(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(54) Title: ORCHESTRATED DIGITAL DISPLAY SYSTEM

FIGURE 2
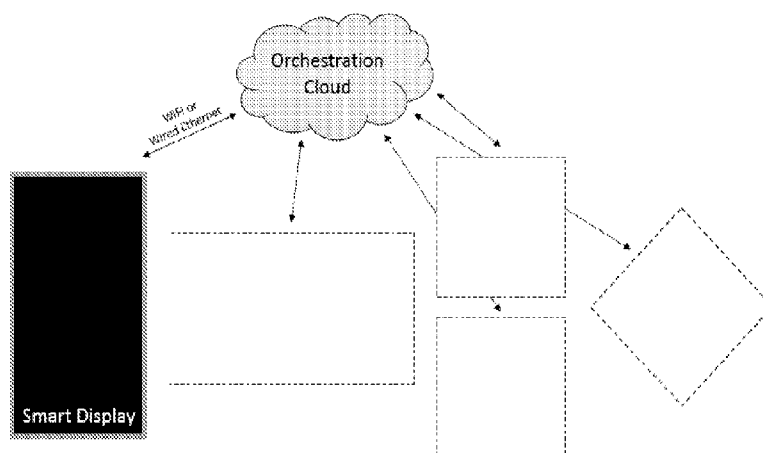
(57) Abstract: A system for orchestrating multiple digital display devices to display a digital content item across the multiple digital display devices, including multiple digital display devices, where each digital display device includes a display screen, a memory, a processor, and data link capabilities, a user device including a display screen, a user interface, a memory, a processor, and data link capabilities, and a cloud-based computing system configured to communicate with the multiple digital display devices and the user device.

WO 2018/098320 A1

ORCHESTRATED DIGITAL DISPLAY SYSTEM

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Cross-Reference to Related Applications

The present application claims priority to U.S. provisional application Serial No. 62/425,940, filed November 23, 2016, the disclosure of which is incorporated herein by reference in its
10   entirety.

Technical Field

The present invention relates to a system for orchestrating multiple digital displays to display one digital content item
15   across the multiple digital displays.

Background of the Invention

It is desirable at times to display one digital content item in a large format. To avoid the expense and complications
20   associated with large displays such as LCD screens or projector screens, users may choose to display the item across several smaller digital displays, so that each display shows a different portion of the content item while conveying the appearance of one cohesive image. Alternatively, users may choose to display
25   an item across multiple displays for stylist effect.

Systems currently on the market for synchronizing and orchestrating multiple displays to show a single content item are complicated and costly. Such systems generally involve an expensive video processor that is directly connected to each
30   display by a wired video connection. The present invention presents a system of wirelessly connected digital displays, which can quickly and easily be orchestrated to display one cohesive image using a user application connected to a cloud

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system, and which may be accomplished without the use of a dedicated video connection to each display.

Summary of the Invention

5   In general, in one aspect, the invention features a system for orchestrating multiple digital display devices to display a digital content item across the multiple digital display devices, including multiple digital display devices, where each digital display device includes a display screen, a memory, a processor,

10   and data link capabilities, a user device including a display screen, a user interface, a memory, a processor, and data link capabilities, and a cloud-based computing system configured to communicate with the multiple digital display devices and the user device, where one or more of the multiple digital display

15   devices, the user device, and the cloud-based computing system are configured to determine a relative geometry and position of each digital display device of the multiple digital display devices, where, upon selection of the digital content item on the user device by a user, the multiple digital display devices

20   are configured to receive data representing the digital content item and display, on the display screens of the multiple digital display devices, a synchronized display representing the digital content item, and where the synchronized display representing the digital content item is a display of the digital content

25   item rendered across the multiple digital display devices in the form of a continuous display of the digital content item, accounting for space between multiple digital display devices and only displaying portions of the continuous display of the digital content item at locations where a digital display device

30   is positioned.

Implementations of the invention may include one or more of the following features. The data link capabilities of the digital display device or the user device may be WiFi capabilities or wired Ethernet capabilities. The display screen

of the digital display device may be an LCD screen, an LED screen,
an OLED screen, a QLED screen, or a digital ink screen. The user
interface may be configured to communicate with the cloud-based
computing system or each digital display device to display a
5   calibration pattern on each digital display device of the
multiple digital display devices. The relative position, a
spatial gap distance, or an orientation of each digital display
device may be determined via the calibration pattern. The user
device may further include a camera, and the camera may be
10 configured to capture one or more images of each digital display
device of the multiple digital display devices and send the one
or more images to the cloud-based computing system. The cloud-
based computing system may be configured to determine an
identity, boundary, and orientation of each digital display
15 device of the multiple digital display devices based on the one
or more images of each digital display device of the multiple
digital display devices. The data representing the digital
content item may be a set of divided portions of the digital
content item, and the cloud-based computing system may be
20 configured to send respective divided portions to corresponding
digital display devices. The data representing the digital
content item may be an undivided portion of the digital content
item, and the processor of each digital display device may be
configured to crop the undivided portion of the digital content
25 item into the portion of the continuous display of the digital
content item to be displayed on the respective digital display
device. The system, via the user interface, may be capable of
adjusting a relative mapping of the digital content item to an
outline of the multiple digital display devices in real-time.
30 The synchronized display may be harmonized over the multiple
digital display devices on the basis of resolution or color
palette. The digital content item may be a static image, a video
clip, a graphics animation, or application. The user device may
be a smartphone, a tablet, or a mobile computing device.

