hinge set HS1, the second hinge set HS2 and the third hinge set HS3 may include any other type of hinge mechanisms, which should not be limited in this disclosure. The optical set or the second cover C2 may be removable.

FIG.3 is a diagram illustrating a projection processor 300 to provide an image to an electronic device 101 carried by a projection display component 100 according to an embodiment of the present invention. The projection processor 300 may have a receiving circuit 301 and an image processing circuit 302. It should be noted that only the components pertinent to the present invention are shown in FIG. 3. In practice, the projection processor 300 may include additional element(s) to achieve other function(s). The receiving circuit 301 is arranged to receive an input image II and transmits the input image II to the image processing circuit 302. For example, the input image II may be a single-view image (e.g., a two-dimensional image) or a multi-view image (e.g., an image pair of a left-view image and a right-view image, or multiple images captured or generated for different viewing angles of the same scene/object). The image processing circuit 304 is arranged to perform at least one predetermined image processing operation on the input image II to generate an output image OI, wherein the projection source PS shown in FIG. 2 is generated according to the output image OI.

It should be noted that the projection processor 300 may be a processor installed within the electronic device 101 and may transmit the output image OI via an internal bus of the electronic device 101; however, in other embodiments, the projection processor 300 may be installed within another device external to the electronic device 101 and may transmit the output image OI to the electronic device 101 via wired/wireless transmission. Furthermore, the projection processor 300 can be applied to a 2D image projection application or 3D image projection application, which is

not limited in the present invention. These alternative designs should fall within the scope of the present invention.

FIG. 4 is a diagram illustrating the image processing circuit 302 of the projection processor 300 according to an embodiment of the present invention. As shown in FIG. 4, the image processing circuit 302 may comprise at least one of an image flip engine 401, an image distortion correction engine 402, an image segmentation engine 403, an image enhancement engine 404 and a notification circuit 405. It should be noted that this embodiment is for illustrative purposes only. In practice, the input image II is not required to be processed in the exact order shown in FIG. 4. The arrangement of the image flip engine 401, the image distortion correction engine 402, the image segmentation engine 403 and the image enhancement engine 404 may be adjusted, depending upon the actual design considerations. Further, at least one of the image flip engine 401, the image distortion correction engine 402, the image segmentation engine 403, the image enhancement engine 404 and a notification circuit 405 may be omitted, depending upon the actual design considerations.

The image flip engine 401 is arranged to perform an image flip operation. In some embodiments, the image flip engine 401 performs an image flip operation to ensure that an orientation of the projected image PI matches an orientation of the input image II. In some other embodiments, the image flip engine 401 performs an image flip operation to ensure that a user can see the projected image PI shown on or behind the first cover C1 with a correct orientation. The image distortion correction engine 402 is arranged to perform the image distortion correction operation to correct an appearance of the projection source PS. The image segmentation engine 403 is arranged to perform an image segmentation operation and change a background of a segmented image to generate the projection source PS. The image enhancement engine 404 is arranged to perform an image enhancement operation to adjust a brightness of the projection source PS, a brightness of the background or a contrast of the whole image. The notification circuit 405 is arranged to control the electronic device 101 to show a projection notice PN according to the status of at least one of the image flip engine 401, the image distortion correction engine 402, the image segmentation engine 403, the image enhancement engine 404, and the projection display component 100, as the status of the projected image PI or any other factors may result in a poor user experience.

FIG. 5 is a diagram illustrating an embodiment of the optical set OS of the present invention. As shown in FIG. 5, two convex lenses L1 and L2 are included to form the optical set OS for projection. According to optical principles of image forming using convex lenses, a user may see that the orientation of the projected image PI is reversed with respect to the orientation of the

projection source PS after projecting through the optical set OS. In this case, the image flip engine 401 may flip the projection source PS (e.g. upside down or reversing left to right) to ensure that the orientation of the projected image PI matches the orientation of the input image II. For example, the reverse projected image can be detected by a sensor installed on the second hinge set HS2 for detecting distances of the lenses. However, it is only for illustrative purpose. In other embodiments, the sensor can be installed on any other place of the projection display component 100 for achieving the same goal. Once the distances fit the condition of reverse image formation, the image flip engine 401 flips the projection source PS. More specifically, as shown in FIG. 5, the projection source PS is reflected by the lens L1 and forms a reflected image RI on the other side of the lens L1, wherein the reflected image RI is reversed with respect to the projection source PS due to the projection source PS is disposed between the focal point f and the twofold focal point $2f$ of the lens L1. Then, the reflected image RI is reflected by the lens L2 and forms the projected image PI, wherein the projected image PI is reversed with respect to the projection source PS as well due to the reflected image RI is disposed in the focal point of the lens L2. In other embodiments, the detection can be done by other means, such as a sensor installed in the base plate BP to detect the distances of the lenses, or a front camera of the electronic device 101 to capture the projected image PI for analysis. These alternative designs fall within the scope of the present invention. In another embodiment, when a user sets the first cover C1 on the wrong side of the electronic device 101 causing that a user may see the projected image PI shown on or behind the first cover C1 with a wrong orientation, the image flip engine 401 may flip the projection source PS. Similarly, the detection may be done by a sensor installed in the first hinge set HS1. However, it is only for illustrative purpose. In other embodiments, the sensor can be installed on any other place of the projection display component for achieving the same goal.

FIG. 6 is a flowchart illustrating an image flip operation performed by the image flip engine 401 according to an embodiment of the present invention. The flow shown in FIG. 6 is described as follows.

Step 600: Start.

Step 602: The user may enable the projection display mode.

Step 604: The image flip engine 401 may check if the projection display component 100 is set correctly. If yes, the flow goes to step 606; otherwise, it goes to step 610.

Step 606: The image flip engine 401 may check if the orientation of the projected image PI is identical with the input image PI. If yes, the flow goes to step 612; otherwise, it goes to step 608.

Step 608: The image flip engine 401 performs the image flip operation.

Step 610: The notification circuit 405 controls the electronic device 101 to show the projection notice PN.

Step 612: End.

In step 604, if there is an incorrect setting which may cause a fail projection (for example, the optical set OS or the first cover C1 is not attached to the base plate BP), an incorrect setting which may cause the size of the projected image PI too small or too large, or an incorrect setting which may cause that the user can not observe the projected image PI correctly, the notification circuit 405 may control the electronic device 101 (particularly, a projection source component PSC of the electronic device 101) to show the projection notice PN for notifying the user. Provided that the end result is substantially the same, the steps shown in FIG. 6 are not required to be executed in the exact order shown. For example, the projection notice PN may be displayed or projected by the projection source component PSC of the electronic device 101 after any step in FIG. 6 when a malfunction of the projection display component 100 or the image processing circuit 302 occurs, or any other factor causes a fail projection.

FIG. 7 is a diagram illustrating a scenario about a working condition of the image distortion correction circuit according to an embodiment of the present invention. As shown in the sub-diagram (A) of FIG. 7, a small-sized lens L1 is used for projection. Therefore, only a portion of the projection source PS is projected via the small-sized lens L1, which causes a distortion of the projected image PI shown on or behind the first cover C1 as shown in the sub-diagram (B) of FIG. 7. In this case, the image distortion correction circuit 402 may correct the appearance of the projection source PS, such that a user may see an un-distorted projected image PI, which looks like the original appearance of the projection source PS, shown on or behind the first cover C1 after distortion correction. In detail, the image distortion correction circuit 402 may correct at least one of the distorted parts of the projection source PS (for example, enlarge the upper part of the projection source PS to a size matching the lower part of the distorted projected image PI), such that after correction, the projected image PI may look like the original appearance of the projection source PS.

FIG. 8 is a diagram illustrating another embodiment of the optical set OS of the present invention. As shown in FIG. 8, the lens L3 included in the optical set OS is set to a position not parallel with the electronic device 101, which causes the size of the projected image PI to be smaller than the desired size. In this case, the image distortion correction circuit 402 may enlarge the size of the projection source PS to ensure a projected image PI is perceived by the user with a suitable size. In other embodiments, any other type of correction may be performed corresponding to different image distortion, which should not be limited in this disclosure. In the embodiments of

FIG. 7 and FIG. 8, an incorrect setting of the optical set OS causing a distortion of the projected image PI can be detected by a sensor installed in the second hinge set HS2. However, it is only for illustrative purpose. In other embodiments, the sensor can be installed on any other place of the projection display component for achieving the same goal. Alternatively, the detection can be performed by other means: for example, a front camera of the electronic device 101 captures the projected image PI. These alternative designs also fall within the scope of the present invention.

FIG. 9 is a flowchart illustrating an image distortion correction operation performed by the image distortion correction circuit 402 according to an embodiment of the present invention. The flow in FIG. 9 is described as follows.

Step 900: Start.

Step 902: The user may enable the projection display mode.

Step 904: The image distortion correction engine 402 may check if the projection display component 100 is set correctly. If yes, the flow goes to step 906; otherwise, the flow goes to step 910.

Step 906: The image distortion correction engine 402 may check if the optical lens covers all the projection sources or if the optical lens is set to a position parallel with the device. If yes, the flow goes to step 912; otherwise, the flow goes to step 908.

Step 908: The image distortion correction engine 402 performs the image distortion correction operation.

Step 910: The notification circuit 405 controls the electronic device 101 to show the projection notice PN.

Step 912: End.

In step 904, if an incorrect setting that causes a fail projection (for example, the lens included in the optical set OS is set to a position that tilts too much, which makes the projection source PS not able to be projected on the first cover C1 via the lens), or an incorrect setting which means the user cannot observe the projected image PI correctly is detected, the notification circuit 405 may further control the electronic device 101 (e.g. a projection source component PSC or a speaker of the electronic device 101) to display, project or generate the projection notice PN for notifying the user. Provided that the result is substantially the same, the steps shown in FIG. 9 are not required to be executed in the exact order shown.

FIG. 10 is a diagram illustrating a scenario related to a working condition of the image segmentation engine 403 according to an embodiment of the present invention. As shown in FIG. 10, when a complexity of a background of the projection source PS is higher than a threshold value TH1 to check if the background of the projection source PS is too complicated, the image

segmentation engine 403 separates the projection source PS from the background. In some other embodiments, any other method may be utilized to check if the background of the projection source PS is too complicated, which should not be limited in this disclosure. Then the image segmentation engine 403 fills the background with a plain color, wherein a contrast value between the plain color of the background and a color of the projection source PS may be controlled to be higher than a threshold value TH2. In this way, the background is suitable for user observation. FIG. 11 is a diagram illustrating a scenario related to a working condition of the image segmentation engine 403 according to another embodiment of the present invention. As shown in FIG. 11, the complexity of the background is not higher than the threshold value TH1, so the image segmentation engine 403 may not separate the projection source PS from the background. The image segmentation engine 403 may further fill the background with a plain color such that the contrast value between the color of the projection source PS and the plain color of the background is controlled to be higher than the threshold value TH2. In this way, the background is suitable for user observation.

