A size of a opening of the light detector is greater than a size of an opening of the scanner. The detection path includes a light source to output light for detection of a distance to an external object, a scanner to output the output light by performing first direction scanning and second direction scanning, a light path separator to output the light from the scanner to an external scan region by reflecting the light and to transmit received light from an external, a light detector to convert the received light from the light path separator into an electric signal, and a processor to detect the distance to the external object in the external scan region based on an electric signal corresponding to the output light and an electric signal corresponding to the received light. A size of an opening of the light detector is greater than a size of an opening of the scanner.
Description

Title of Invention: DISTANCE DETECTION APPARATUS AND DISPLAY APPARATUS FOR IMPROVING LIGHT RECEPTION PERFORMANCE

Technical Field
[1] The present invention relates to a distance detection apparatus and a display apparatus and, more particularly, to a distance detection apparatus and display apparatus for improving light reception performance.

Background Art
[2] A distance detection apparatus is a device to detect a distance to an external object. There is a growing trend, among electronic devices, of detecting a distance to an external object and providing an operation according to the detected distance.

[3] In this regard, there have been various attempts to make the distance detection apparatus compact and lightweight and to increase accuracy of the distance detection apparatus.

Disclosure of Invention

Technical Problem
[4] It is an object of the present invention to provide a distance detection apparatus and display apparatus for improving light reception performance.

Solution to Problem
[5] In accordance with an aspect of the present invention, the above and other objects can be accomplished by the provision of a distance detection apparatus including a light source configured to output light for detection of a distance to an external object, a scanner configured to output the output light by performing first direction scanning and second direction scanning, a light path separator configured to output the output light from the scanner to an external scan region by reflecting the output light and to transmit received light from an external, a light detector configured to convert the received light from the light path separator into an electric signal, and a processor configured to detect the distance to the external object in the external scan region based on an electric signal corresponding to the output light and an electric signal corresponding to the received light, wherein a size of an opening provided to the light detector is greater than a size of an opening provided to the scanner.

[6] In accordance with another aspect of the present invention, there is provided a display apparatus including a light source configured to output visible light and output light for detection of a distance to an external object, a scanner configured to output a
projection image and the output light by performing first direction scanning and second
direction scanning, the projection image being based on visible light, a light path
separator configured to output the projection image and the output light from the
scanner to an external scan region by reflecting the projection image and the output
light and to transmit received light from an external, a light detector configured to
convert the received light from the light path separator into an electric signal, and a
processor configured to detect the distance to the external object in the external scan
region based on an electric signal corresponding to the output light and an electric
signal corresponding to the received light, wherein a size of an opening provided to the
light detector is greater than a size of an opening provided to the scanner.

Advantageous Effects of Invention

As is apparent from the above description, a distance detection apparatus and display
apparatus according to one embodiment of the present invention employ a light path
separator to reflect output light from a scanner to output the light to an external scan
region and to transmit the received light corresponding to the output light, and a light
detector to convert the received light from the light path separator into an electric
signal. Particularly, the opening of the light detector is set to be larger than the opening
of the scanner and, accordingly, gain of the amount of received light may be increased.
Thereby, the light reception performance of the distance detection apparatus may be
improved.

Moreover, with the path of the output light spaced apart from the path of the received
light, the difference between the output angle of the output light and the reception
angle of the received light is within a predetermined range. Accordingly, the degree of
shading of the external object according to the difference between the output angle of
the output light and the reception angle of the received light may be even lower than in
other structures.

That is, the distance detection apparatus and display apparatus according to one em-
bodyment of the present invention may increase gain of the amount of the received
light and lower the degree of shading of the external object, thereby improving light
reception performance.

Brief Description of Drawings

The above and other objects, features and other advantages of the present invention
will be more clearly understood from the following detailed description taken in con-
junction with the accompanying drawings, in which:
FIG. 1 is a view illustrating a distance detection apparatus outputting rays of light for detection of distance simultaneously according to an exemplary embodiment of the present invention;

FIG. 2 is a block diagram schematically illustrating the light output module of FIG. 1;

FIG. 3 is a structural diagram illustrating an example of the light output module of FIG. 1;

FIG. 4 is a structural diagram illustrating another example of the light output module of FIG. 1;

FIG. 5 is a diagram illustrating a method of detecting a distance in the light output module of FIG. 3 or 4;

FIG. 6 is a conceptual diagram illustrating a display apparatus according to another embodiment of the present invention; and

FIGS. 7 and 8 are views illustrating sensing of a touch input and a gesture input in the light output module of FIG. 6.