In general, in another aspect, the invention features a method for orchestrating multiple digital display devices to display a digital content item across the multiple digital display devices, including determining a relative geometry and position of each digital display device of the multiple digital display devices through one or more of the multiple digital display devices, a user device, and a cloud-based computing system, selecting, by the user device, the digital content item, receiving, by the multiple digital display devices, data representing the digital content item, displaying, by display screens of the multiple digital display devices, a synchronized display representing the digital content item, where each digital display device of the multiple digital display devices includes the display screen, a memory, a processor, and data link capabilities, where the user device includes a display screen, a user interface, a memory, a processor, and data link capabilities, where the cloud-based computing system communicates with the multiple digital display devices and the user device, and where the synchronized display representing the digital content item is a display of the digital content item rendered across the multiple digital display devices in the form of a continuous display of the digital content item, accounting for space between multiple digital display devices and only displaying portions of the continuous display of the digital content item at locations where a digital display device is positioned.

Implementations of the invention may include one or more of the following features. The data link capabilities of the digital display device or the user device may be WiFi capabilities or wired Ethernet capabilities. The display screen of the digital display device may be an LCD screen, an LED screen, an OLED screen, a QLED screen, or a digital ink screen. The user interface may communicate with the cloud-based computing system or each digital display device to display a calibration pattern

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on each digital display device of the multiple digital display devices. The relative position, a spatial gap distance, or an orientation of each digital display device may be determined via the calibration pattern. The user device may further include a

5   camera, and the camera may capture one or more images of each digital display device of the multiple digital display devices and send the one or more images to the cloud-based computing system. The cloud-based computing system may determine an identity, boundary, and orientation of each digital display

10 device of the multiple digital display devices based on the one or more images of each digital display device of the multiple digital display devices. The data representing the digital content item may be a set of divided portions of the digital content item, and the cloud-based computing system may send

15 respective divided portions to corresponding digital display devices. The data representing the digital content item may be an undivided portion of the digital content item, and the processor of each digital display device may crop the undivided portion of the digital content item into the portion of the

20 continuous display of the digital content item to be displayed on the respective digital display device. The method may further include adjusting, by the user interface, a relative mapping of the digital content item to an outline of the multiple digital display devices in real-time. The synchronized display may be

25 harmonized over the multiple digital display devices on the basis of resolution or color palette. The digital content item may be a static image, a video clip, a graphics animation, or application. The user device may be a smartphone, a tablet, or a mobile computing device.

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Brief Description of the Drawings

Fig. 1 shows a digital content item rendered across various digital displays as if the digital content item were displayed

on one continuous surface with the image being visible only where an actual digital display is positioned;

Fig. 2 shows digital displays connected to a Cloud System via the Internet;

Fig. 3 shows digital displays connected to a Cloud System via the Internet;

Fig. 4 shows a group of orchestrated digital displays, referred to as an Orchestration Display group;

Fig. 5 shows an example of possible calibration patterns on displays in an Orchestration Display group;

Fig. 6 shows an orchestration outline of the digital displays;

Fig. 7 shows an exemplary digital content item;

Fig. 8 shows specific parts of the digital content item seen in Fig. 7 to be arranged across various displays shown in Fig. 6; and

Fig. 9 shows each digital display of multiple digital displays receiving information over a network.

Detailed Description of the Invention

The present invention enables a user to display one digital content item on multiple digital displays, herein referred to as Orchestrated Displays, by coordinating and synchronizing digital media content rendering and playback across the displays. Orchestrated Displays refers to the ensemble of displays that operate in a coordinated and synchronized manner. The content item may be a static image, a video clip, graphics animation, or an application ("app"). The digital displays do not need to be equally sized, adjacent, or aligned. They may have different orientations and may have spatial gaps between the digital displays. In the latter case, the digital content item is rendered across the various digital displays as if the digital content item were displayed on one continuous surface with the image being visible only where an actual digital display is positioned, as seen in Fig. 1.

The Orchestrated Displays are Internet-enabled, preferably by WiFi, (wired) Ethernet, or other type of data link, and include a digital display screen, i.e., an LCD, LED, OLED, QLED or digital ink screen, a memory, and a processor. As illustrated

5   in Figs. 2 and 3, each digital display connects to a Cloud System via the Internet before it can be used in a set of Orchestrated Displays. In this case, no other connection with the Orchestrated Displays is required.

Prior connection of the digital display ensures that the

10   software running in each display is communicating with the Cloud System. During the display registration process, each digital display is assigned a unique identifier, such as a serial number or MAC address, and the attributes of the display, including, at a minimum, the height and width of the display's active area

15   and pixel resolution, are recorded.

