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(54) Title: SYSTEM AND METHOD FOR REMOTE TOUCH DETECTION

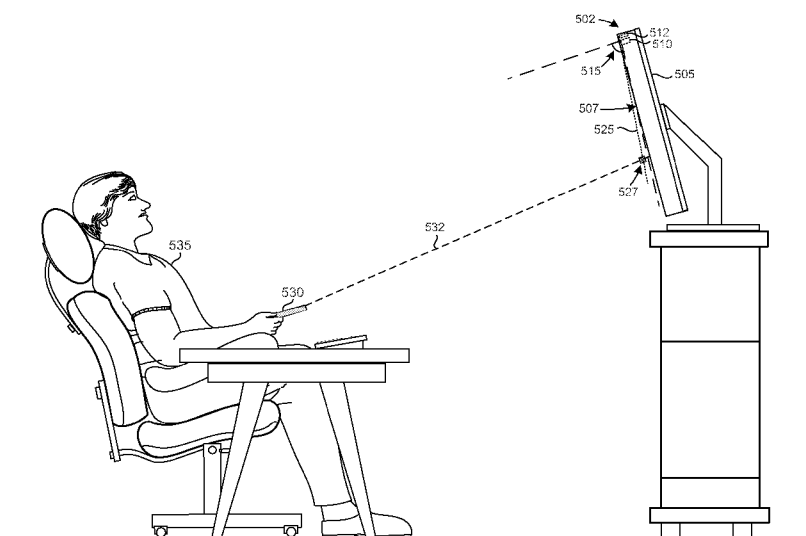


FIG. 5A

(57) Abstract: Embodiments of the present invention disclose a system and method for remote touch detection. According to one embodiment, an infrared light source is projected across a front surface of a display via at least one light emitting device. Furthermore, an infrared signal is transmitted in a direction of the front surface of the display via a remote pointing device. A surface target position is then determined based on measurement data caused by disruption of a portion of the infrared light source of the light emitting device by either the infrared signal or a physical touch from a user.

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SYSTEM AND METHOD FOR REMOTE TOUCH DETECTION

BACKGROUND

[0001] Providing efficient and intuitive interaction between a computer system and users thereof is essential for delivering an engaging and enjoyable user-experience. Today, most computer systems include a keyboard for allowing a user to manually input information into the computer system, and a mouse for selecting or highlighting items shown on an associated display unit. As computer systems have grown in popularity, however, alternate input and interaction systems have been developed. For example, touch-based, or touchscreen, computer systems allow a user to physically touch the display unit and have that touch registered as an input at the particular touch location, thereby enabling a user to interact physically with objects shown on the display of the computer system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The features and advantages of the inventions as well as additional features and advantages thereof will be more clearly understood hereinafter as a result of a detailed description of particular embodiments of the invention when taken in conjunction with the following drawings in which:

[0003] FIG. 1 is a three-dimensional perspective view of an all-in-one touchscreen computing system according to an embodiment of the present invention.

[0004] FIG. 2 is a simplified block diagram of the touchscreen computer vision system according to an embodiment of the present invention.

[0005] FIG. 3 is an illustrative example of operation of a light emitting device and optical sensor according to an embodiment of the invention.

[0006] FIGS. 4A and 4B are top down perspective views of the computer vision system and operating environments thereof according to an embodiment of the present invention.

[0007] FIG. 5A illustrates an exemplary environment of a user interacting with the computer vision system, while FIG. 5B illustrates a top down view perspective view

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of the computer vision system and the operating user shown in FIG. 5A according to one embodiment of the present invention.

[0008] FIG. 6 illustrates the processing steps for the remote input detection according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] The following discussion is directed to various embodiments. Although one or more of these embodiments may be specified, the embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. In addition, one skilled in the art will understand that the following description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to intimate that the scope of the disclosure, including the claims, is limited to that embodiment.

[00010] While touch technology is an exciting and natural means of user interface, it can still be improved. One fundamental drawback of conventional touchscreen interface systems is that the user must be within a few feet of the touchscreen computer for operation. In addition to limiting user movement and system placement, physical touching of the display screen may also cause arm and shoulder fatigue with extended use of the system.

[00011] Embodiments of the present invention provide a system and method for remote touch detection capable utilizing existing touchscreen computer system without hardware modification. That is, the touchscreen computer vision system is capable of supporting both physical touch, or “black or shadow” detection, and remote touch, or “white” detection. As such, embodiments in accordance with the present invention allow system interaction with an laser beam or infrared signal such as one from a laser pointer, thereby enabling users to remotely interface with a touchscreen system while maintaining line-of-sight contact of the laser beam with the front surface of the display.

[00012] Several advantages are afforded by the remote touch input method of the present embodiments. For example, the operating user does not need to be in close proximity to the touch display in order to interface with it. Accordingly, such a

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configuration allows for greater user mobility and more flexible placement of the touchscreen display. Furthermore, the remote touch system of the present embodiments helps to alleviate arm and shoulder fatigue caused by extended sessions of physically touching a vertical screen since user input can now be done from a comfortable location with only the press of a button or a flick of the wrist from the remote pointing device.

[00013] Referring now in more detail to the drawings in which like numerals identify corresponding parts throughout the views, FIG. 1A is a three-dimensional perspective view of an all-in-one computer having multiple optical sensors, while FIG. 1B is a top down view of a display device and optical sensors including the field of views thereof according to an embodiment of the present invention. As shown in FIG. 1A, the system 100 includes a housing 105 for enclosing a display panel 109 and light emitting devices 113a and 113b and optical sensors 110a and 110b. The system also includes input devices such as a keyboard 120 and a mouse 125 for text entry, navigating the user interface, and manipulating data by a user for example.