Best Mode for Carrying out the Invention

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

As used herein, the suffixes "module" and "unit" applied to constituents are added or used interchangeably to facilitate description of the present invention, and do not suggest any unique meanings or functions. Accordingly, the terms "module" and "unit" may be used interchangeably.

As described herein, a distance detection apparatus is an apparatus capable of displaying a projection image on dual screens in a scanning manner. Particularly, with the distance detection apparatus, the distance and movement of an external object may be recognized, while a projection image is displayed on the dual screens in a scanning manner.

To this end, the distance detection apparatus may include a light output module to output a projection image. In addition to the projection image, the light output module may output light to detect the distance or movement of an external object.

In addition, the distance detection apparatus may receive light scattered or reflected by an external object, and detect the distance to the external object based on the difference between the received light and the output light. In addition, based on the detected distance to the external object or a gesture of the external object, a corresponding projection image may be output.
The distance detection apparatus may be included in a home appliance such as a mobile terminal, a TV, a set-top box, a media player, a gaming device, an air conditioner, a refrigerator, a washing machine, a cooker, and a robot cleaner, or may be included in a vehicle.

Hereinafter, a detailed description will be given of a distance detection apparatus.

FIG. 1 is a view illustrating a distance detection apparatus outputting rays of light for detection of distance simultaneously according to an exemplary embodiment of the present invention.

Referring to FIG. 1, the distance detection apparatus 10 may include a light output module 100.

The light output module 100 may output light for detection of a distance to an external object through first direction scanning and second direction scanning, receive light corresponding to the output light, and detect the distance or movement of the external object 750 based on the output light and the received light.

Particularly, the light output module 100 may output light through a scanning technique. To this end, the light output module 100 may be provided with a two-dimensional (2D) scanner 140.

According to this embodiment, the scanner 140 in the light output module 100 may output the input light to an external scan region 710 by sequentially and repeatedly performing first direction scanning and second direction scanning. FIG. 1 exemplarily shows emitting the output light to the scan region 710.

The scanner 140 in the light output module 100 according to this embodiment may receive output light IR, i.e. infrared light from a light source, and emit the output light outward through the first direction scanning and the second direction scanning. Particularly, in sequentially and repeatedly performing scanning from left to right and vice versa for the external scan region 710, scanning of the entire external scan region 710 may be performed frame by frame.

That is, with the light output module 100, the distance to the external object 750 may be detected, and therefore the distance or movement of the object 750 may be sensed.

In this specification, a technique for improving the reception efficiency of the light output module 100 in receiving light is proposed. The technique will be described in detail with reference to FIGS. 3 to 8.

FIG. 2 is a block diagram schematically illustrating the light output module of FIG. 1

Referring to FIG. 2, the light output module 100 outputs light in a time of flight (TOF) scheme.

To this end, the light output module 100 may include a memory 120, a scanner 140, a processor 170, a communication module 180, a drive unit 185, a power supply 190, a light source 210, and a light detector 280.
The memory 120 may serve to store a program for processing and controlling the processor 170, or to temporarily store input or output data (e.g., still images, moving images, etc.).

The communication module 180 functions as an interface with all external devices connected to the light output module 100 wirelessly or through a wire. The communication module 180 may receive data or power from those external devices and transmit the same to elements in the light output module 100, and transmit data in the light output module 100 to external devices.

Particularly, the communication module 180 may receive a radio signal from a nearby mobile terminal (not shown). Herein, the radio signal may include various types of data such as a voice call signal, video call signal, text data, and image data.

To this end, the communication module 180 may include a short range communication module (not shown). Available short range communication technologies include Bluetooth, radio frequency identification (RFID), infrared data association (IrDA), ultra wideband (UWB), ZigBee, and near field communication (NFC).

The scanner 140 may externally output input light by sequentially and repeatedly performing the first direction scanning and the second direction scanning.

The light input to the scanner 140 may include output light for detecting of distance to the external object. Herein, the output light may be infrared light.