The present invention occurs in two phases, namely display mapping and content preparation and rendering. The purpose of display mapping is to define the specific size, relative location, and orientation of each of the Orchestrated Displays

20   to determine which part of each image is displayed on each digital display. To begin the display mapping phase, the Cloud System interacts with a user via an interface on a user device to create an Orchestration Group and to assign registered digital displays to that group, as seen in Fig. 4. To determine

25   the attributes of each digital display, the user interface, in communication with the Cloud System or each digital display, displays a calibration pattern on each display that is part of the Orchestrated Display group. The calibration pattern is unique to each digital display and includes a graphics image

30   with a unique identifier. The graphics image fills the active digital display and provides display reference points. The unique visual identifier can range from a simple number to patterns and complex images embedding encoded information. An exemplary calibration is shown in Fig. 5.

In a preferred embodiment, a user device, such as a smart phone having a processor and a camera, is connected to the Cloud System and used to take a picture of the group of digital displays i.e., the Orchestration Group, to capture their

5   relative geometry, positions, and other attributes. The image from the smart phone is uploaded to the Cloud System, where it is analyzed to determine the identity, boundaries, and orientation of each digital display device. Other measurements may not be required. The display attributes of each digital

10   display are compared to the information extracted from the image to determine the precise relative geometry of the various display surfaces in an arbitrary reference system. These attributes are called Orchestration Attributes. Orientation of each digital display may be determined using the orientation

15   sensor built into the displays or by analyzing the relative orientation of the calibration patterns as discussed above, as shown in Fig. 5.

The content preparation and render phase begins with a user selecting a digital content item, such as the image seen in Fig.

20   7, to be displayed. A user interface located on a mobile device or any computing user device connected to the Cloud System allows a user to select a digital content item and assign it to the Orchestrated Display group to be displayed in real-time or at a later time. The user interface may display an outline of the

25   orchestration group as an overlay on top of the digital content item and permit the user to pan and/or enlarge the digital content item to determine a specific fit with the various Orchestrated Displays. The relative changes to the digital content item may or may not be reflected in real-time on the

30   Orchestrated Displays. In one implementation, the Orchestration Attributes stored in the Cloud System are used to pre-process the digital content item and create a separate file for each digital display that is part of the Orchestrated Display group, where the separate files incorporate the specific parts of the

content item that will be displayed on the specific displays.
The specific content of each file is determined in order to
harmonize the display of the digital content item across all of
the Orchestrated Displays, considering their respective size,
5   relative distance, orientation, and resolution, as well as other
attributes, such as color palette. The specific portions of the
digital content item to be displayed are shown in Fig. 8. Time
synchronization information may be also added to each file to
ensure strict playback synchronization in the case of video,
10   animation, or app media. The files are downloaded to the
Orchestrated Displays over wired, WiFi, or other data link
connections and stored in each display. Upon receiving a command
to play the orchestrated content, each Orchestrated Display
starts playing its respective media file synchronously with the
15   other digital displays that are part of the Orchestrated Display
group. Synchronization is ensured using precise timing
information distributed in real-time over the network. Each
digital display receives this timing information over the
network and precisely synchronizes image playback frame
20   accurately, as illustrated in Fig. 9.

In another implementation, Orchestrated Attributes are
downloaded to each digital display to make the display "aware"
of its relative position and orientation within the Orchestrated
Display group. Time synchronization information is added to the
25   digital content item before it is downloaded and stored in all
digital displays that are part of the Orchestrated Display group,
meaning that the same file containing the complete digital
content item is downloaded to each display. The processor
embedded in each digital display uses the attributes to extract
30   the portion of the digital content item that will be displayed
on its specific display surface by cropping the content item to
the display size and location, rotating images to align with
surface orientation of the digital display, and adjusting the
digital content item to harmonize display resolution, color

palette, and other pertinent visual attributes. Time synchronization is preserved during the processing. Cropping and rotation of the digital content item occurs either in real-time during playback or upon receiving the original content file, in
5   which case the extracted portion of the content item is stored locally to be used for synchronized playback when needed. During playback, synchronization is ensured using precise timing information distributed in real-time over the network. Each digital display receives this timing information over the
10 network and precisely synchronizes image playback frames accurately.

It will be understood by those of ordinary skill in the art that various changes may be made and equivalents may be substituted for elements without departing from the scope of the
15 invention. In addition, many modifications may be made to adapt a particular feature or material to the teachings of the invention without departing from the scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will
20 include all embodiments falling within the scope of the claims.

CLAIMS

What is claimed is:

5   1.   A system for orchestrating multiple digital display devices
to display a digital content item across the multiple digital
display devices, comprising:

multiple digital display devices, wherein each digital
display device includes a display screen, a memory, a processor,
10   and data link capabilities;

a user device including a display screen, a user interface,
a memory, a processor, and data link capabilities; and

a cloud-based computing system configured to communicate
with the multiple digital display devices and the user device;
15   wherein one or more of the multiple digital display devices,
the user device, and the cloud-based computing system are
configured to determine a relative geometry and position of each
digital display device of the multiple digital display devices;

wherein, upon selection of the digital content item on the
20   user device by a user, the multiple digital display devices are
configured to receive data representing the digital content item
and display, on the display screens of the multiple digital
display devices, a synchronized display representing the digital
content item; and
25   wherein the synchronized display representing the digital
content item is a display of the digital content item rendered
across the multiple digital display devices in the form of a
continuous display of the digital content item, accounting for
space between multiple digital display devices and only
30   displaying portions of the continuous display of the digital
content item at locations where a digital display device is
positioned.