FIG. 12 is a flowchart illustrating an image segmentation operation performed by the image segmentation engine 403 according to an embodiment of the present invention. The flow in FIG. 12 is described as follows.

Step 1200: Start.

Step 1202: The user may enable the projection display mode.

Step 1204: The image segmentation engine 403 analyzes the content of the projection source PS according to side information generated from a camera, depth sensor or algorithm, etc.

Step 1206: The image segmentation engine 403 checks if the background is suitable for user observing. If yes, the flow goes to step 1214; otherwise, the flow goes to step 1208.

Step 1208: The image segmentation engine 403 performs an image segmentation operation.

Step 1210: The image segmentation engine 403 checks if the image segmentation operation succeeds. If yes, the flow goes to step 1214; otherwise, the flow goes to step 1212.

Step 1212: The notification circuit 405 controls the electronic device 101 to show the projection notice PN.

Step 1214: End.

In step 1206, The image segmentation engine 403 checks if the complexity of the background is higher than the threshold value TH1, and checks if the contrast value between the color of the background and the color of the projection source PS is sufficient to determine whether to perform

the image segmentation operation. In step 1210, when the image segmentation engine 403 detects a segmentation failure (for example, after the segmentation, the complexity of the background is still higher than the threshold value TH1 which means the user may not observe the projected image PI clearly), the notification circuit 405 controls the electronic device 101 (particularly, a projection source component PSC of the electronic device 101) to display or project the projection notice PN for notifying the user. Provided that the result is substantially the same, the steps shown in FIG. 12 are not required to be executed in the exact order shown. For example, the projection notice PN may be displayed or projected by the projection source component PSC of the electronic device 101 after any step in FIG. 12 when a malfunction of the projection display component 100 occurs or any other factor causes a fail projection.

FIG. 13 is a flowchart illustrating an image enhancement operation performed by the image enhancement engine 404 according to an embodiment of the present invention. The flow in FIG. 13 is described as follows.

Step 1300: Start.

Step 1302: The image enhancement engine 404 checks if the brightness of the projection source PS is lower than a threshold value TH3. If yes, the flow goes to step 1304; otherwise, the flow goes to step 1306.

Step 1304: The image enhancement engine 404 increases the brightness of the projection source PS.

Step 1306: The image enhancement engine 404 checks if a difference between the brightness of the background and the brightness of the projection source PS is lower than a threshold value TH4. If yes, the flow goes to step 1308; otherwise, the flow goes to step 1310.

Step 1308: The image enhancement engine 404 increases the contrast by, for example, decreasing the brightness of the background.

Step 1310: The image enhancement engine 404 checks if a similarity between an ambient light and the color of projection source PS is higher than a threshold value TH5. If yes, the flow goes to step 1312; otherwise, the flow goes to step 1314.

Step 1312: The notification circuit 405 controls the electronic device 101 to show the projection notice PN.

Step 1314: End.

In this embodiment, the image enhancement engine 404 may adjust the brightness of the projection source PS and/or the brightness of the background. In step 1310, if the similarity between the color of the ambient light and the color of the projection source PS is higher than the

threshold value TH5, the notification circuit 405 controls the electronic device 101 (particularly, a projection source component PSC of the electronic device 101) to display or project the projection notice PN for notifying the user. In this embodiment, the ambient light can be detected by a red/green/blue (RGB) light sensor installed in the electronic device 101. Provided that the result is substantially the same, the steps shown in FIG. 13 are not required to be executed in the exact order shown. For example, the projection notice PN may be displayed or projected by the projection source component PSC of the electronic device 101 after any step in FIG. 13 when a malfunction of the projection display component 100 occurs or any other factor causes a fail projection.

In one embodiment, the projection source PS can be divided into four segments on the projection source component PSC of the electronic device 101, so the projected image PI can be seen from four different viewpoints, wherein these four segments is processed by the projection processor 300 in parallel. It should be noted that the number of segments is only for illustrative purpose, not a limitation of the present invention. To have the information of the video view number, in one embodiment, the view number is derived from H.264's Supplemental Enhancement Information (SEI) transmitted from a transmitter.

FIG. 14 is a diagram illustrating a data processing system 1400 employing the projection processor 300 according to an embodiment of the present invention. The data processing system 1400 may be part of an electronic device such as a mobile phone. The data processing system 1400 may comprise at least one of a sensor 1401 (e.g. an image sensor), an image signal processor (ISP) 1402, an image encoder 1403, an image decoder 1404, a video encoder 1405, a video decoder 1406, a graphic engine 1407, a battery meter 1408, a battery 1409, a micro control unit (MCU) 1410, a display processor 1411, a driver integrated circuit (IC) 1412, a projection source component 1413 and the aforementioned projection processor 300. The projection processor 300 receives the input image II from the display processor 1411 for a plurality of applications, and generates the output image OI to the driver IC 1412. The driver IC 1412 drives the projection source component 1413 such that the projection source PS is displayed or projected by the projection source component 1413 according to the output image OI. The other exemplary embodiments of the plurality of applications of the projection processor 300 installed in the data processing system 1400 will be discussed later.

FIG. 15 is a diagram illustrating an embodiment related to a photograph application for the projection processor 300 installed in the data processing system 1400 according to the embodiment of FIG. 14. As shown in FIG. 15, when a projection display mode is enabled by the user and the electronic device 101 is used for taking photographs, the sensor 1401 may transmit the captured image into the ISP 1402 for processing, and the ISP 1402 may transmit the processed image to the

image encoder 1403 so it can be stored in an external storage device, and may also transmit it to the display processor 1411. The display processor 1411 may perform additional image processing (e.g. scaling, rotation) upon the processed image generated from the ISP 1402 to generate the input image II to the projection processor 300 where it can undergo the predetermined processing operation described above for projection. The projection processor generates the output image OI. The projection source PS is displayed or projected by the projection source component 1413 according to the output image OI.

FIG. 16 is a diagram illustrating an embodiment for a recording application for the projection processor 300 installed in the data processing system 1400 according to the embodiment of FIG. 14. As shown in FIG. 16, when a projection display mode is enabled by the user and the electronic device 101 is used for video recording, the sensor 1401 may transmit a video sequence composed of a plurality of successive captured images to the ISP 1402 for processing. The ISP 1402 may then transmit the processed video sequence to the video encoder 1405 where it can be stored in an external storage device, and may also transmit it to the display processor 1411. The display processor 1411 may perform additional image processing (e.g. scaling, rotation) upon each captured image included in the processed video sequence generated from the ISP 1402 to generate the input image II to the projection processor 300 so it can undergo the predetermined processing operation described above for projection. The projection processor 300 generates the output image OI. The projection source PS is displayed or projected by the projection source component 1413 according to the output image OI.

FIG. 17 is a diagram illustrating an embodiment related to a video playback application for the projection processor 300 installed in the data processing system 1400 according to the embodiment of FIG. 14. As shown in FIG. 17, when a projection display mode is enabled by the user and the electronic device 101 is used for video playback, the video decoder 1406 may transmit a video sequence composed of successive decoded images to the display processor 1411 by decoding a video sequence composed of successive encoded images read from an external storage device. The display processor 1411 may perform additional image processing (e.g. scaling, rotation) upon each image included in the decoded video sequence to generate the input image II to the projection processor 300 so it can undergo the predetermined processing operation described above for projection. The projection processor 300 generates the output image OI. The projection source PS is displayed or projected by the projection source component 1413 according to the output image OI.

FIG. 18 is a diagram illustrating an embodiment related to a gaming application for the projection processor 300 installed in the data processing system 1400 according to the embodiment

of FIG. 14. As shown in FIG. 18, the graphic engine 1407 may generate a graphic image of a game to the display processor 1411. The display processor 1411 may perform additional image processing (e.g. scaling, rotation) upon the graphic image to generate the input image II to the projection processor 300 so it can undergo the predetermined processing operation described above
5 for projection. The projection processor 300 generates the output image OI. The projection source PS is displayed on the projection source component 1413 according to the output image OI.

FIG. 19 is a diagram illustrating an embodiment related to a gallery application for the projection processor 300 installed in the data processing system 1400 according to the embodiment of FIG. 14. As shown in FIG. 19, the image decoder 1404 may generate a decoded image to the
10 display processor 1411 by decoding an encoded image read from an external storage device. The display processor 1411 may perform additional image processing (e.g. scaling, rotation) upon the decoded image to generate the input image II to the projection processor 300 so it can undergo the predetermined processing operation described above for projection. The projection processor generates the output image OI. The projection source PS is displayed or projected by the projection
15 source component 1413 according to the output image OI.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

CLAIMS

1. A projection processor, comprising:

a receiving circuit, arranged to receive an input image; and

an image processing circuit, arranged to perform at least one predetermined image processing
5 operation upon the input image to generate an output image, wherein a projection source is generated according to the output image;

wherein the projection source is displayed or projected by a projection source component of an electronic device, such that a first cover of a projection display component partially reflects the projection source.

10 2. The projection processor of claim 1, wherein the first cover comprises:

at least one non-opaque plate, arranged to partially reflects the projection source, such that a projected image is shown on or behind the at least one non-opaque plate.

3. The projection processor of claim 1, wherein the image processing circuit comprises an image flip engine, and the predetermined image processing operation comprises an image flip
15 operation controlled by the image flip engine.

4. The projection processor of claim 3, wherein the image flip engine performs the image flip operation to ensure that an orientation of the projected image matches an orientation of the input image or the projected image is shown on or behind the first cover with a correct orientation.

5. The projection processor of claim 3, wherein the image flip engine performs the image flip
20 operation when an orientation of the projected image is not identical with the input image or the projected image is shown on or behind the first cover with an incorrect orientation.

6. The projection processor of claim 1, wherein the image processing circuit comprises an image distortion correction engine, and the predetermined image processing operation comprises an image distortion correction operation controlled by the image distortion correction engine.

25 7. The projection processor of claim 6, wherein the image distortion correction engine performs the image distortion correction operation to correct an appearance of the projection source when only a portion of the projection source is projected through a lens.

8. The projection processor of claim 6, wherein the image distortion correction engine performs the image distortion correction operation when the optical lens is not parallel with the electronic
30 device.

9. The projection processor of claim 1, wherein the image processing circuit comprises an image segmentation engine, and the predetermined image processing operation comprises an image segmentation operation controlled by the image segmentation engine.

10. The projection processor of claim 9, wherein the image segmentation engine separates the projection source from a background of the projection source and fills the background with a plain color.

5 11. The projection processor of claim 9, wherein the image segmentation engine performs the image segmentation operation when a background corresponding to the projection source is not suitable for observing.