The scanner 140 may sequentially and repeatedly perform scanning from left to right and vice versa for an external scan region to perform scanning of the entire external scan region frame by frame. The scanner 140 may output light to the external scan region through the scanning.

The processor 170 may control overall operations of the light output module 100. Specifically, it may control operations of the respective units in the light output module 100.

Meanwhile, the processor 170 may transmit an electric signal corresponding to the output light to the drive unit 185 to detect a distance to an external object.

The processor 170 may control operation of the scanner 140. Specifically, the processor 170 may control the scanner 140 to sequentially and repeatedly perform the first direction scanning and the second direction scanning to externally output light.

The processor 170 may perform detection of distance to an external object based on the electric signal corresponding to the output light transmitted to the drive unit 185 and the electric signal corresponding to the light received by the light detector 280.

For example, the processor 170 may detect a distance to an external scan region 700 using a phase difference between the electric signal corresponding to the output light and the electric signal corresponding to the received light. In addition, the processor 170 may detect a user gesture based on the distance information about the external
scan region detected frame by frame.

In addition, the light source 210 may include an infrared light source that outputs infrared light.

The light detector 280 may convert the light received in response to the output light into an electric signal. To this end, the light detector 280 may include a photodiode to convert an optical signal into a reception signal, i.e., an electric signal. Particularly, the light detector 280 may include an avalanche photodiode to convert the received light scattered by the external object into an electrical signal as a photodiode having high photoelectric conversion efficiency.

In the case in which the output light is infrared light, the light detector 280 may include a charge coupled device (CCD) or a complementary metal oxide semiconductor (CMOS) sensor to receive the infrared light.

Although not shown in FIG. 2, a sampler (not shown) to convert an analog signal into a digital signal may be further provided between the light detector 280 and the processor 170.

The drive unit 185 may control the infrared light source in the drive unit 185 to output infrared light in response to the electric signal corresponding to the output light received from the processor 170.

When power is externally or internally applied to the power supply 190 according to control by the processor 170, the power supply 190 may supply necessary power to the respective elements to operate the elements.

Meanwhile, the scanner 140 in the light output module 100 may perform scanning to output light through an opening having a predetermined size, and the light scattered or reflected by an external object may be incident on the scanner 140 through the opening.

In the case in which light is received and output through the scanner 140 as above, namely, in the case in which the light path for light output partially overlaps the light path for light reception, the corresponding light output module may be called a coaxial optical system.

If the size of the opening of the scanner 140 increases, the amount of received light may increase. However, the scanner 140 is compact in size, and accordingly increasing the size of the opening beyond a certain size is impossible. In addition, as the size of the opening increases, directionality of the output light is lowered. Thereby, in the structure of the coaxial optical system, the amount of received light decreases, and thus distance detection may not be accurately performed.

To address this problem, the present invention proposes a method for increasing the amount of the received light regardless of the size of the opening of the scanner 140. To this end, the present invention proposes that the light be received through a separate
unit rather than through the scanner 140.

Meanwhile, a system having a structure completely separating the path of output light from the path of received light may be referred to as a separated optical system. In this structure, the output angle of the output light differs from the reception angle of the received light, and thus shading occurs at the boundary region of the external object.

To prevent shading, the present invention proposes that the light is received through a separate unit rather than through the scanner 140 such that the difference between the output angle of the output light and the reception angle of the received light is within a predetermined range. That is, the present invention proposes the light output module 100 as shown in FIGS. 3 and 4.

FIG. 3 is a structural diagram illustrating an example of the light output module of FIG. 1, and FIG. 4 is a structural diagram illustrating another example of the light output module of FIG. 1.

The light output module 100 of FIG. 3 may include an output light source 210IR to output infrared light as the output. The output light source 210IR may include a laser diode or a light emitting diode (LED).

The output light source 210IR may be driven by an electric signal from the drive unit 185. The electric signal from the drive unit 185 may be generated according to control by the processor 170. To this end, the output light source 210IR may output light.

The light output from the output light source 210IR is reflected by a light reflector 257 and incident onto the scanner 140.

The scanner 140, which has an opening 141 of a first size SI, outputs light through scanning. The output angle of the light may be Θi as shown in FIG. 3. The output light from the scanner 140 is transmitted through the light reflector 257 and incident upon a light path separator 258.

The light reflector 257 may pass or reflect the incident light.