2.   The system of claim 1, wherein the data link capabilities of the digital display device or the user device are WiFi capabilities or wired Ethernet capabilities.

5   3.   The system of claim 1, wherein the display screen of the digital display device is an LCD screen, an LED screen, an OLED screen, a QLED screen, or a digital ink screen.

4.   The system of claim 1, wherein the user interface is
10   configured to communicate with the cloud-based computing system or each digital display device to display a calibration pattern on each digital display device of the multiple digital display devices.

15   5.   The system of claim 4, wherein the relative position, a spatial gap distance, or an orientation of each digital display device is determined via the calibration pattern.

6.   The system of claim 1, wherein the user device further
20   includes a camera, and wherein the camera is configured to capture one or more images of each digital display device of the multiple digital display devices and send the one or more images to the cloud-based computing system.

25   7.   The system of claim 6, wherein the cloud-based computing system is configured to determine an identity, boundary, and orientation of each digital display device of the multiple digital display devices based on the one or more images of each digital display device of the multiple digital display devices.

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8.   The system of claim 1, wherein the data representing the digital content item is a set of divided portions of the digital content item, and wherein the cloud-based computing system is

configured to send respective divided portions to corresponding digital display devices.

9.   The system of claim 1, wherein the data representing the digital content item is an undivided portion of the digital content item, and wherein the processor of each digital display device is configured to crop the undivided portion of the digital content item into the portion of the continuous display of the digital content item to be displayed on the respective digital display device.

10.   The system of claim 1, wherein the system, via the user interface, is capable of adjusting a relative mapping of the digital content item to an outline of the multiple digital display devices in real-time.

11.   The system of claim 1, wherein the synchronized display is harmonized over the multiple digital display devices on the basis of resolution or color palette.

12.   The system of claim 1, wherein the digital content item is a static image, a video clip, a graphics animation, or application.

13.   The system of claim 1, wherein the user device is a smartphone, a tablet, or a mobile computing device.
14.   A method for orchestrating multiple digital display devices to display a digital content item across the multiple digital display devices, comprising:
        determining a relative geometry and position of each digital display device of the multiple digital display devices through one or more of the multiple digital display devices, a user device, and a cloud-based computing system;
        selecting, by the user device, the digital content item;

receiving, by the multiple digital display devices, data representing the digital content item;

displaying, by display screens of the multiple digital display devices, a synchronized display representing the digital

5   content item;

wherein each digital display device of the multiple digital display devices includes the display screen, a memory, a processor, and data link capabilities;

wherein the user device includes a display screen, a user

10   interface, a memory, a processor, and data link capabilities;

wherein the cloud-based computing system communicates with the multiple digital display devices and the user device; and

wherein the synchronized display representing the digital content item is a display of the digital content item rendered

15   across the multiple digital display devices in the form of a continuous display of the digital content item, accounting for space between multiple digital display devices and only displaying portions of the continuous display of the digital content item at locations where a digital display device is

20   positioned.

15. The method of claim 14, wherein the data link capabilities of the digital display device or the user device are WiFi capabilities or wired Ethernet capabilities.

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16. The method of claim 14, wherein the display screen of the digital display device is an LCD screen, an LED screen, an OLED screen, a QLED screen, or a digital ink screen.

30   17. The method of claim 14, wherein the user interface communicates with the cloud-based computing system or each digital display device to display a calibration pattern on each digital display device of the multiple digital display devices.

18.   The method of claim 17, wherein the relative position, a
spatial gap distance, or an orientation of each digital display
device is determined via the calibration pattern.

5   19.   The method of claim 14, wherein the user device further
includes a camera, and wherein the camera captures one or more
images of each digital display device of the multiple digital
display devices and sends the one or more images to the cloud-
based computing system.

10

20.   The method of claim 19, wherein the cloud-based computing
system determines an identity, boundary, and orientation of each
digital display device of the multiple digital display devices
based on the one or more images of each digital display device

15   of the multiple digital display devices.

21.   The method of claim 14, wherein the data representing the
digital content item is a set of divided portions of the digital
content item, and wherein the cloud-based computing system sends

20   respective divided portions to corresponding digital display
devices.

22.   The method of claim 14, wherein the data representing the
digital content item is an undivided portion of the digital

25   content item, and wherein the processor of each digital display
device crops the undivided portion of the digital content item
into the portion of the continuous display of the digital content
item to be displayed on the respective digital display device.

30   23.   The method of claim 14, further comprising adjusting, by
the user interface, a relative mapping of the digital content
item to an outline of the multiple digital display devices in
real-time.

24. The method of claim 14, wherein the synchronized display is harmonized over the multiple digital display devices on the basis of resolution or color palette.

5 25. The method of claim 14, wherein the digital content item is a static image, a video clip, a graphics animation, or application.