[00014] The display system 100 may includes a display panel 109 and a transparent layer 107 in front of the display panel 109, though the transparent layer 107 may be omitted in certain embodiments. The front side of the display panel 109 is the surface that displays an image and the back of the panel 109 is opposite the front. Light emitting devices 113a and 113b and optical sensors 110a and 110b can be on the same side of the transparent layer 107 as the display panel 109 to protect the optical sensors from contaminates. In an alternative embodiment, the light emitting device and optical sensors 110a and 110b may be in front of the transparent layer 107. The transparent layer 107 can be glass, plastic, or another transparent material. The display panel 109 may be a liquid crystal display (LCD) panel, a plasma display, a cathode ray tube (CRT), an OLED or a projection display such as digital light processing (DLP), for example. In one embodiment, mounting the light emitting devices 113a and 113b and optical sensors 110a and 110b in an area of the display system 100 that is outside of the perimeter of the of the display panel 109 provides that the clarity of the transparent layer is not reduced by the light emitting devices or optical sensors.

[00015] In one embodiment, optical sensors 110a and 110b represent may two-dimensional cameras including a charge-coupled device (CCD) or complementary metal-

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oxide semiconductor (CMOS) phototransistors for example, and are configured to receive external light or shadows and convert the light or shadow to data. In another embodiment, optical sensors 110a and 110b represent three-dimensional optical sensors configured to report a three-dimensional depth map to a processor. The three-dimensional optical sensors 110a and 110b can determine the depth of an object located within its respective field of view 115a and 115b. The depth map changes over time as an object and signal moves in the respective field of view 115a of optical sensor 110a, or within the field of view 115b of optical sensor 110b. According to one embodiment, the depth of the object can be used to determine if the object is within a programmed distance of the display panel but not actually contacting the front side of the display panel. For example, the object may be a user's hand or finger approaching the front side of the display panel 109, or an infrared signal emitted from a laser pointing device operated by a user. Still further, and according to one embodiment, optical sensors 110a and 110b are positioned at top most corners around the perimeter of the display panel 109 such that each field of view 115a and 115b includes the areas above and surrounding the display panel 109. As such, a touch input such as a user's hand or infrared signal for example, may both be detected, and any associated motions around the perimeter and in front of the computer system 100 can be accurately interpreted by the computer processor.

[00016] FIG. 2 is a simplified block diagram of the computer vision system according to an embodiment of the present invention. As shown in this exemplary embodiment, the system 200 includes a processor 220 coupled to a display unit 230, a system control unit 240, a computer-readable storage medium 225, light emitter 210, and optical sensor 213 configured to capture touch input 204, or measurement data related to an object or input disruption near the front of the display unit 230. In one embodiment, processor 220 represents a central processing unit configured to execute program instructions. Display unit 230 represents an electronic visual display or touch-sensitive display such as a desktop flat panel monitor configured to display images and a graphical user interface for enabling interaction between the user and the computer system. Storage medium 225 represents volatile storage (e.g. random access memory), non-volatile store (e.g. hard disk drive, read-only memory, compact disc read only memory, flash storage, etc.), or combinations thereof. In one embodiment, system control unit 240 may represent an application program or user interface control module configured to receive

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and process measurement data of a detected object. Furthermore, storage medium 225 includes software 228 that is executable by processor 220 and, that when executed, causes the processor 220 to perform some or all of the functionality described herein.

[00017] FIG. 3 is an illustrative example of operation of the light emitting device and optical sensor according to an embodiment of the invention. The light emitting device 325 is configured to project a light source 327 such as an infrared light or a laser light source for example, that emits light and may be invisible to the user. In one embodiment, the light emitting device 325 emits a structured light that is projected as a light pattern such as a plane, grid, or more complex shape at a known angle. The way that the light pattern deforms when disrupted by an object or light source, allows the computer vision system to calculate the depth and surface information of the object or light source. For example, the optical sensor 315 can receive disrupted light 329 as measurement data, which is reflected from a light emitting device 325 from an object 320 for example. Furthermore, the light emitting device 325 can be in any position relative to the optical sensor 315 that allows the light source 327 to be disrupted or reflected off the object 320 and be captured by the optical sensor 315. The infrared light 325 can be disrupted and reflected from an object 320 such as user's hand or other light source, so as to be captured by the optical sensor 315.

[00018] FIGS. 4A and 4B are top down perspective views of the computer vision system and operating environments thereof according to an embodiment of the present invention. As shown in the embodiment of FIG. 4A, the touchscreen system includes a display 405 for enclosing light emitting devices 412a and 412b and optical sensors 410a and 410b. According to the present embodiment, light emitting devices 412a and 412b project light source 417a and 417b respectively. More specifically, the light emitters 412a and 412b projects a plane of infrared light 417a and 417b that covers the front surface 407 of the display panel 405. Optical sensors 410a and 410b include respective fields of views 415a and 415b configured to detect and capture disruptions in either light source 417a or 417b caused by an input object or device approaching the front display surface 407. The object may be a physical object such as a finger or stylus is in contact with the display surface 407 as shown in FIG. 4A, or an invisible input or infrared signal emitted onto the front surface 407 of the display as shown in FIG. 4B.

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[00019] More particularly, an object such as a user's hand 428 may approach the display 405 and cause a disruption in either light source 417a or 417b at position 425 in FIG. 4A. Similarly, a remote pointing device 430 operated by a user may output an infrared signal 432 in the direction of the display 405 so as to cause a disruption in the plane of either light source 417a or 417b at position 425 in FIG. 4B. When the infrared signal 432 disrupts the plane of either light source 417a or 417b, the disruption is accordingly detected by one of the optical sensors 410a or 410b. Thereafter, a processing controller receives measurement or disruption information from the optical sensors in the form of a shadow data where the disrupted area may appear black or white for example.