The light path separator 258 may reflect the output light from the scanner 140 such that the output light is directed to an external scan region, and the light received in response to the output light may be transmitted through the light path separator 258. To this end, the light path separator 258 may include a half mirror configured to pass a part of light and reflect the other part of the light. In another example, the light path separator 258 may be provided with a mirror configured to pass or reflect light depending on the incident angle of the light.

To pass and reflect light as above, the light path separator 258 is preferably disposed such that the extension line of the light path separator 258 intersects the plane on which the scanner 140 is arranged.

Particularly, the direction in which the output light from the scanner 140 travels to
the light path separator 258 preferably intersects the direction in which the received light travels from the light path separator 258 to the light detector 280.

Next, the light path separator 258 transfers the light received in response to the output light toward the light detector 280 by allowing the received light to be transmitted therethrough.

The light detector 280 has an opening 281 of a second size S2, and receives light from the light path separator 258. To increase the amount of the received light, the size of S2 of the opening 281 of the light detector 280 is preferably set to be greater than the size S1 of the opening 141 of the scanner 140. To this end, the gain of the amount of the received light is increased. Thereby, light reception performance of the distance detection apparatus is improved.

As shown in FIG. 3, according to the size S2 of the opening 281 of the light detector 280, the reception angle at which the light is received by the light path separator 258 may be θ2. Referring to FIG. 3, due to the size S2 of the opening 281 of the light detector 280, θ2 is greater than θ1. Therefore, the amount of the received light may increase.

In addition, the output angle of the output light from the light path separator 258 and the reception angle of the light received by the light path separator 258 are set to be within a predetermined range, with the path of the output light separated from the path of the received light. That is, by setting the output angle of the output light from the light path separator 258 to almost coincide with the reception angle of the light received by the light path separator 258, the degree of shading for the external object may be significantly lowered compared to a structure in which the output angle of the output light is different from the reception angle of the received light.

Next, details of the light output module 100 of FIG. 4 are similar to those of the light output module 100 of FIG. 3, except that a polarization splitter 259 is used in place of the mirror 258 as the light path separator.

The light source 210 may output light in the S polarization direction, and the scanner 140 may output the light output in the S polarization direction. The light path separator, i.e., the polarization splitter 259 may reflect the light output in the S polarization direction such that the output light is directed to an external scan region.

In addition, the light path separator, i.e., the polarization splitter 259 transmits the output light scattered or reflected by an external object and traveling in the P polarization direction to the light detector 280.

With this structure, the amount of the received light may increase since the size S2 of the opening 281 of the light detector 280 is greater than the size S1 of the opening 141 of the scanner 140.

In addition, by setting the output angle of the output light to coincide with the
reception angle of the received light, with the path of the output light spaced apart from the path of the received light, the degree of shading for the external object may be significantly lowered compared to a structure in which the output angle of the output light is different from the reception angle of the received light.

FIG. 5 is a diagram illustrating a method of detecting a distance in the light output module of FIG. 3 or 4. In FIG. 5, Tx denotes the phase signal of the output light, and Rx denotes the phase signal of the received light.

Referring to FIG. 5, the processor 170 of the light output module 100 may calculate a distance information level according to the phase difference $\Phi$ between the phase signal of the output light and the phase signal of the input light.

For example, a large phase difference means that the external object is at a far distance, and thus the distance information level may be set to be high. A small phase difference means that the external object is at a close distance, and thus the distance information level may be set to be low.

Setting of the distance level is performed for each section in the external scan region 700 by scanning the external scan region 700 horizontally and vertically as described above. It is also possible to detect the distance information level of each section of the external scan region 700.

Meanwhile, the processor 170 of the distance detector may calculate the distance information based on the phase difference between an electric signal for the output light and an electric signal for the received light.

FIG. 6 is a conceptual diagram illustrating a display apparatus according to another embodiment of the present invention.

Referring to FIG. 6, a display apparatus 30 may include a light output module 600 and a screen 200.

The light output module 600 of FIG. 6 outputs light in the same manner as the light output module 100 of FIG. 1. However, unlike the light output module 100 of FIG. 1, it also projects an image based on visible light.

That is, the light output module 600 may output light for detection of distance to an external object through the first direction scanning and the second direction scanning, receive light in response to the output light, and detect the distance or movement of the external object based on the output light and the received light.