26. The method of claim 14, wherein the user device is a
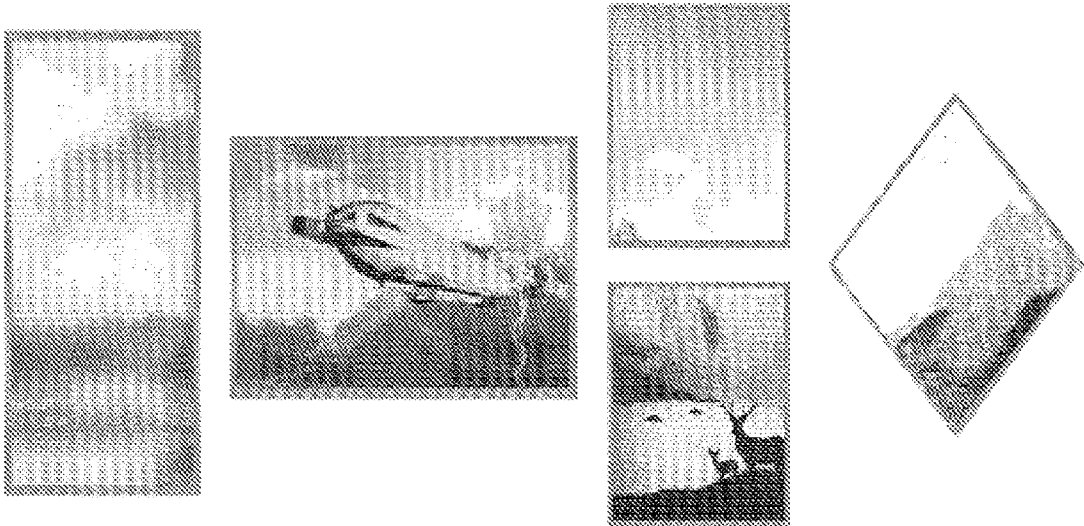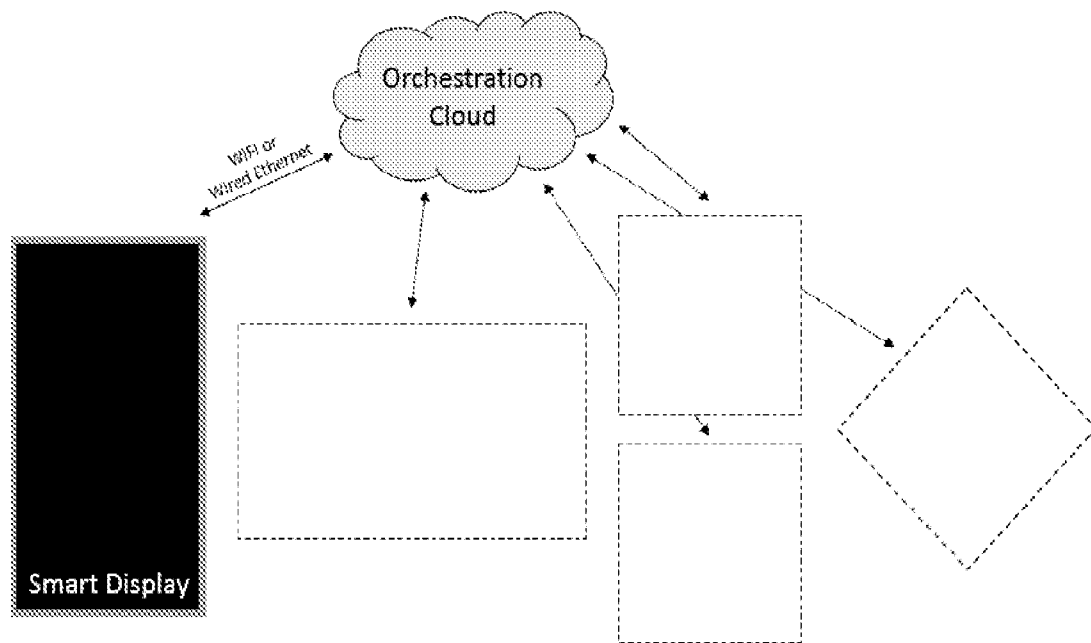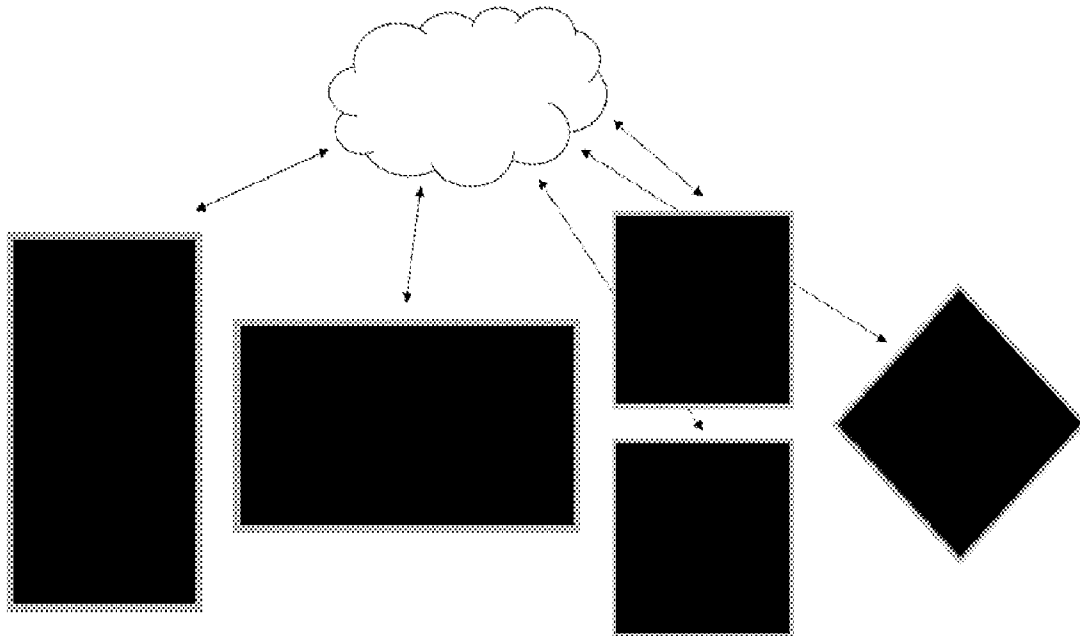10 smartphone, a tablet, or a mobile computing device.
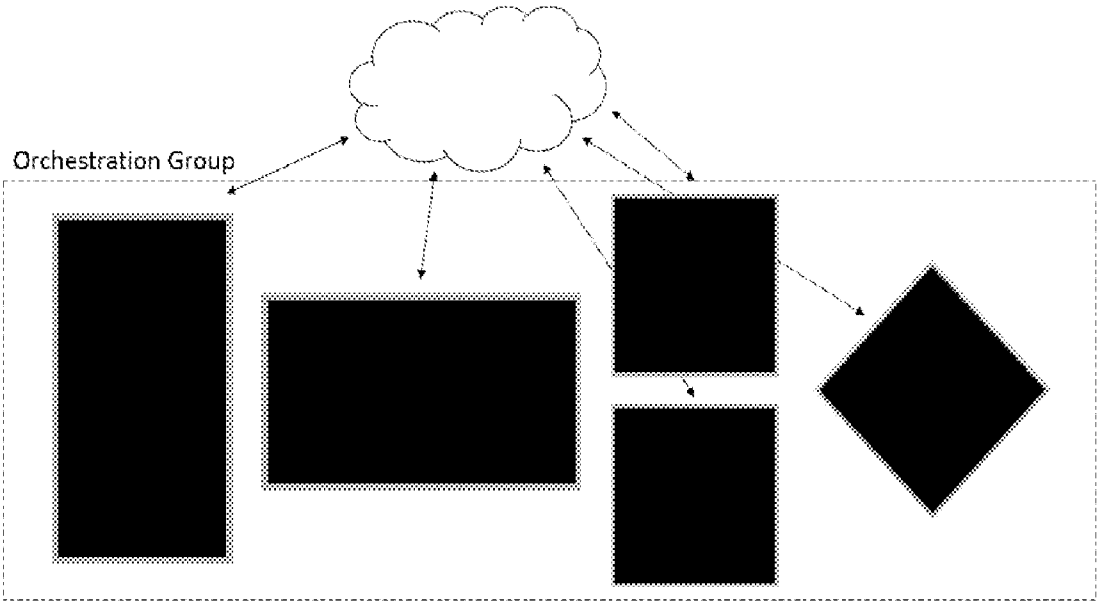
Fig. 1