12. The projection processor of claim 1, wherein the image processing circuit comprises an image enhancement engine, and the predetermined image processing operation comprises an image enhancement operation controlled by the image enhancement engine.

10 13. The projection processor of claim 12, wherein the image enhancement engine performs the image enhancement operation when brightness of the projection source is lower than a first threshold or a difference between brightness of background and brightness of the projection source is lower than a second threshold value.

15 14. A projection method employed by a projection processor, comprising:
receiving an input image; and
performing at least one predetermined image processing operation upon the input image to generate an output image, wherein a projection source is generated according to the output image;
wherein the projection source is displayed or projected by a projection source component of an electronic device, such that a first cover of a projection display component partially reflects the
20 projection source.

15. The projection method of claim 14, wherein the first cover comprises at least one non-opaque plate arranged to partially reflects the projection source, such that a projected image is shown on or behind the at least one non-opaque plate.

25 16. The projection method of claim 14, wherein the predetermined image processing operation comprises an image flip operation.

17. The projection method of claim 16, wherein the image flip operation comprises:
flipping the input image to ensure that an orientation of the projected image matches an orientation of the input image or the projected image is shown on or behind the first cover with a correct orientation.

30 18. The projection method of claim 16, wherein the image flip operation is performed when an orientation of the projected image is not identical with the input image or the projected image is shown on or behind the first cover with an incorrect orientation.

19. The projection method of claim 14, wherein the predetermined image processing operation comprises an image distortion correction operation.

20. The projection method of claim 19, wherein the image distortion correction operation is performed to correct an appearance of the projection source when only a portion of the projection source is projected through a lens.

5 21. The projection method of claim 19, wherein the image distortion correction operation is performed when the optical lens is not parallel with the electronic device.

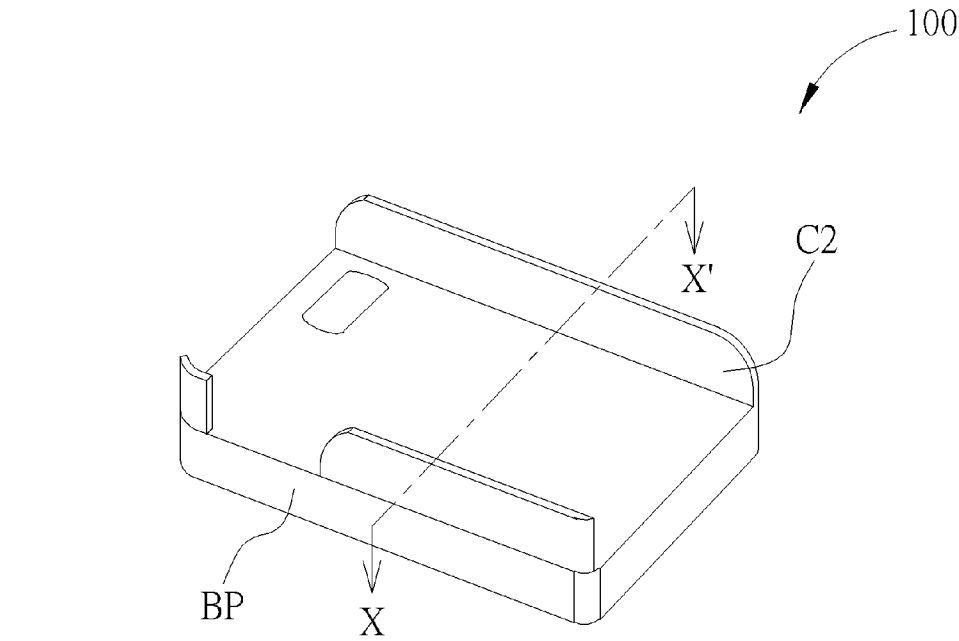
22. The projection method of claim 14, wherein the predetermined image processing operation comprises an image segmentation operation.

10 23. The projection method of claim 22, wherein the image segmentation operation comprising: separating the projection source from a background the projection source and fills the background with a plain color.

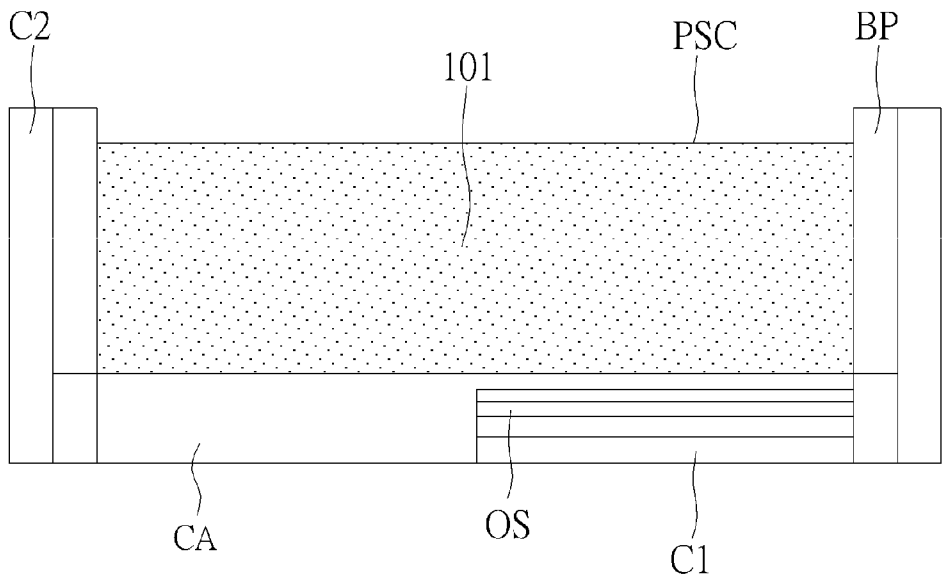
24. The projection method of claim 22, wherein the image segmentation operation is performed when a background corresponding to the projection source is not suitable for observing.

25. The projection method of claim 14, wherein the predetermined image processing operation comprises an image enhancement operation.

15 26. The projection method of claim 25, wherein the image enhancement operation is performed when brightness of the projection source is lower than a first threshold or a difference between brightness of background and brightness of the projection source is lower than a second threshold value.



(A)



(B)