[00020] FIG. 5A illustrates an exemplary environment of a user interacting with the computer vision system, while FIG. 5B illustrates a top down view perspective view of the computer vision system and an operating user shown in FIG. 5A according to one embodiment of the present invention. As shown in FIGS. 5A and 5B, the operating environment includes a user 535 aiming a remote pointing device 530 at a display system 502. The user may be positioned further away (e.g. greater than one meter) from the display system than traditional touchscreen operating environments. Like the previous embodiments, the display system includes a light emitting device 510 configured to project a light source plane 525 across the front surface 507 of the display panel 505, and an optical sensor 510 configured with a field of view 515. Furthermore, as the infrared signal 532 from the remote pointing device 530 approaches the front surface of the display panel, the signal 532 eventually breaks and disrupts a portion of the light source 525 or plane thereof.

[00021] As shown in the embodiment of FIG. 5A, the plane of the light source 525 is disrupted by the infrared signal 532 near position 527, which is proximate to the front surface of the display panel. Thereafter, the optical sensor 510 captures the light caused by the disruption and associates measurement data therewith. For example, in the case of a physical disruption from a stylus or hand for example, the optical sensors are configured to capture measurement data having an approximate "black" color value at or near (0, 0, 0) within a RGB color model caused by the change in intensity of the light source emitted by the light emitters at the area of disruption. Similarly, in the case of a disruption from a light source such as a laser beam or infrared signal from a remote pointing device for

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example, the optical sensors are also configured to simultaneously capture measurement data having an approximate “white” color value at or near (255, 255, 255) within a RGB color model caused by the change in intensity of the light source emitted by the light emitters at the area of disruption. Based upon this disruption and measurement data, the processor of the computer vision system can determine the approximate location of the disruption and the surface target position, which is the desired touch input location on the front surface of the display panel. Furthermore, and as shown in the embodiment of FIGS. 5A – 5B, the user 535 and the user’s hand is in a natural and relaxed positioned while interacting with the computer vision system 502.

[00022] FIG. 6 illustrates the processing steps for remote touch detection according to an embodiment of the present invention. In step 602, the computer vision system projects an infrared light source as a plane to cover the front surface of the display device. Next, in step 604 an infrared signal from a user operating a remote pointing device directed towards the front surface of the display, is received at the light source projected by the light emitting device. A disruption in the light source is then captured by the optical sensor as measurement or disruption data in step 606. That is, the optical sensor detects the relative location of the disruption on the front surface of the display caused by the infrared signal or physical object breaking and disrupting the plane of the light source from the light emitting device.

[00023] In step 608, the processor calculates the surface target position based on measurement data captured by the optical sensor. Next, in step 610, the system determines if the surface target position has moved, or if the user is moving the remote pointing device or physical object across the front display surface, and if so, updates the surface target position accordingly. According to one embodiment, once the surface target position is stationary for a predetermined time, the processor registers the surface target position as a touch input location in step 612 for determining an appropriate operation of the computer system.

[00024] Embodiments of the present invention provide a method for implementing a remote pointing device for use with touchscreen computer vision systems. In particular, the computer vision system of the present embodiments is configured to detect touch inputs caused by physical objects contacting a front surface of the display panel, in

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addition to touch inputs caused by an infrared light source contacting the front surface of the display panel. As such, a laser pointing device operated by a user and emitting an infrared signal may serve as a remote operating device for controlling and operating a touchscreen computing system.

[00025] Many advantages are afforded by the remote touch detection system and method according to embodiments of the present invention. For instance, the display panel of the touchscreen computing system may be placed in a location in which physical touch of the display is difficult or impossible (e.g. ceiling mounted). In such a case, the user may operate the computing system remotely from a more comfortable position than normal (e.g. lying down). Still further, the computer vision system of the present embodiments helps to reduce upper body fatigue caused by prolonged extension of a user's arms when physically contacting the display panel with their hands or a stylus for example. Moreover, embodiments of the present invention can be beneficial for users with physical disabilities by attaching the laser emitter to a headband or body part other than the user's hand for example.

[00026] Furthermore, while the invention has been described with respect to particular embodiments, one skilled in the art will recognize that numerous modifications are possible. For example, although exemplary embodiments depict an all-in-one computer as the representative display panel of the computer vision system, the invention is not limited thereto. For example, the computer vision system of the present embodiments may be implemented in a netbook, a tablet personal computer, a cell phone, or any other electronic device having a display panel, light emitting device, and optical sensor.

[00027] Still further, a single light emitting device and single optical sensor may be utilized in the computer vision system in lieu of the two emitting devices and two optical sensors depicted in the figures. Thus, although the invention has been described with respect to exemplary embodiments, it will be appreciated that the invention is intended to cover all modifications and equivalents within the scope of the following claims.

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WHAT IS CLAIMED IS:

- 1 1. A method for interacting with a computer system having a display, the
2 method comprising:
3 projecting an infrared light source across a front surface of the display via at least
4 one light emitting device;
5 transmitting, via a remote pointing device operated by a user, an infrared signal in
6 a direction of the front surface of the display; and
7 determining a surface target position based on measurement data caused by
8 disruption at least a portion of the infrared light source of the light emitting device by
9 either the infrared signal or a physical touch from a user.
- 1 2. The method of claim 1, wherein determining the surface target position
2 further includes:
3 capturing measurement data from the disruption of the infrared light source via at
4 least one optical sensor positioned on the front surface of the display.
- 1 3. The method of claim 1, further comprising:
2 continually updating the surface target position as the infrared signal moves
3 around the front surface of the display.
- 1 4. The method of claim 1, wherein the infrared light source projects as plane
2 so as to cover the entire front surface of the display.
- 1 5. The method of claim 2, wherein the measurement data includes data
2 indicating a change of intensity of the light source at an area where the disruption by the
3 infrared signal occurred.
- 1 6. The method of claim 2, wherein a surface target position can be
2 determined for a user operating the remote pointing device at a distance greater than one
3 meter from the front surface of the display.
- 1 7. The method of claim 2, wherein the display includes at least two optical
2 sensors positioned on opposite sides of the front surface of the display.