In addition to outputting light, the light output module 600 may output a projection image based on the visible light through the first direction scanning and the second direction scanning.

To this end, the light output module 600 may be provided with a 2D scanner capable of outputting a projection image and light simultaneously.

Since a user 700 positioned at an opposing side of the light output module 600
recognizes a projection image on the screen 200, this projection may be referred to as rear projection.

[91] Meanwhile, distance detection may be performed for the user 700 positioned in front of the screen 200, based on the light output toward the screen 200.

[92] For example, as shown in FIG. 6, when the user 700 positioned in front of the screen 200 uses a finger 20 to implement touch input by touching the screen 200, the light output module 600 may receive light scattered or reflected by the finger 20 of the user, and sense the touch input based on the output light and the received light.

[93] In another example, as shown in FIG. 6, when the user 700 positioned in front of the screen 200 uses a hand 60 to implement gesture input in front of the screen 200, the light output module 600 may receive light scattered or reflected by the hand 60 of the user, and sense the gesture input based on the output light and the received light.

[94] As such, the display apparatus 30 allows touch input and gesture input.

[95] FIGS. 7 and 8 are views illustrating sensing of touch input and gesture input in the light output module of FIG. 6.

[96] The light output module 600 of FIG. 7 may include a light source 210, a light collector 212, an optical synthesizer 220, a light reflector 257, a light path switching unit 258, a scanner 140, a processor 170, a drive unit 185, and a light detector 280.

[97] The light source 210 may include a plurality of light sources. That is, the light source 210, a red light source 210R, a green light source 210G, a blue light source 210B, and an output light source 210IR configured to output infrared light. Each of the light sources 210R, 210G and 210B may include a laser diode.

[98] Each of the light sources 210R, 210G, 210 and 210IR may be driven by an electric signal from the drive unit 185. The electric signal from the drive unit 185 may be generated under control of the processor 170. The output light source 210IR may output light by being driven by an electric signal corresponding to the output signal.

[99] The light beams output from the light sources 210R, 210G, 210 and 210IR are collimated through a collimator lens in the light collector 212.

[100] The optical synthesizer 220 synthesizes the light beams output from the light sources 210R, 210G, 210 and 210IR and outputs the synthesized light in one direction. To this end, the optical synthesizer 220 may include four 2D MEMS mirrors 220a, 220b, 220c and 220d.

[101] That is, a first optical synthesizer 220a, a second optical synthesizer 220b, a third optical synthesizer 220c, and a fourth optical synthesizer 220d respectively direct red light output from the red light source 210R, green light output from the green light source 210G, blue light output from the blue light source 210B and the light output from the output light source 210IR to the scanner 140.

[102] The light reflector 257 reflects the red light, green light, blue light and the output
light of the output light source 210IR having passed through the optical synthesizer 220 toward the scanner 140. The light reflector 257 reflects light beams of various wavelengths. To this end, the light reflector 257 may be embodied by a total mirror (TM).

[103] The scanner 140, which has an opening 141 of a first size SI, scans and outputs visible light RGB and the output light IR. Particularly, the visible light RGB and the light IR output from the scanner 140 may be transmitted through the light reflector 257 and incident on the light path separator 258.

[104] The light reflector 257 may pass or reflect the incident light. For example, in the case in which the light reflector 257 is embodied by a half mirror, the light reflector 257 may transmit a part of light and reflect the other part of the light.

[105] The light path separator 258 may reflect the visible light RGB and output light IR from the scanner 140 toward an external scan region. Particularly, visible light RGB and the output light IR may be output to the screen 200. Thereby, a projection image corresponding to the visible light RGB may be displayed on the screen 200.

[106] Meanwhile, it is possible to perform the distance detection for the user positioned in front of the screen 200 based on the light output to the screen 200.

[107] For example, the light IR may be scattered or reflected by the finger 20 or hand 60 of the user and incident on the light output module 600.

[108] The light path separator 258 may transmit the light received in response to the output light IR.

[109] To this end, the light path separator 258 may be provided with a half mirror configured to pass a part of light and reflect the other part of the light. In another example, the light path separator 258 may be provided with a mirror configured to pass or reflect light according to the incident angle of the incident light.

[110] Next, the light path separator 258 transmits the light received in response to the output light IR to the light detector 280.