FIG. 1

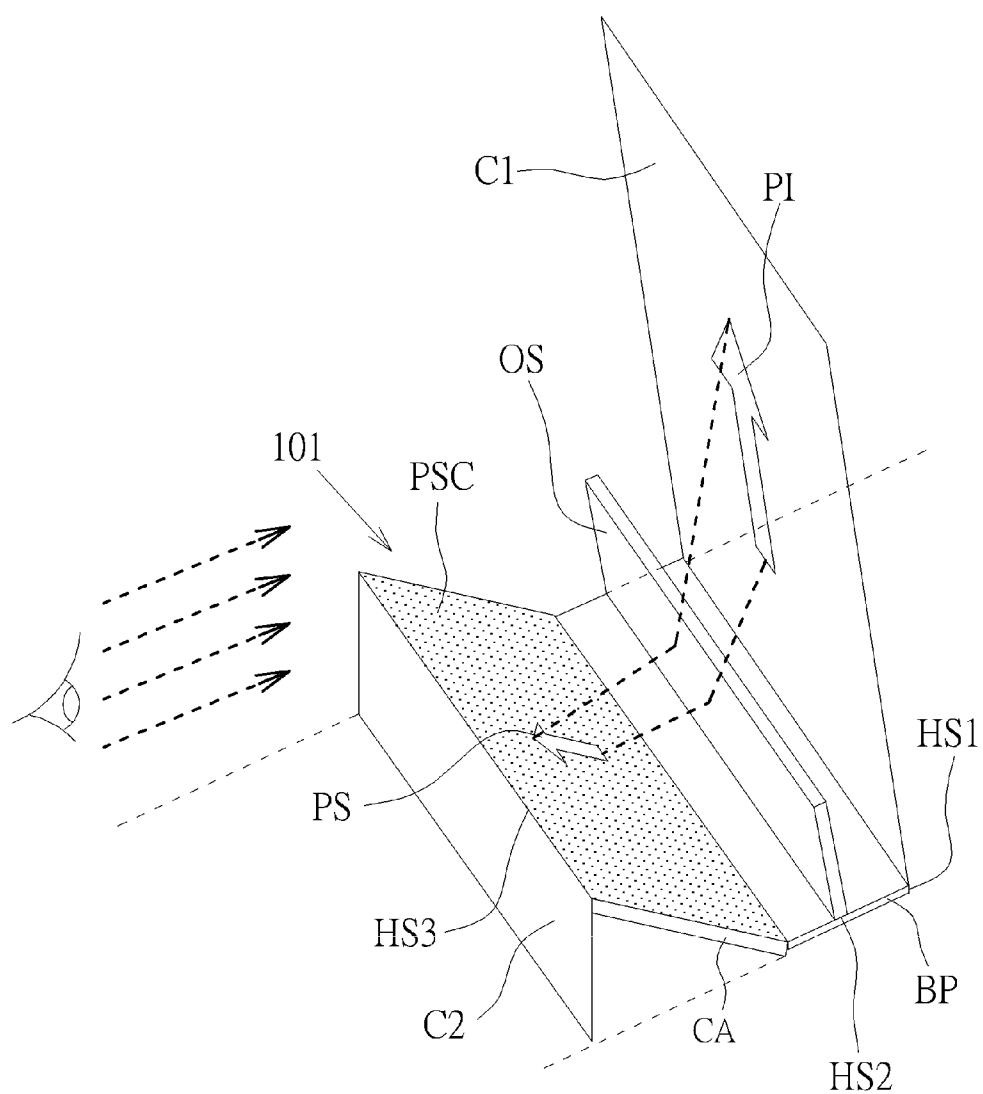


FIG. 2

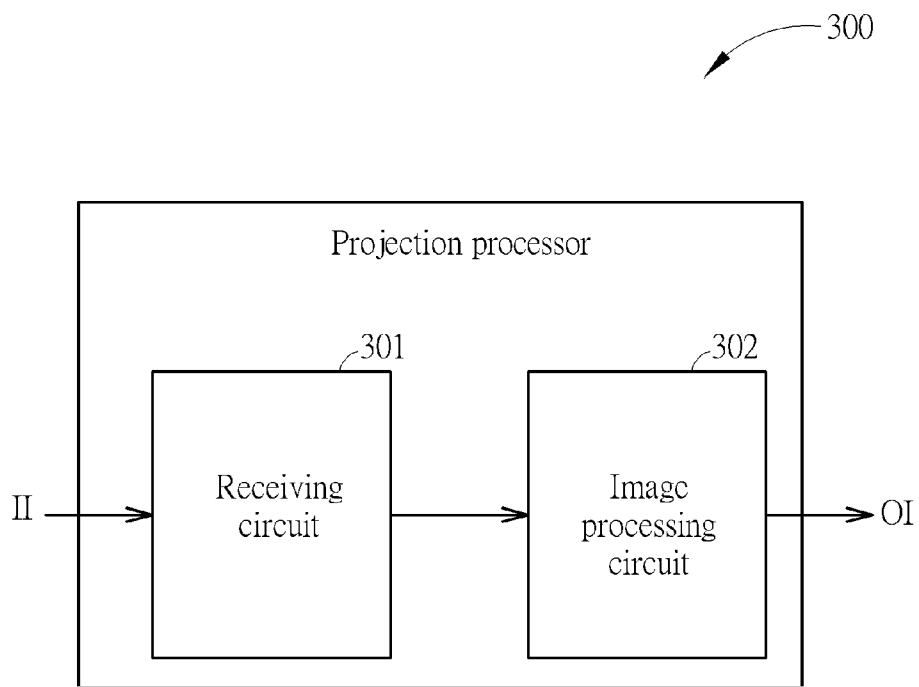


FIG. 3

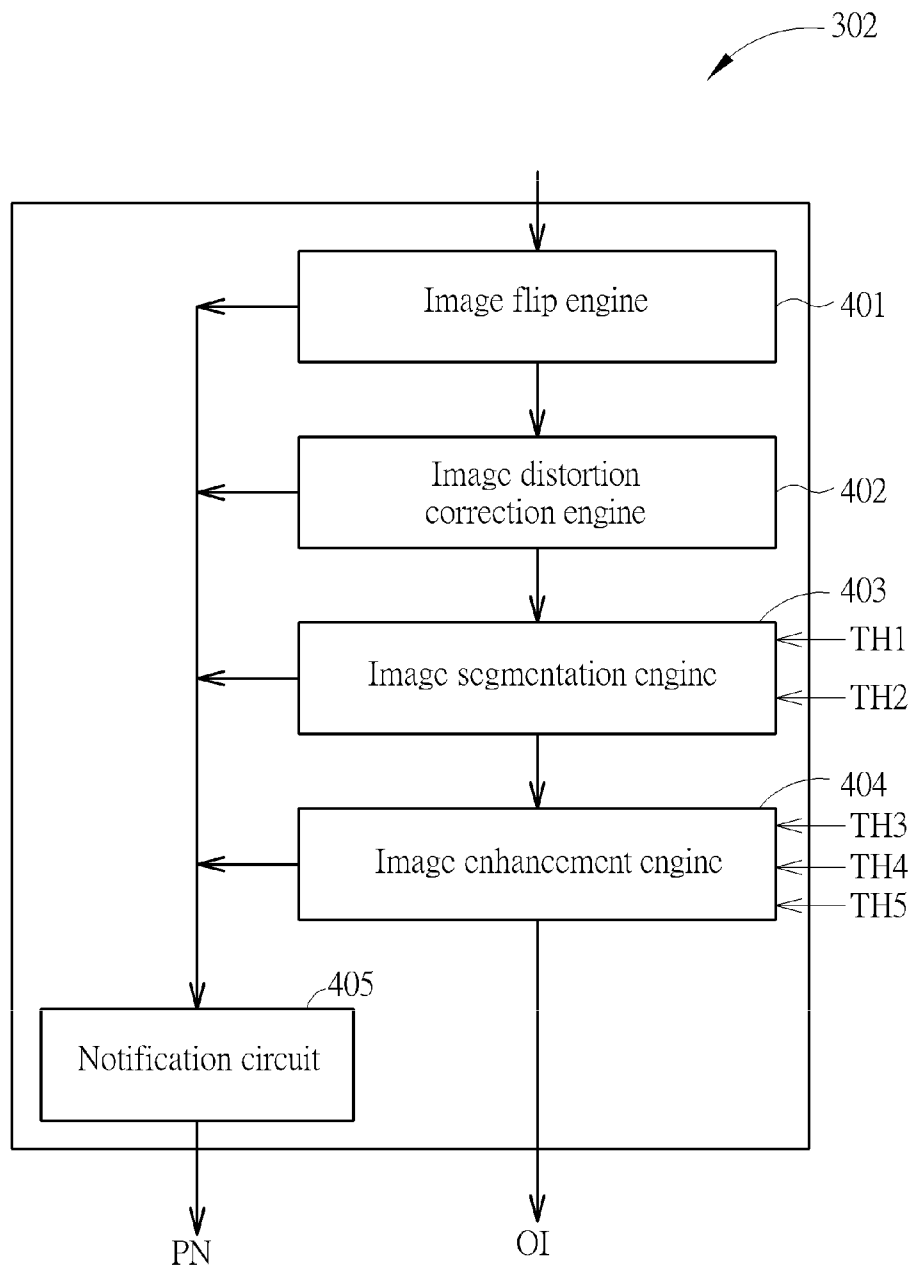


FIG. 4

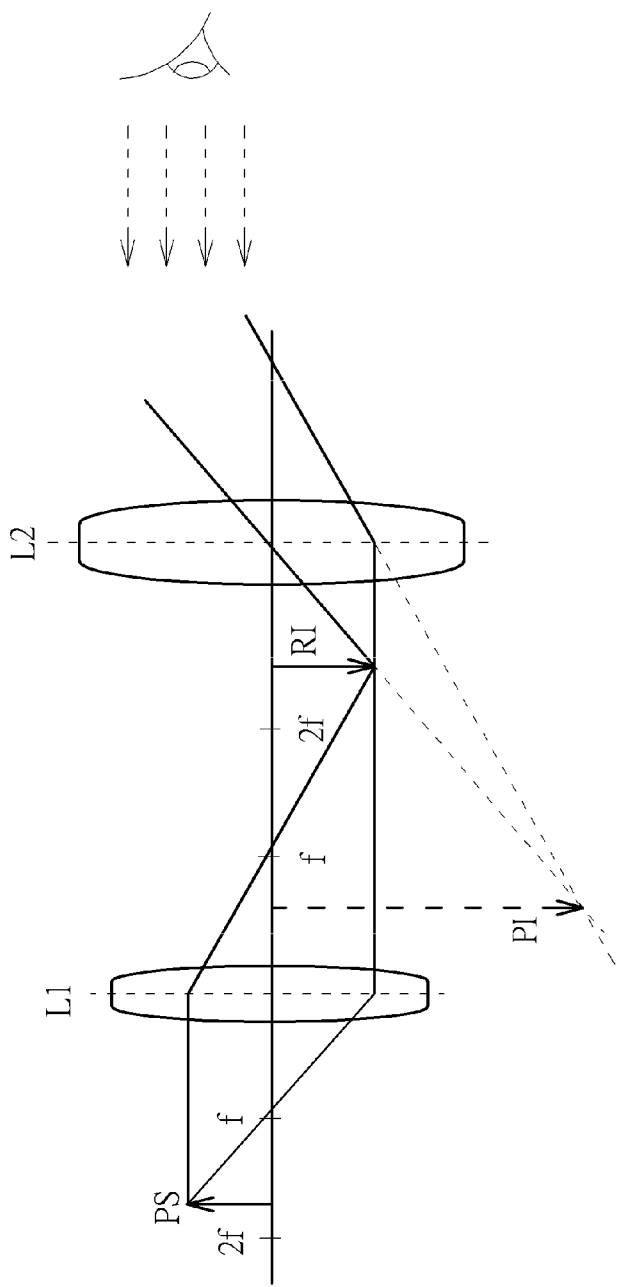


FIG. 5

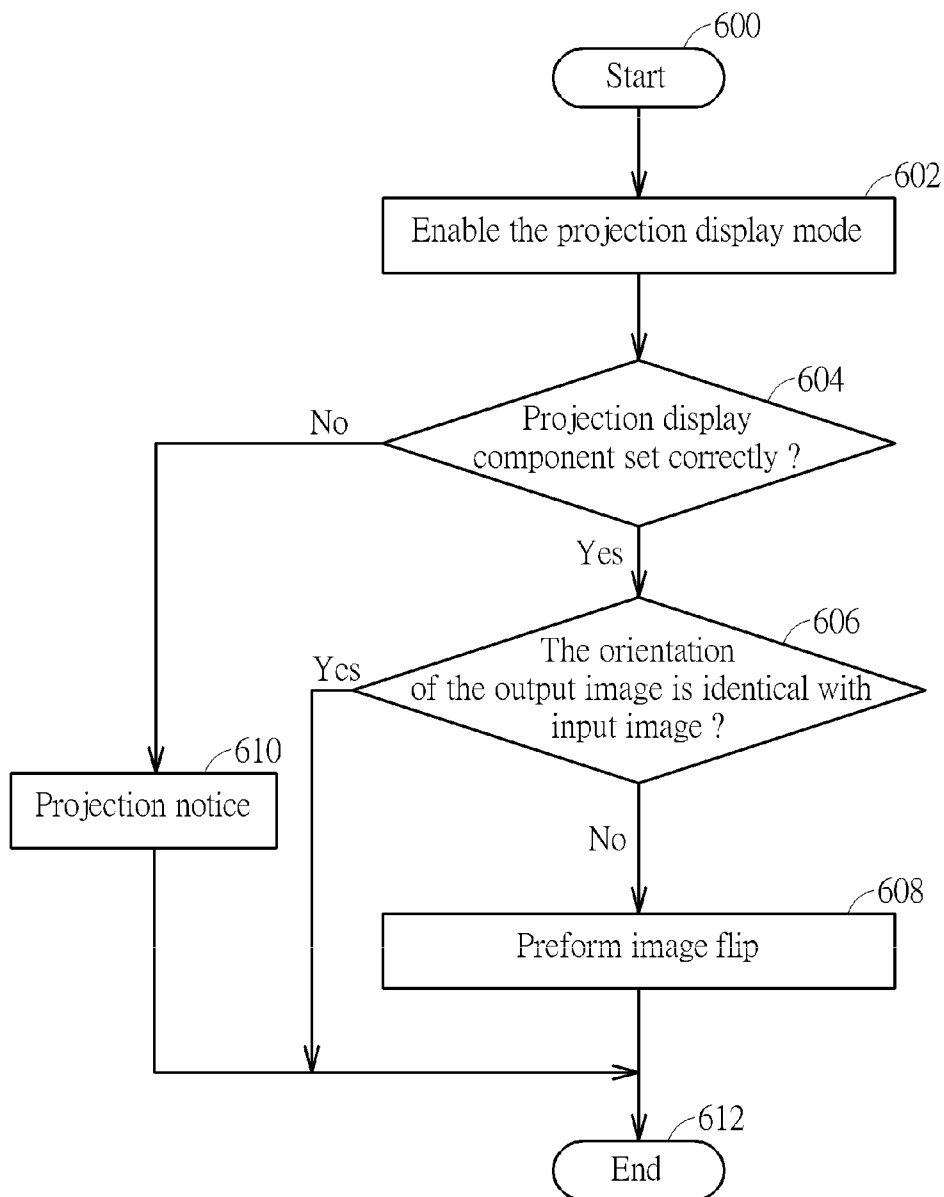


FIG. 6

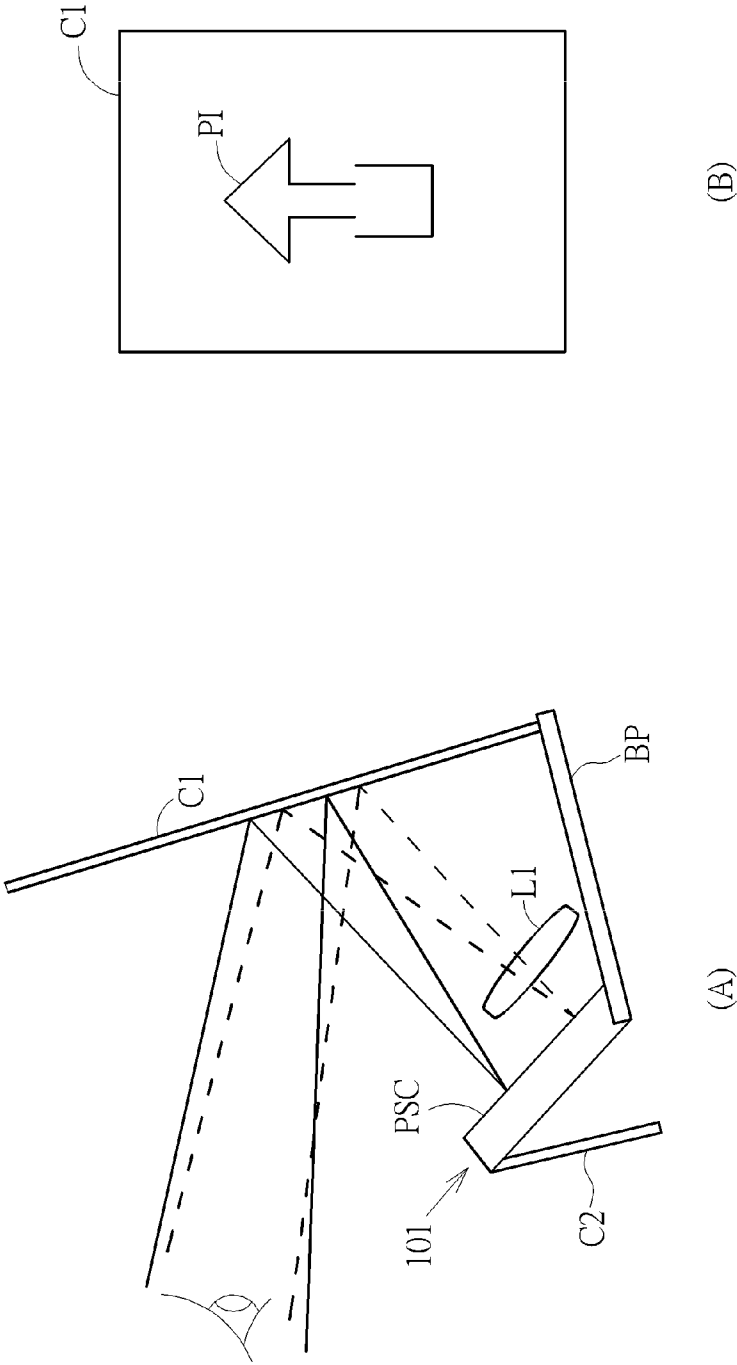


FIG. 7

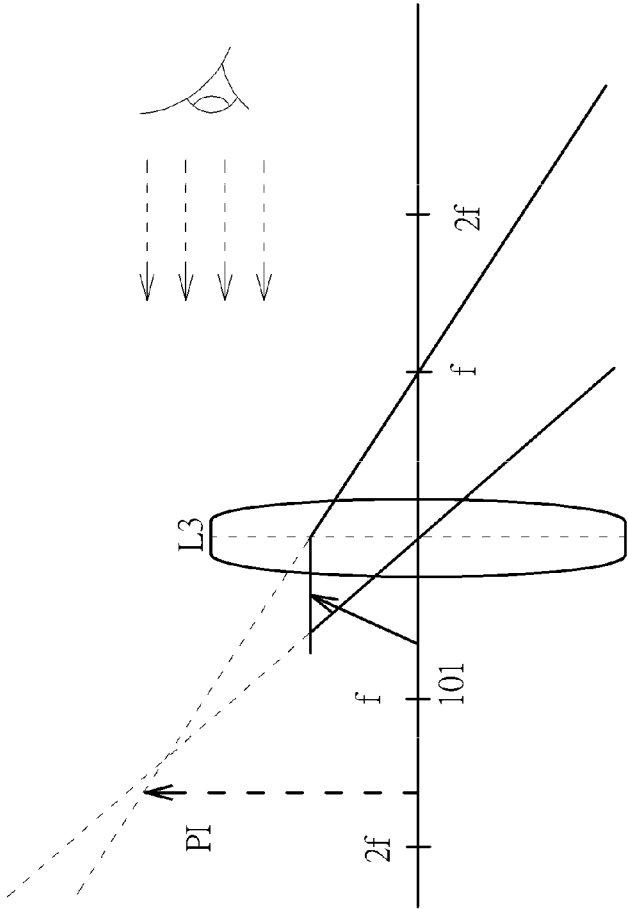


FIG. 8

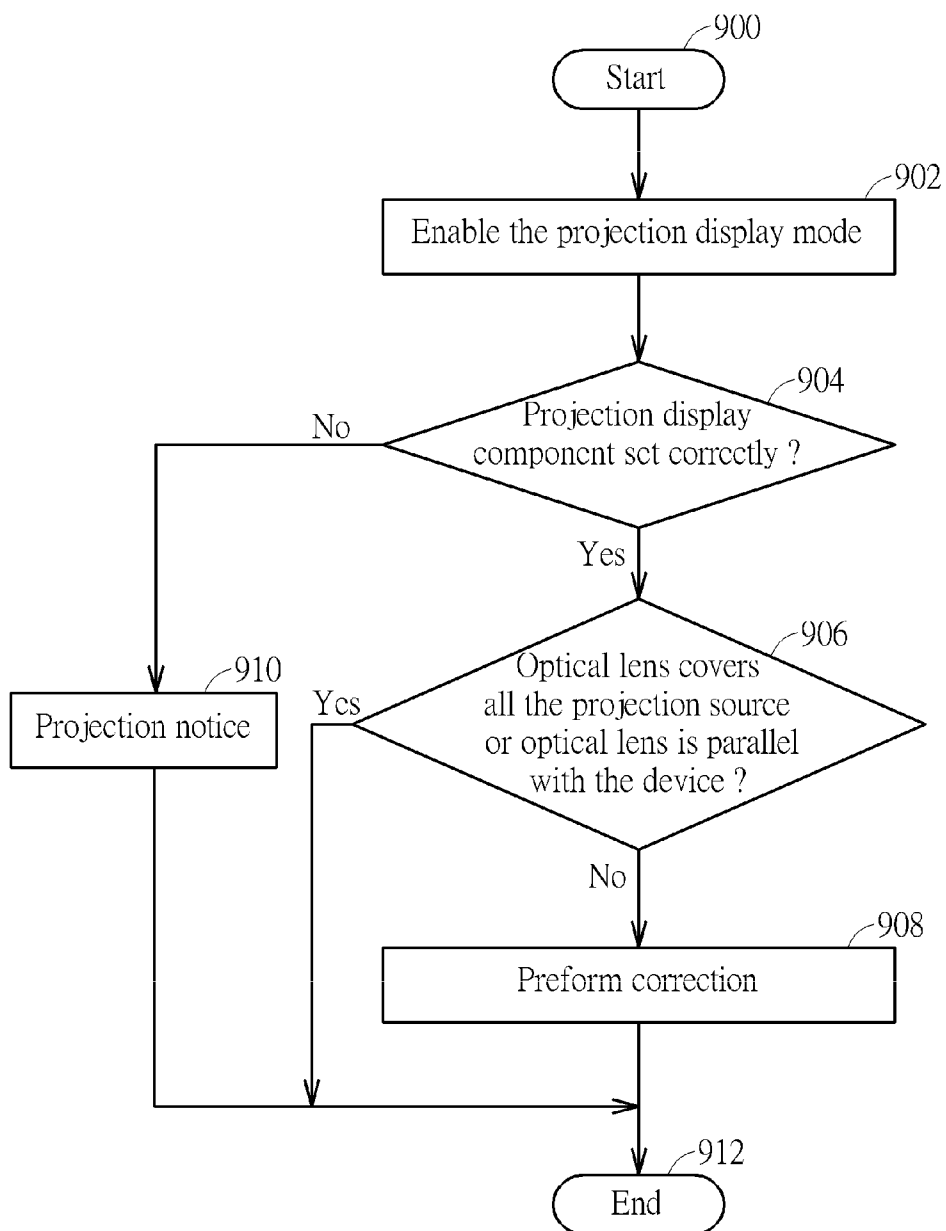


FIG. 9

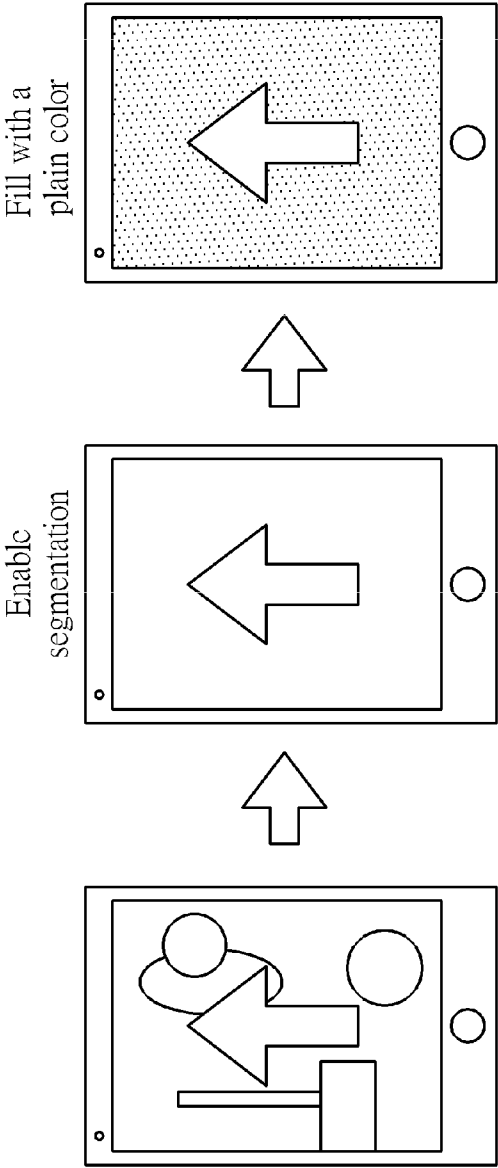


FIG. 10

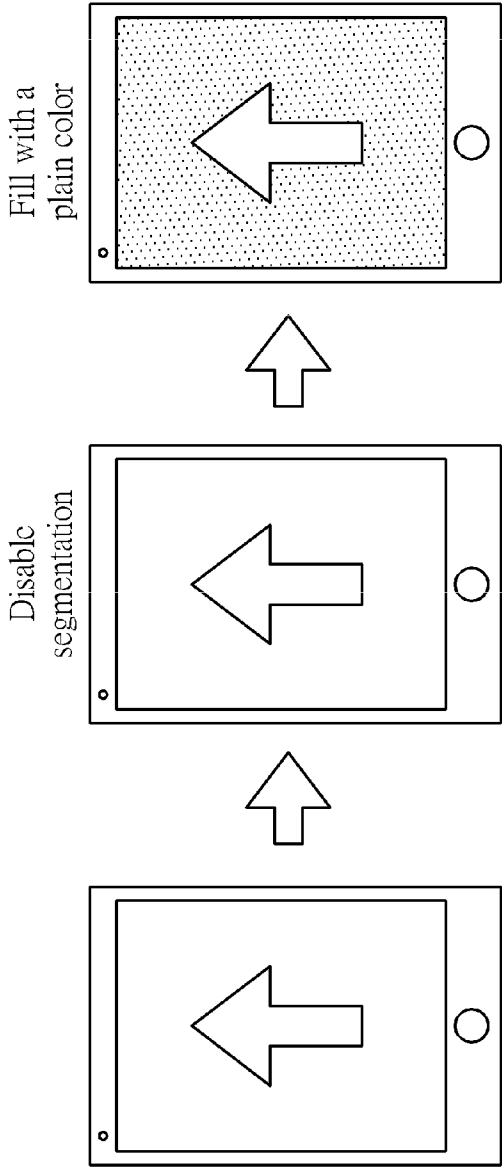