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1 8. A computer system comprising:
2 a processor;
3 a display including a front surface for displaying images to a user;
4 a light emitting device positioned proximate to the front surface of the display and
5 configured to project an infrared light source across the front surface of the display;
6 at least one optical sensor coupled to the processor;
7 wherein the processor is configured to determine a surface target position based
8 on measurement data caused by disruption of at least a portion of the infrared light source
9 of the light emitting device by either an infrared signal or a physical touch.

1 9. The system of claim 8, wherein the at least one optical sensor is configured
2 to capture measurement data caused by the disruption of the infrared signal.

1 10. The system of claim 8, wherein the infrared light source projects as plane
2 so as to cover the entire front surface of the display.

1 11. The system of claim 8, wherein the measurement data includes data
2 indicating a change of intensity of the light source at an area where the disruption by the
3 infrared signal occurred.

1 12. The system of claim 9, wherein the system includes at least two optical
2 sensors positioned on opposite sides of the front surface of the display.

3 13. The system of claim 9, wherein a surface target position can be determined
4 for a user operating the remote pointing device at a distance greater than one meter from
5 the front surface of the display.

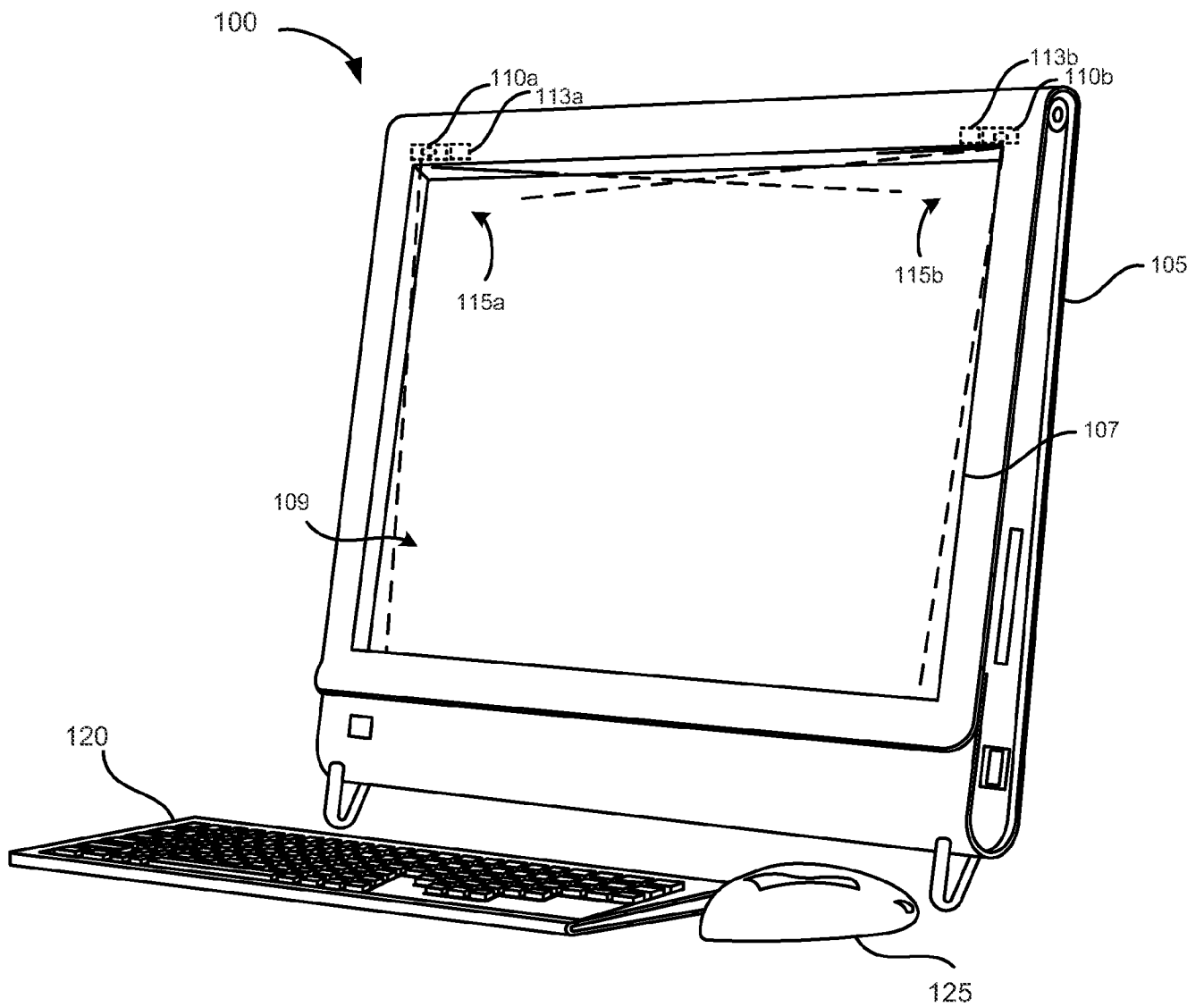
1 14. A computer readable storage medium having stored executable
2 instructions, that when executed by a processor, causes the processor to:
3 capture disruption data from at least one optical sensor positioned on the front
4 surface of the display, and
5 determine a surface target position based on the disruption data;

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6 wherein the disruption data is caused by disruption of a portion of an infrared light
7 source of a light emitting device by either an infrared signal or a physical touch on the
8 front surface of the display.