[III] At this time, the light detector 280, which has an opening 281 of a second side S2, receives light from the light path separator 258. To increase the amount of the received light, the size S2 of the opening 281 of the light detector 280 is preferably set to be greater than the size SI of the opening 141 of the scanner 140. Thereby, the gain of the amount of the received light may be increased. Accordingly, light reception performance of the display apparatus 30 may be improved.

[112] In addition, by setting the output angle of the visible light RGB and output light IR to coincide with the reception angle of the received light, with the path of the visible light RGB and output light IR spaced apart from the path of the received light, the degree of shading for the external object may be significantly lowered compared to a structure in which the output angle of the visible light RGB and output light IR is different from
the reception angle of the received light.

While the light path separator 258 in the light output module 600 is illustrated as being provided with a mirror in FIG. 7, the polarization splitter 259 may be used in place of the mirror 258 as the light path separator, as shown in FIG. 8.

Referring to FIG. 8, the light source 210 may output light in the S polarization direction, and the scanner 140 may output the light output in the S polarization direction. The light path separator, i.e., the polarization splitter 259 may reflect the light output in the S polarization direction such that the output light is directed to an external scan region.

In addition, the light path separator, i.e., the polarization splitter 259 transmits the output light scattered or reflected by an external object and traveling in the P polarization direction to the light detector 280.

With this structure, the amount of the received light may increase since the size S2 of the opening 281 of the light detector 280 is greater than the size S1 of the opening 141 of the scanner 140.

In addition, by setting the output angle of the output light to coincide with the reception angle of the received light, with the path of the output light spaced apart from the path of the received light, the degree of shading for the external object may be significantly lowered compared to a structure in which the output angle of the output light is different from the reception angle of the received light.

The light detector 280 may convert the received light into an electric signal, and the processor 170 may perform distance detection sensing or touch input based on the received light from the finger 20 and the output light.

Meanwhile, in the case in which the user implements gesture input in front of the screen 200 by moving the hand 60, the output light IR may be scattered or reflected by the hand 60 of the user, and incident on the light output module 600. Specifically, the received light may be input to the light detector 280 via a light collector 218 and an infrared light transmission filter 282.

The light detector 280 may convert the received light into an electric signal, and the processor 170 may perform distance detection and sensing of a gesture input based on the light received from the user's hand 60 and the output light.

According to this embodiment, visible light RGB output from the scanner 140 is emitted. Therefore, even in the case in which the screen 200 to display a projection image is provided with a free-form surface, it is possible to display the image in accordance with the curved surface of the screen.

The processor 170 may control a visible light-based image to be projected onto the screen 200 in a manner that the image is scaled and thus a scaled image is displayed on the screen in case that the screen is provided with the free-form surface.
For example, it is possible to recognize curvature of the screen 200 through the distance detection using the output light, to scale an image to be displayed in accordance with the curved surface, and to display a scaled projection image. Thereby, display on the free-formed surface is possible.

In the case in which the user performs a finger touch on the screen 200, the processor 170 may recognize the touch input based on the received light reflected or scattered by the finger.

Particularly, the intensity of light received in a section of the screen 200 to which a finger touch is applied is higher than in the other sections of the screen 200, and therefore the processor 170 may recognize the touch input based on this fact.

The distance detection apparatus according to the present invention is not limited to the embodiments described above. All or parts of the embodiments may be selectively combined and configured to make various modifications thereto.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

**Industrial Applicability**

The present invention may be applied to a distance detection apparatus and a display apparatus and, more particularly, to a distance detection apparatus and display apparatus for improving light reception performance.
Claims

[Claim 1] A distance detection apparatus comprising:
a light source configured to output light for detection of a distance to an
external object;
a scanner configured to output the output light by performing first
direction scanning and second direction scanning;
a light path separator configured to output the output light from the
scanner to an external scan region by reflecting the output light and to
transmit received light from an external;
a light detector configured to convert the received light from the light
path separator into an electric signal; and
a processor configured to detect the distance to the external object in
the external scan region based on an electric signal corresponding to the
output light and an electric signal corresponding to the received light,
wherein a size of an opening provided to the light detector is greater
than a size of an opening provided to the scanner.

[Claim 2] The distance detection apparatus according to claim 1, wherein the light
path separator comprises a mirror configured to output the output light
from the scanner to the external scan region by reflecting the output
light and to transmit the received light from the external.