FIG. 11

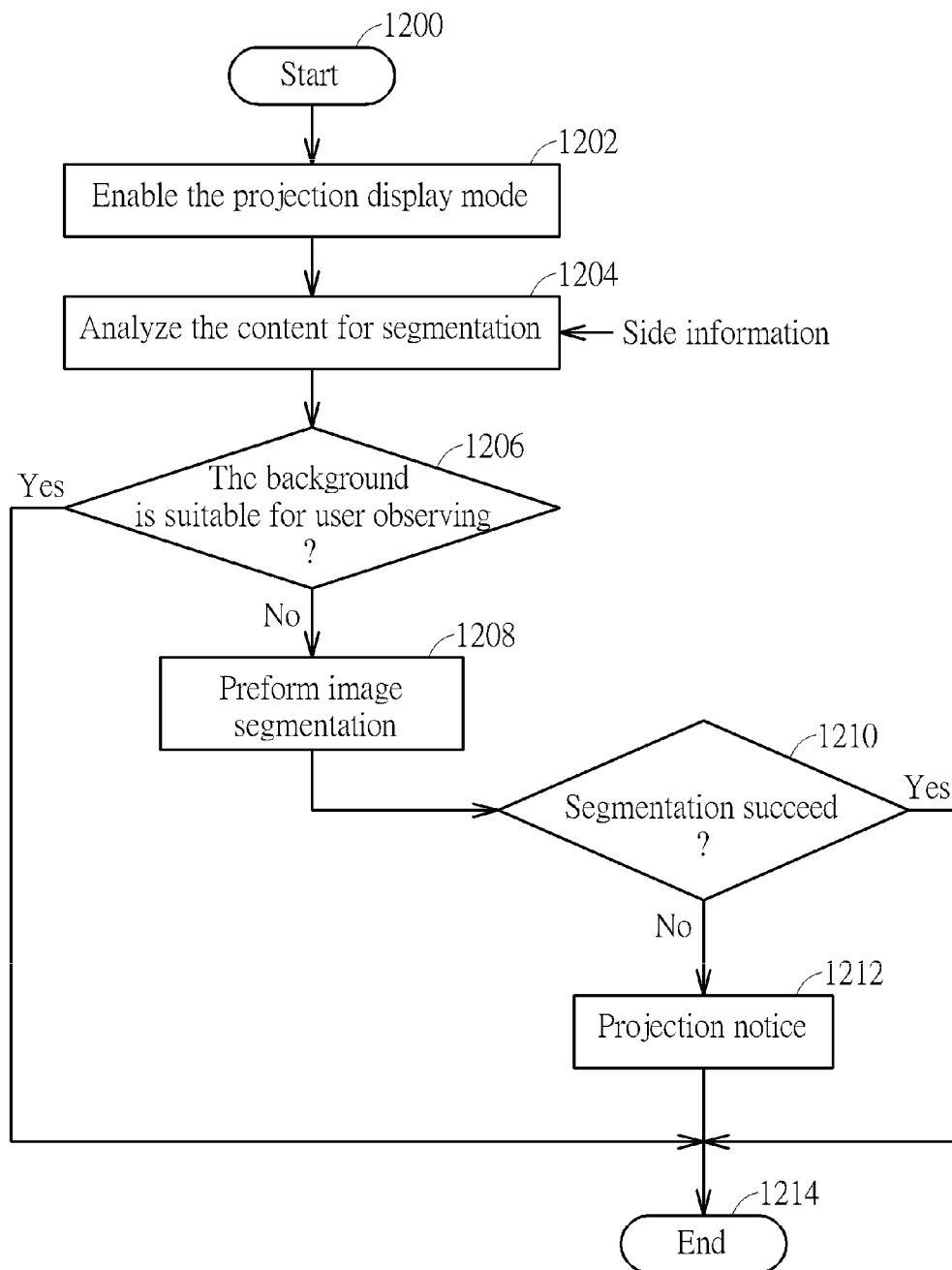


FIG. 12

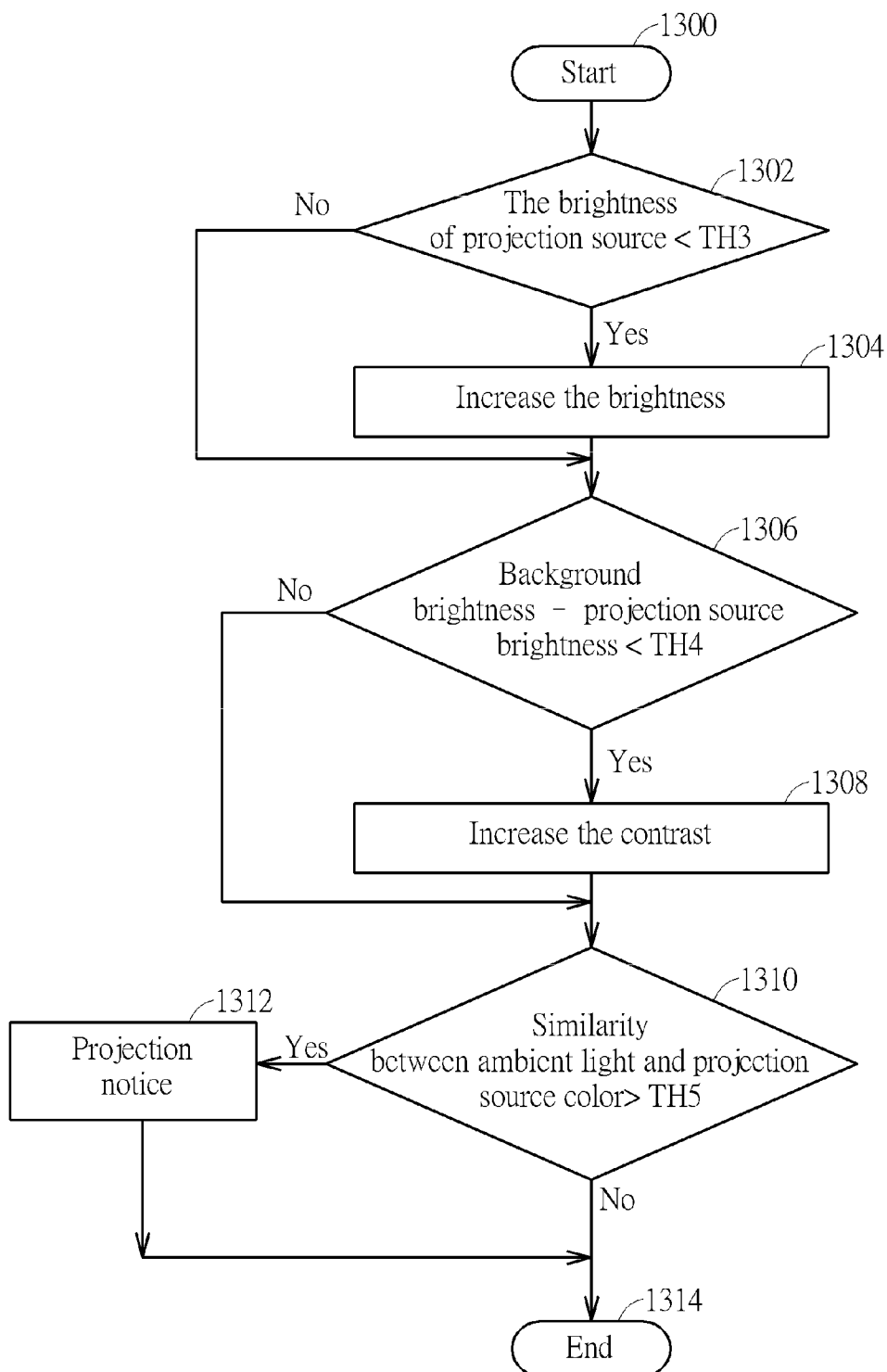


FIG. 13

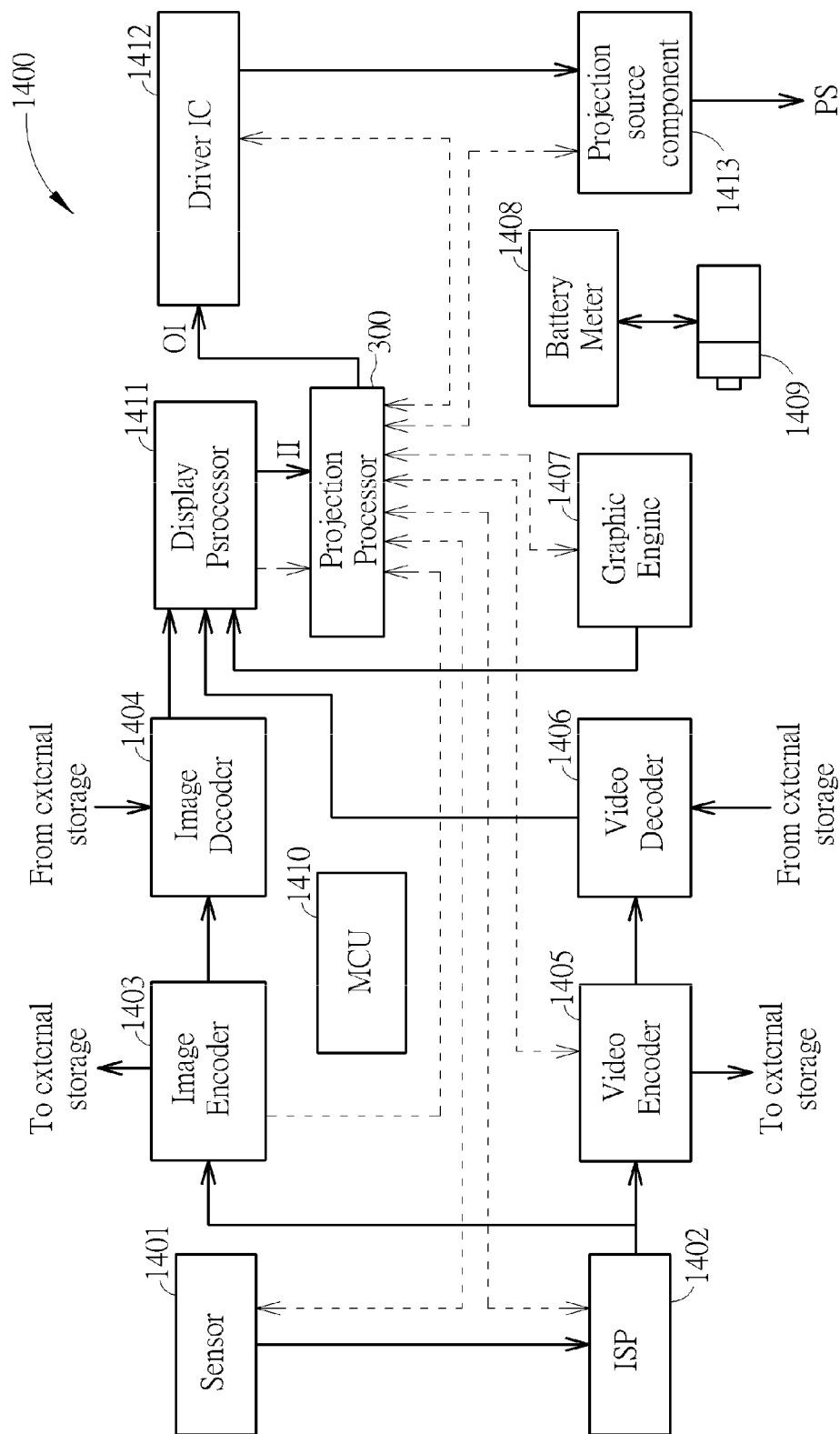


FIG. 14

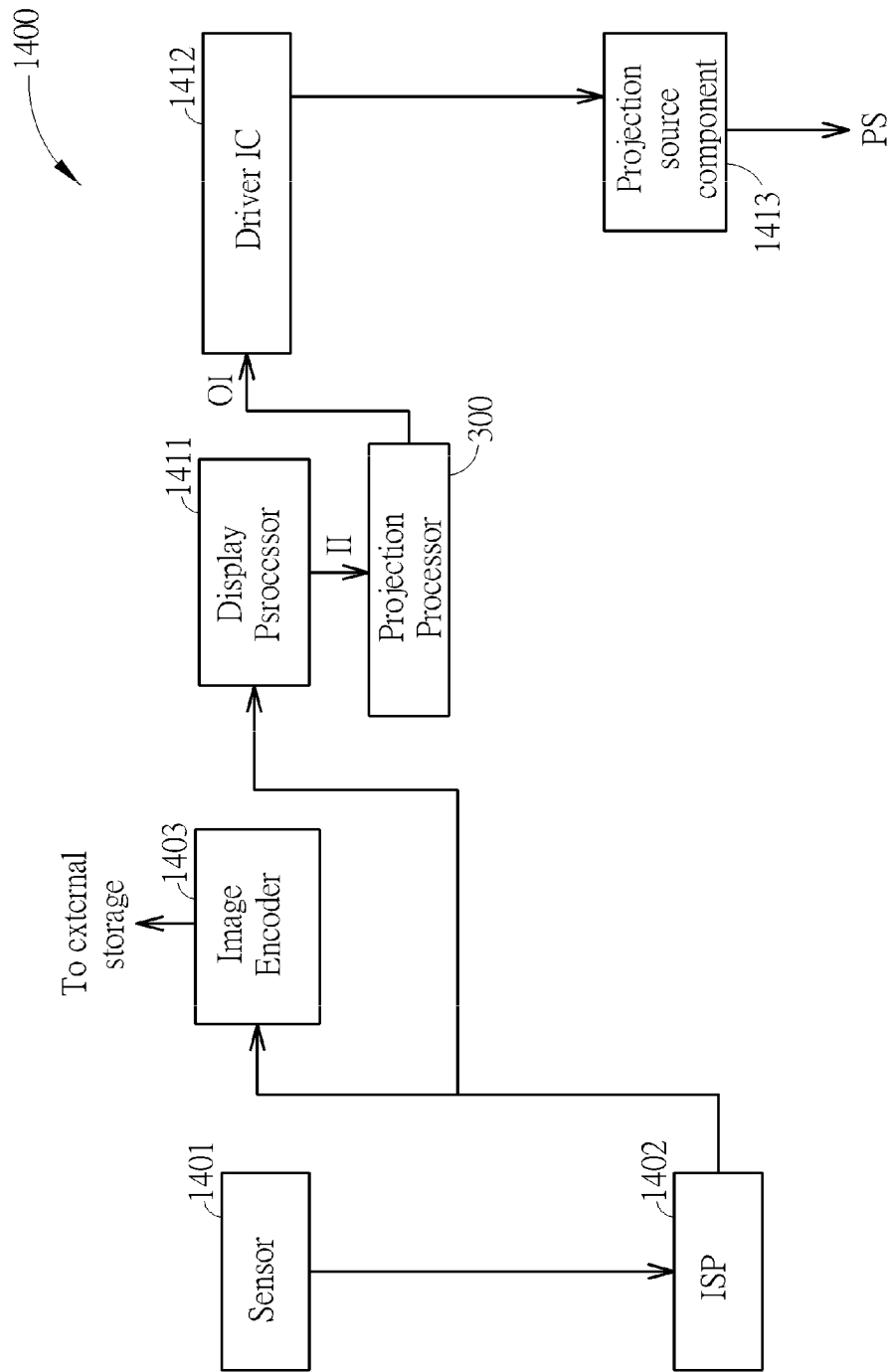


FIG. 15

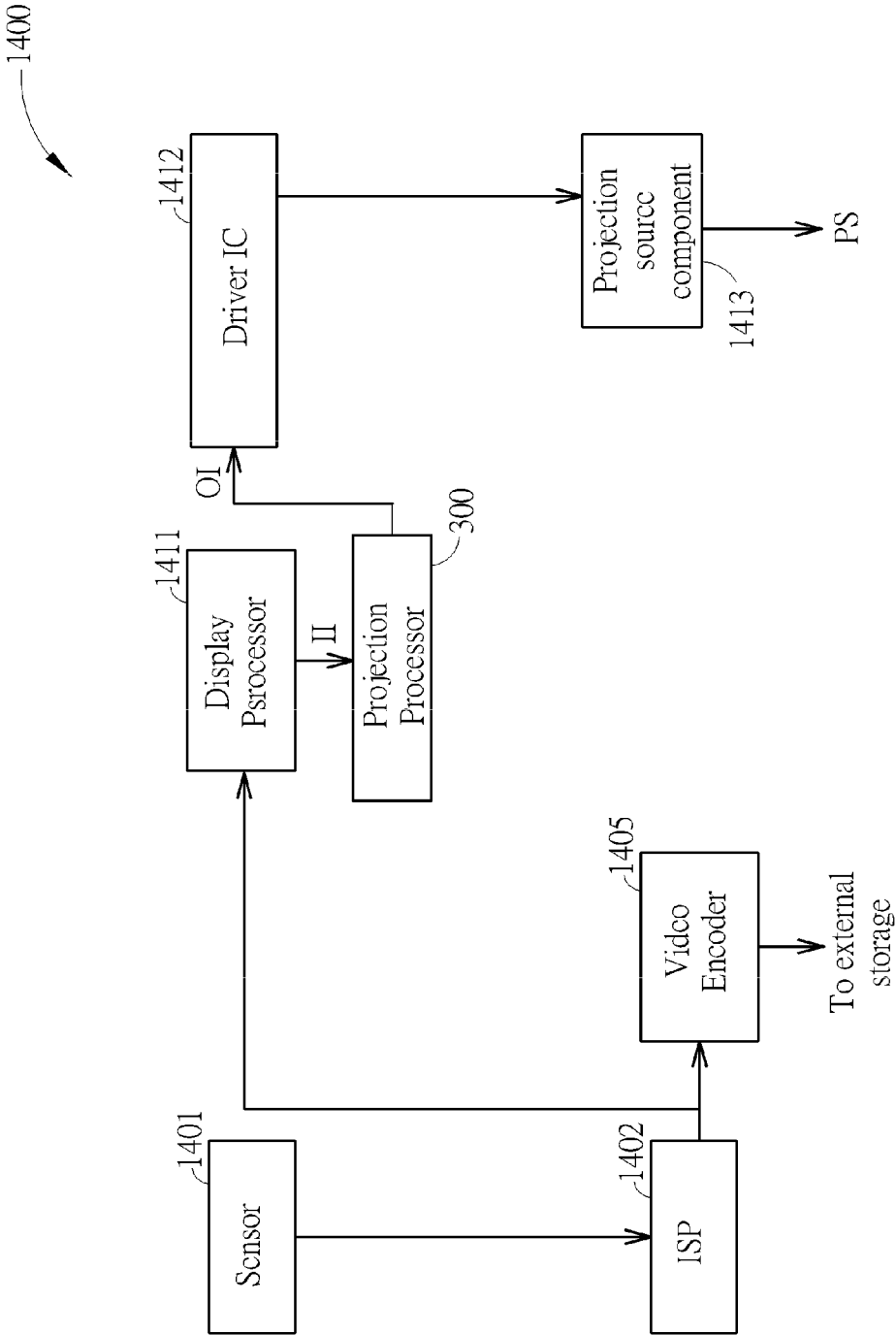


FIG. 16

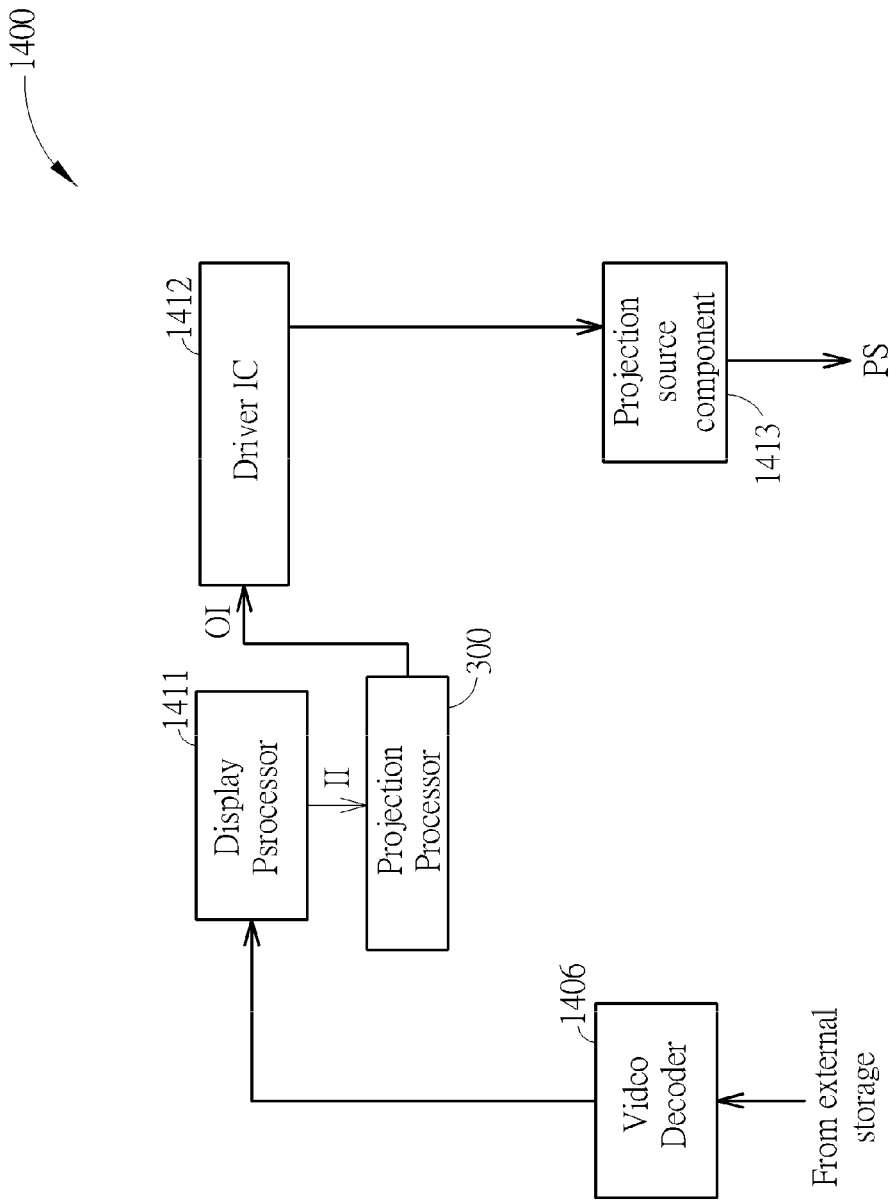


FIG. 17

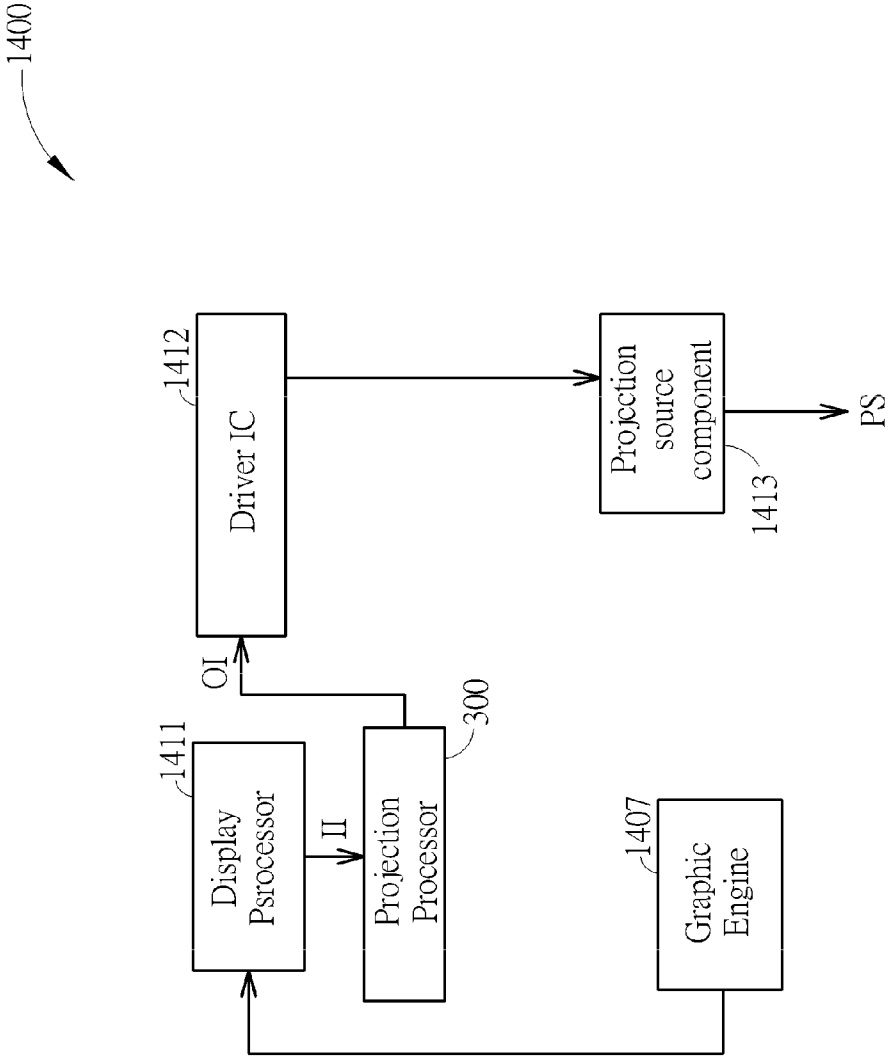


FIG. 18

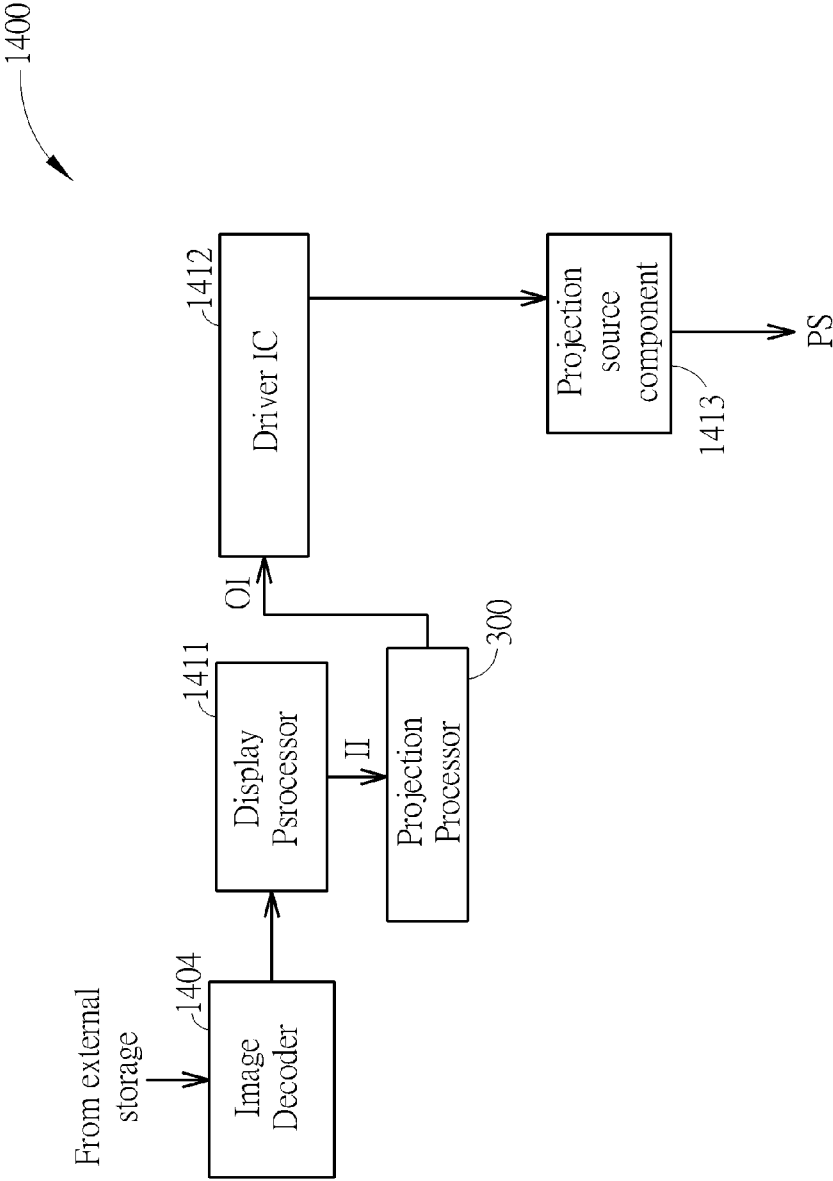


FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/079933

A. CLASSIFICATION OF SUBJECT MATTER