1 15. The computer readable storage medium of claim 14, wherein the
2 executable instructions further cause the processor to:

3 continually update the surface target position as the infrared signal moves around
4 the front surface of the display.

**FIG. 1**

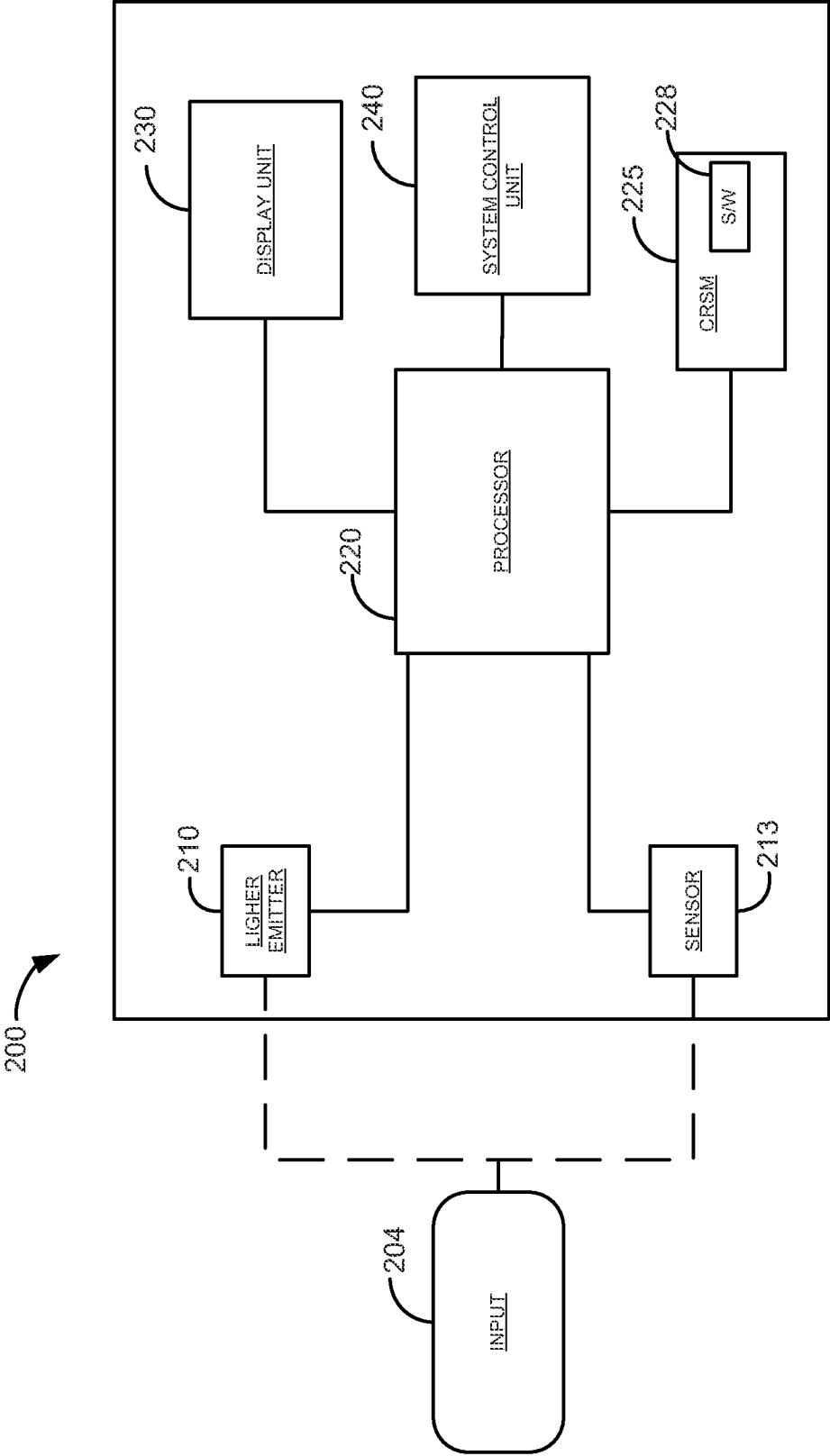
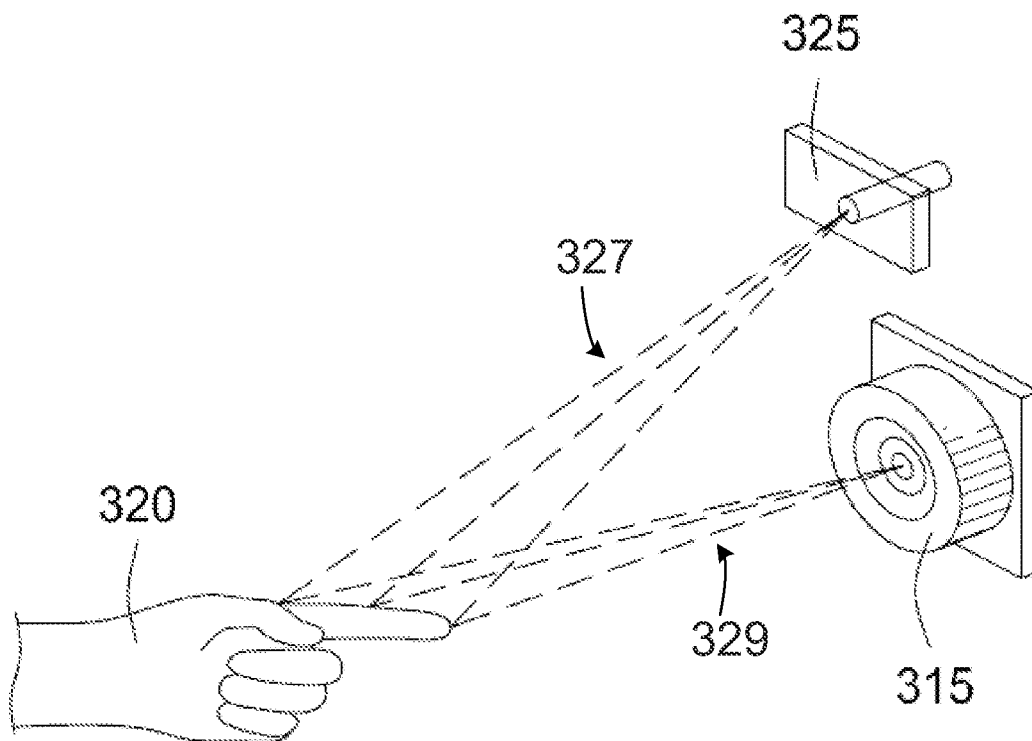