[Claim 3] The distance detection apparatus according to claim 1, wherein the light
path separator comprises a polarization separator configured to output
the output light of first polarization from the scanner to the external
scan region by reflecting the output light and to transmit the received
light of second polarization from the external.

[Claim 4] The distance detection apparatus according to claim 1, wherein the light
path separator is disposed such that an extension direction of the light
path separator intersects an extension direction of the scanner.

[Claim 5] The distance detection apparatus according to any one of claims 1 to 4,
further comprising a second mirror configured to output the output light
from the light source to the scanner by reflecting the output light.

[Claim 6] The distance detection apparatus according to claim 1, wherein a
difference between an output angle of the output light output from the
light path separator and a reception angle of the received light received
by the light path separator is within a predetermined range.

[Claim 7] The distance detection apparatus according to claim 1, wherein a
direction of travel of the output light between the scanner and the light
path separator intersects a direction of travel of the received light between the light path separator and the light detector.

[Claim 8] The distance detection apparatus according to claim 1, wherein the processor detects the distance to the external object in the external scan region based on a phase difference between the electric signal corresponding to the output light and the electric signal corresponding to the received light.

[Claim 9] A display apparatus comprising:

- a light source configured to output visible light and output light for detection of a distance to an external object;
- a scanner configured to output a projection image and the output light by performing first direction scanning and second direction scanning, the projection image being based on visible light;
- a light path separator configured to output the projection image and the output light from the scanner to an external scan region by reflecting the projection image and the output light and to transmit received light from an external;
- a light detector configured to convert the received light from the light path separator into an electric signal; and
- a processor configured to detect the distance to the external object in the external scan region based on an electric signal corresponding to the output light and an electric signal corresponding to the received light, wherein a size of an opening provided to the light detector is greater than a size of an opening provided to the scanner.

[Claim 10] The display apparatus according to claim 9, wherein the light path separator comprises a mirror configured to output the projection image and the output light from the scanner to the external scan region by reflecting the projection image and the output light and to transmit the received light from the external.

[Claim 11] The display apparatus according to claim 9, wherein the light path separator comprises a polarization separator configured to output the projection image and output light of first polarization from the scanner to the external scan region by reflecting the projection image and output light and to transmit the received light of second polarization in response to the output light.

[Claim 12] The display apparatus according to claim 9, wherein the light path separator is disposed such that an extension direction of the light path separator intersects an extension direction of the scanner.
[Claim 13] The display apparatus according to claim 9, further comprising a second mirror configured to output the projection image and output light from the light source to the scanner by reflecting the projection image and the output light.

[Claim 14] The display apparatus according to claim 9, wherein the processor performs a control operation to project the projection image onto a screen such that the projection image is scaled and displayed on the screen in consideration of a curved surface provided to the screen, the projection image being based on visible light.

[Claim 15] The display apparatus according to claim 9, wherein, when a user touches the screen with a finger, the processor recognizes a corresponding touch input based on the received light reflected or scattered by the finger.
[Fig. 3]
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
G01C 3/08(2006.01)i, G01B 11/14(2006.01)i, G01B 9/00(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)
G01C 3/08; G01S 7/48; G06K 9/00; G01C 3/06; G01B 11/14; G01B 9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: distance, light, scanner, separator, processor, reflector and opening

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No.</th>
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<td>US 2012-0249996 Al (TANAKA et al.) 04 October 2012; See abst act, paragraphs [0060]-[0113], claim 1 and figures 1-3</td>
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<td>1-15</td>
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<tr>
<td>A</td>
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Further documents are listed in the continuation of Box C.  

See patent family annex.

* Special categories of cited documents:
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"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.

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"&" document member of the same patent family.

Date of the actual completion of the international search: 19 November 2014 (19.11.2014)

Date of mailing of the international search report: 19 November 2014 (19.11.2014)

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<tr>
<td>US 2012-0249996 Al</td>
<td>04/10/2012</td>
<td>CN 102736075 A</td>
<td>17/10/2012</td>
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<td>DE 102012102244 Al</td>
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<td>JP 05532003 B2</td>
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<td>US 8681319 B2</td>
<td>25/03/2014</td>
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<td>CN 101149252 A</td>
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<td>CN 101149252 B</td>
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