FIGURE 2

FIGURE 3

FIGURE 4

Orchestration Group
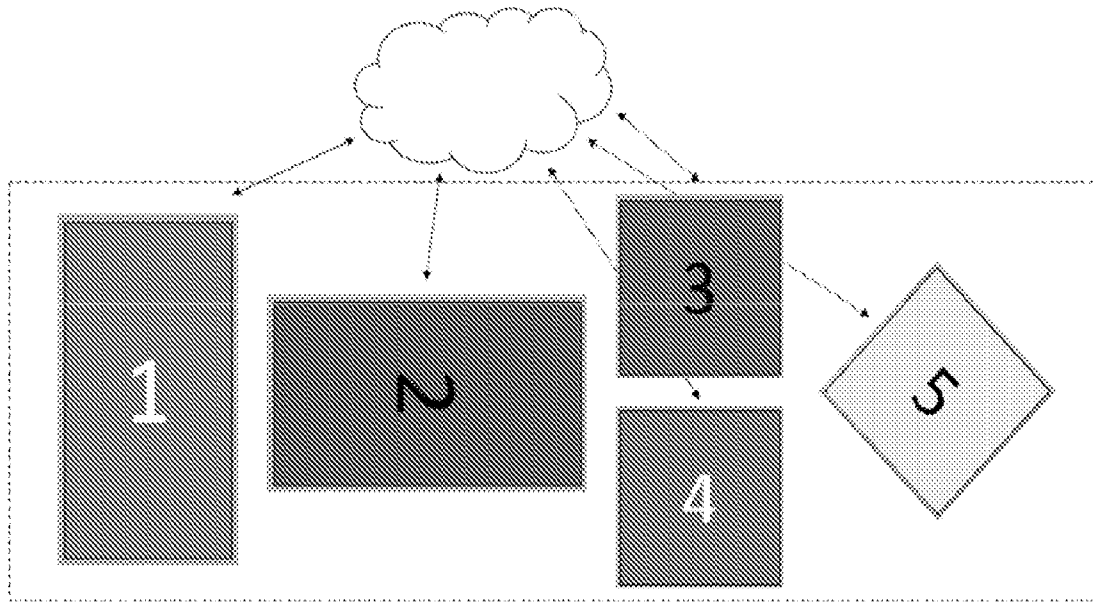
FIGURE 5
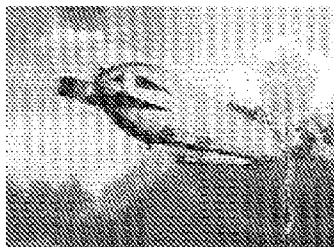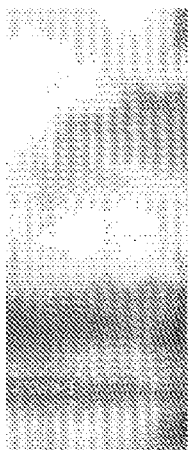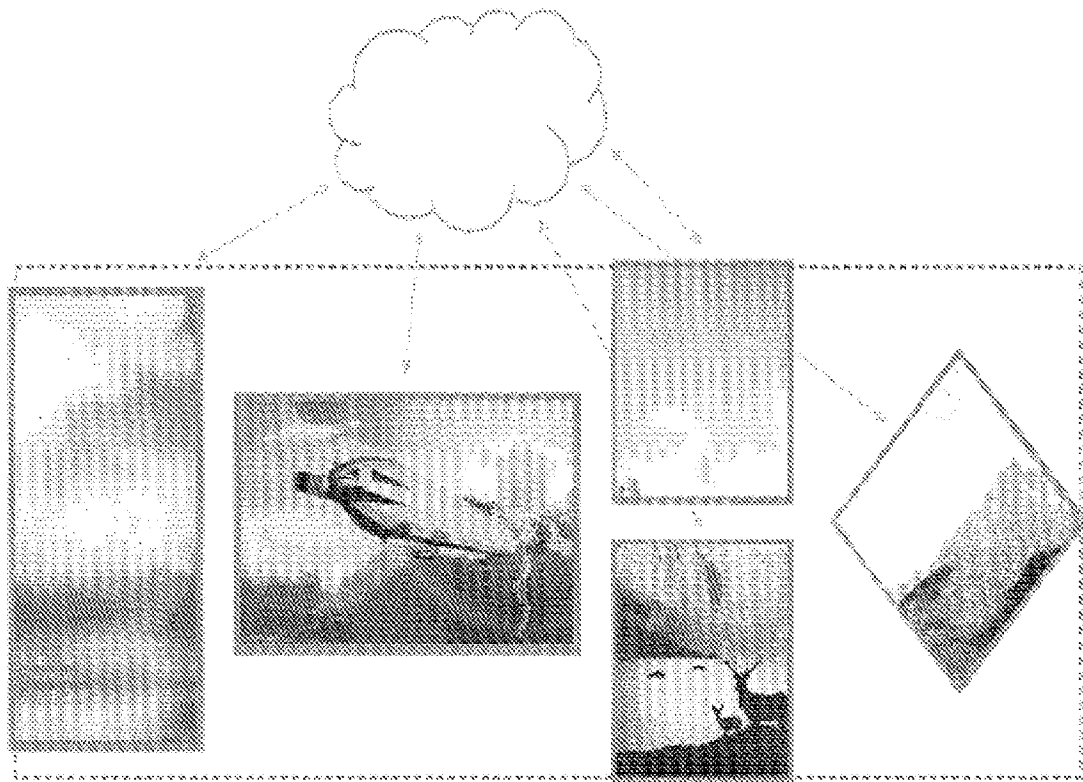