FIG. 2

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**FIG. 3**

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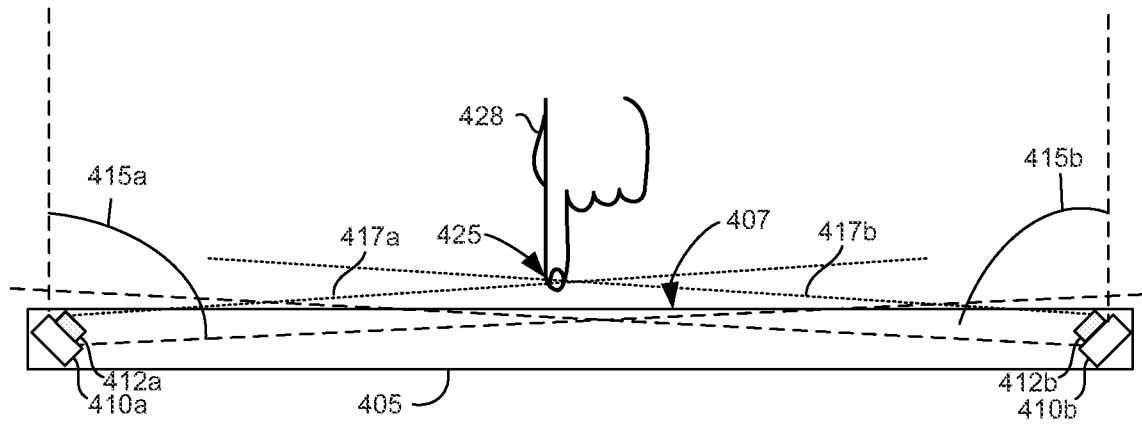