H04N 5/74(2006.01)i

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)

H04N, G03B, H04L, G09G

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

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

database: CPRS, CNKI, WPI, EPODOC; keywords: project, reflect, source, image

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101398596 A (HIER GROUP CO ET AL.) 01 April 2009 (2009-04-01) claims 1-9, the description page 4, line 5 to page 6, line 11	1-26
A	CN 102520900 A (TCL GROUP CO., LTD.) 27 June 2012 (2012-06-27) the whole document	1-26
A	WO 2013090100 A1 (CLAVIN JOHN ET AL.) 20 June 2013 (2013-06-20) the whole document	1-26

☐ 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

“E” earlier application or patent but published on or after the international filing date

“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

25 August 2015

Date of mailing of the international search report

01 September 2015

Name and mailing address of the ISA/CN

STATE INTELLECTUAL PROPERTY OFFICE OF THE
P.R.CHINA
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088, China

Facsimile No. (86-10)62019451

Authorized officer

XU, Rong

Telephone No. (86-10)62089295

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2015/079933

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	101398596	A	01 April 2009	None			
CN	102520900	A	27 June 2012	CN	102520900	B	25 March 2015
WO	2013090100	A1	20 June 2013	CN	103091844	A	08 May 2013
				US	2013147686	A1	13 June 2013
				HK	1183103	A0	13 December 2013