FIGURE 6
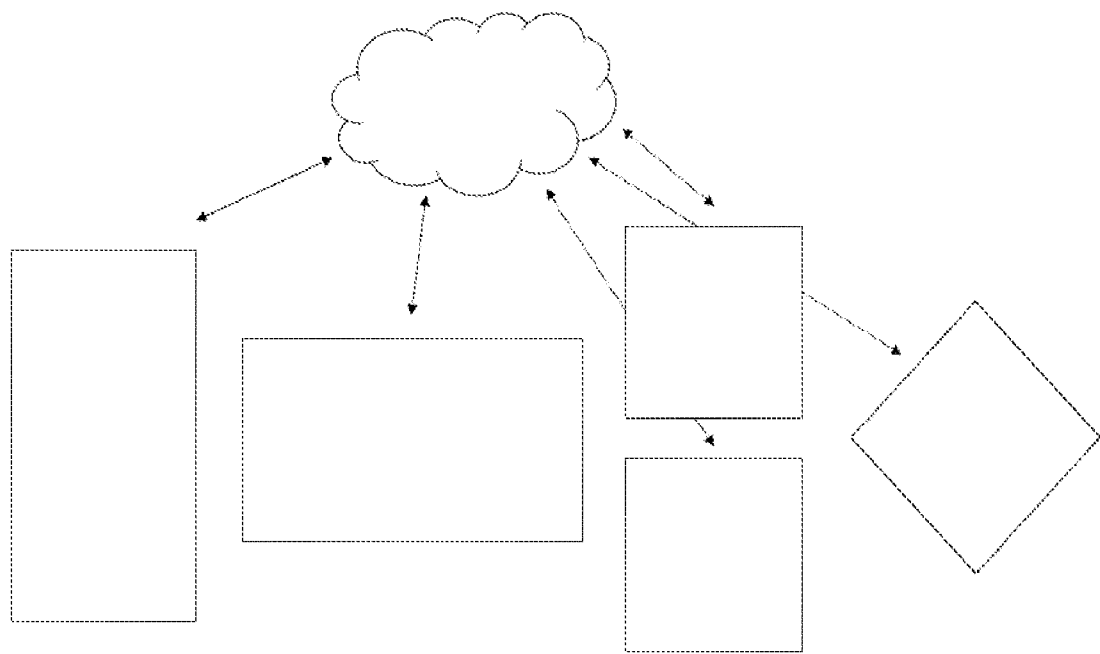
Fig. 7
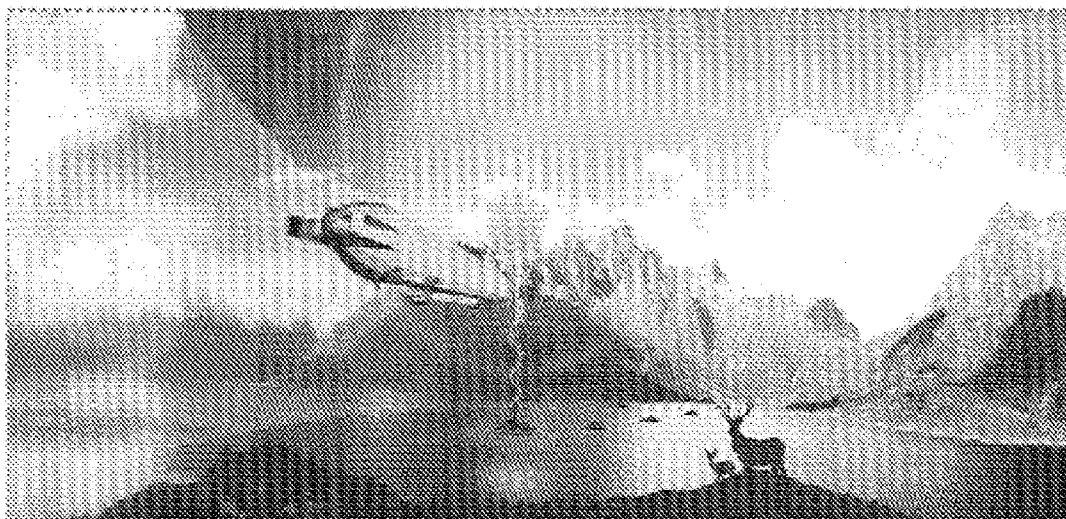
Fig. 8
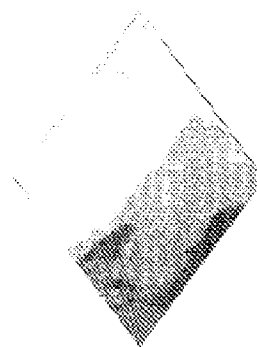
Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/63068