FIG. 4A

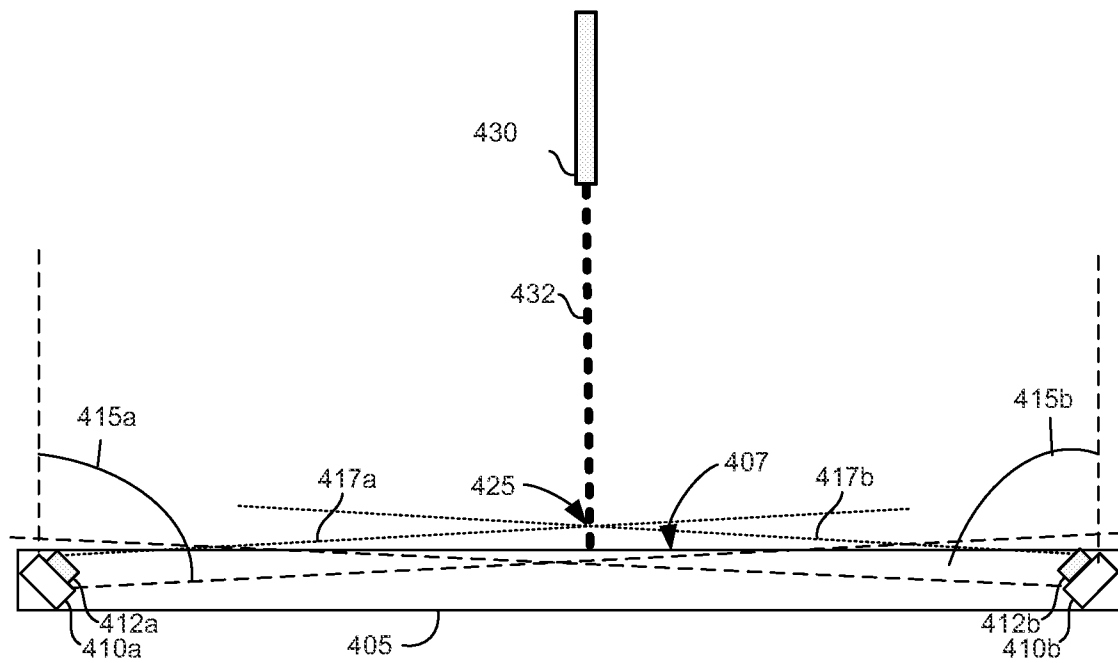


FIG. 4B

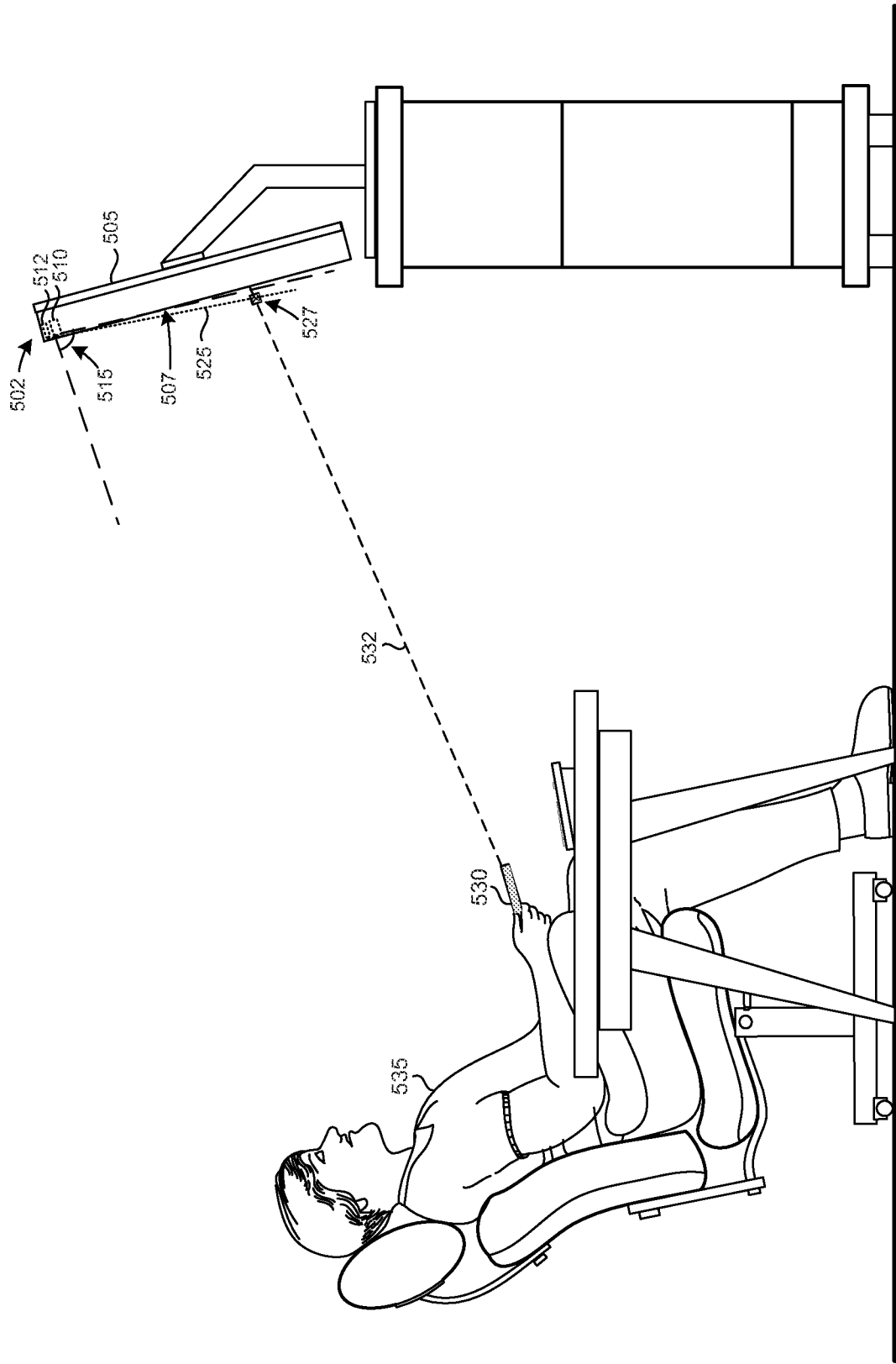


FIG. 5A

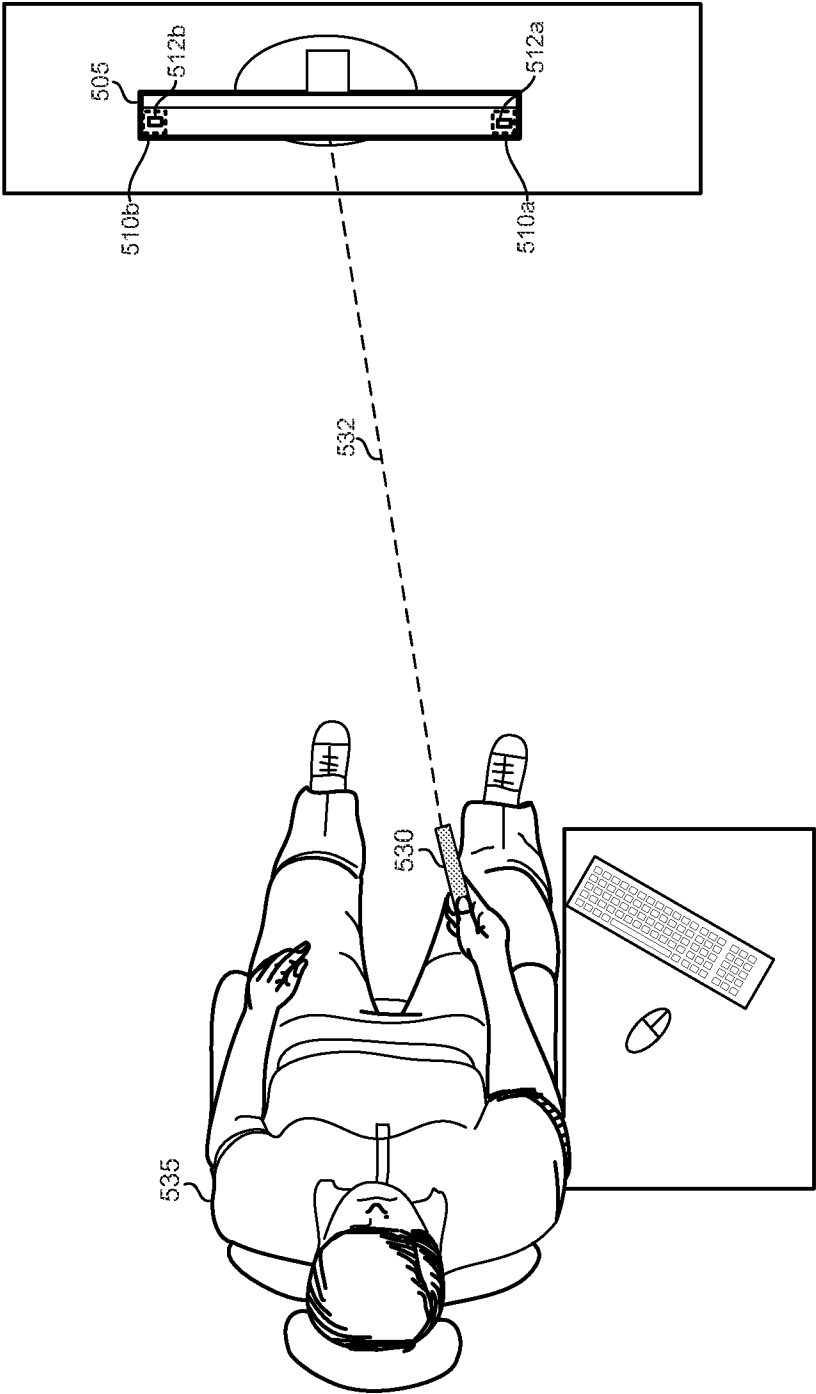
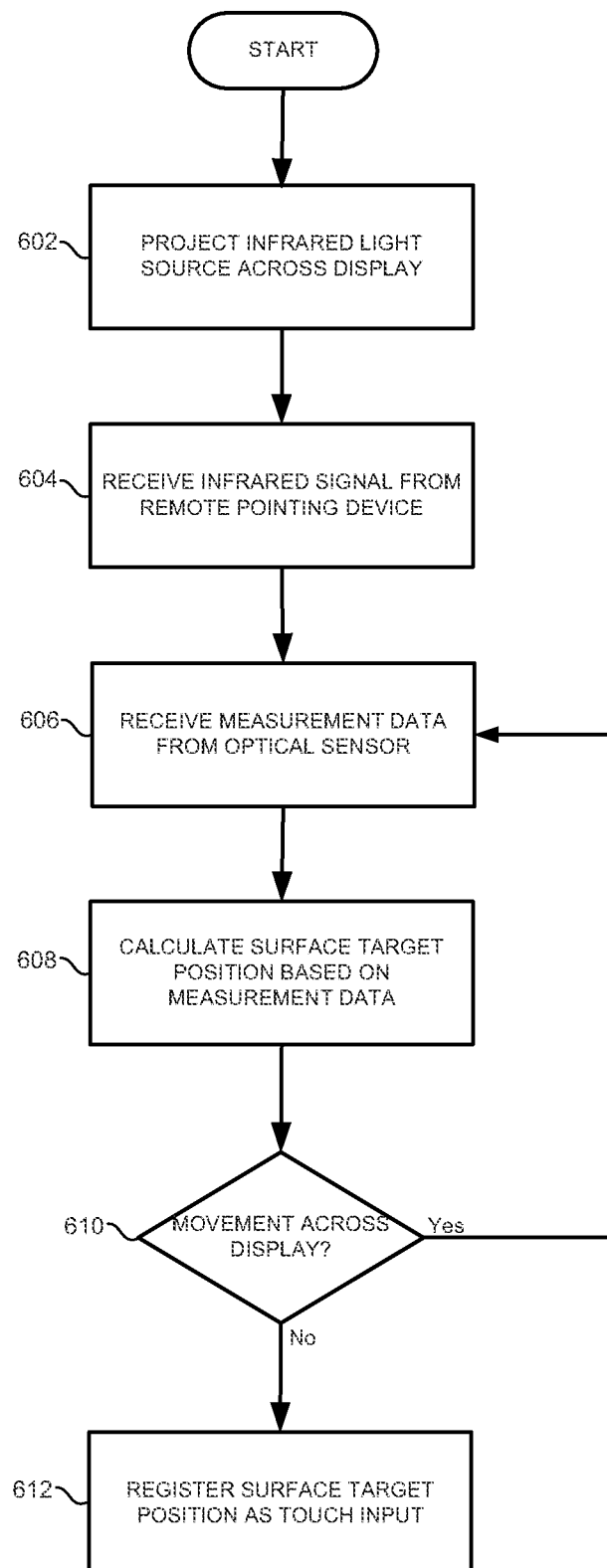


FIG. 5B

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**FIG. 6**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/043447**A. CLASSIFICATION OF SUBJECT MATTER****G06F 3/042(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)

G06F 3/042; G06F 3/00; G06F 3/03; G06F 3/033; G06F 3/041

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

eKOMPASS(KIPO internal) & Keywords: "touch screen, infrared, source, detection, position, and similar terms"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-0910024 B1 (HOGAHEM TECH. CO.) 30 July 2009 See summary of the invention; Figures 8-11; Claims 2,6-10	1-15
X	KR 10-2008-0100008 A (LG DISPLAY CO.) 14 November 2008 See summary of the invention; Figures 4,5; Claims 1,3,4	1-15
A	KR 10-0913758 B1 (HOGAHEM TECH. CO.) 24 August 2009 See summary of the invention; Figures 1,2; Claims 1,2	1-15
A	KR 10-2009-0026957 A (LG DISPLAY CO.) 16 March 2009 See summary of the invention; Figures 1,2; Claim 1	1-15
A	KR 10-0968205 B1 (KOREA ELECTRON. TECH. INS.) 06 July 2010 See summary of the invention; Figure 1; Claim 1	1-15

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

* Special categories of cited documents:

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

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"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

28 APRIL 2011 (28.04.2011)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Cheongsu-ro,
Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

JEONG, Jae Woo

Telephone No. 82-42-481-5718



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2010/043447

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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KR 10-0968205 B1	06.07.2010	None	