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G09G 5/14; G06F 3/14, G06F 3/147 (2018.01)

CPC - G09G 2300/026, G09G 2356/00, G09G 2370/022

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)

See Search History Document

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

See Search History Document

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

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y -- A	US 2013/0265487 A1 (REALTEK SEMICONDUCTOR CORP.) 10 October 2013 (10.10.2013), entire document especially Figs 1, 6; paras [0021], [0022], [0027]	1-4, 6, 7, 10, 12-16, 19, 20, 23, 25, 26 ------------------------ 5, 8, 9, 11, 17, 18, 21, 22, 24
Y -- A	US 2012/0206319 A1 (LUCERO et al.) 16 August 2012 (16.08.2012), entire document especially paras [0029]-[0030]	1-4, 6, 7, 10, 12-16, 19, 20, 23, 25, 26 ------------------------ 5, 8, 9, 11, 17, 18, 21, 22, 24
Y -- A	US 2015/0382388 A1 (THOMSON LICENSING) 31 December 2015 (31.12.2015), entire document especially para [0010]	4 ------------------------ 5
Y	US 2016/0011843 A1 (BUCHNER) 14 January 2016 (14.01.2016), entire document especially paras [0026], [0030]	19, 20
A	US 2012/0075334 A1 (POURBIGHARAZ et al.) 29 March 2012 (29.03.2012), entire document	1-26
A, P	US 2017/0201740 A1 (MICROSOFT TECHNOLOGY LICENSING, LLC) 13 July 2017 (13.07.2017), entire document	1-26

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

*	Special categories of cited documents:	"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
"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	"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
"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)	"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
"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	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 February 2018	05 MAR 2018

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)