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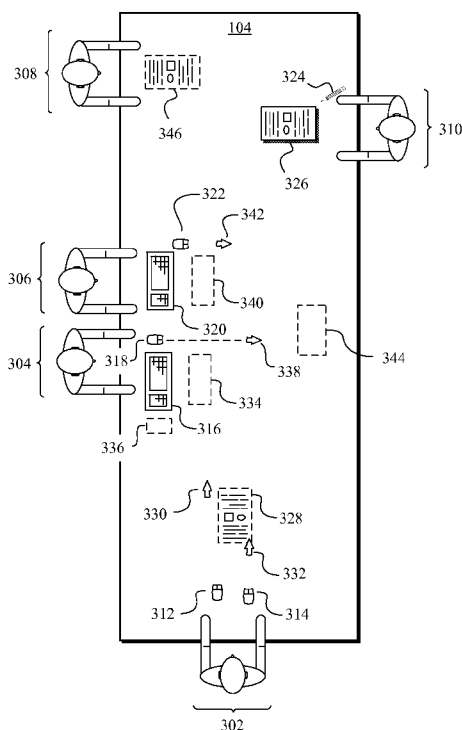
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[Continued on next page]

(54) Title: USING PHYSICAL OBJECTS IN CONJUNCTION WITH AN INTERACTIVE SURFACE

**FIG. 3**

(57) Abstract: An interaction management module (IMM) is described for allowing users to engage an interactive surface in a collaborative environment using various input devices, such as keyboard-type devices and mouse-type devices. The IMM displays digital objects on the interactive surface that are associated with the devices in various ways. The digital objects can include input display interfaces, cursors, soft-key input mechanisms, and so on. Further, the IMM provides a mechanism for establishing a frame of reference for governing the placement of each cursor on the interactive surface. Further, the IMM provides a mechanism for allowing users to make a digital copy of a physical article placed on the interactive surface. The IMM also provides a mechanism which duplicates actions taken on the digital copy with respect to the physical article, and vice versa.



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USING PHYSICAL OBJECTS IN CONJUNCTION WITH AN INTERACTIVE SURFACE

BACKGROUND

[0001] An interactive surface provides an alternative mechanism for interacting with
5 computer-implemented applications. A typical interactive surface includes a projection
mechanism for displaying information on the interactive surface. The interactive surface also
includes an input mechanism for detecting selections made by a user in the course of
interacting with the interactive surface. For example, the interactive surface may detect when
the user touches particular parts of the interactive surface. Through such interaction, the user
10 may manipulate digital objects which are displayed by the interactive surface and perform
other operations.

[0002] There remains ample room for improvement in interactive surface technology.
For instance, the input mechanism provided by an interactive surface is sometimes
cumbersome to use (because, for instance, users may have difficulty entering information or
15 manipulating digital objects using this input mechanism). The input mechanism may also
provide unsatisfactory precision and responsiveness.

[0003] Further, the interactive surface may potentially confuse users. This may be
particularly a problem when multiple users engage the same interactive surface. In this
scenario, the interactive surface can potentially become cluttered with multiple digital
20 objects. Further, for a large interactive surface, it may become difficult for users to
manipulate some digital objects that are beyond their reach.

[0004] Further, the interactive surface may fail to provide a collaborative environment
which accommodates the manner in which users naturally interact in groups. For example,
the collaborative environment may fail to provide a convenient mechanism for sharing

information among participants of a meeting; the interactive surface may likewise fail to provide a suitable mechanism for collaboratively working on shared information.

[0005] There may be additional shortcomings of existing interactive surface technology.

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SUMMARY

[0006] In one illustrative implementation, an interactive management module (IMM) is described for allowing users to engage an interactive surface using physical devices (“devices”). The IMM detects placement of a device at a selected location and orientation on the interactive surface. In response, the IMM displays a digital object on the interactive surface for use in association with the device. The digital object can be placed in proximity to the device; further, the digital object can have the same orientation as the device. In one case, the device is a keyboard-type device and the digital object provides a display interface that presents a visual representation of information entered by a user using the keyboard-type device.

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[0007] According to another illustrative aspect, the IMM can interact with multiple physical input devices that are placed on the interactive surface at the same time, thus accommodating the use of the interactive surface in a collaborative environment.

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[0008] According to another illustrative aspect, the IMM displays a visual attribute which associates the device with the digital object. For example, the IMM can present borders (or the like) around both the digital object and the device; the borders can be assigned the same color to convey the affiliation between the digital object and the device. Alternatively, or in addition, the visual attribute can correspond to a line which connects the digital object to the device.

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[0009] According to another illustrative aspect, a user can move the device in proximity to another existing display object. In response, the IMM can automatically associate the device with that other display object.

5 [0010] According to another illustrative aspect, the user can move another existing display object in proximity to the device. In response, the IMM can automatically associate the existing display object with the device.

[0011] According to another illustrative aspect, the IMM can detect the placement of a second device in proximity to the first-mentioned device. In response, the IMM can associate both devices with a single digital object. In one particular example, a first user may enter a
10 first selection using the first device and a second user may enter a second selection using the second device. Upon bringing the first and second devices together, the IMM can merge the selections identified by the two users, creating a combined selection.

[0012] According to another illustrative aspect, the IMM can display a new digital object at a location on the interactive surface which: a) satisfies at least one placement constraint to
15 an extent deemed appropriate; and b) reduces interference between the new digital object and other existing objects on the interactive surface.

[0013] According to another illustrative aspect, the device is a mouse-type device. The IMM operates by determining an absolute position of the mouse-type device and an orientation of the mouse-type device on the interactive surface. The IMM uses this
20 information to define a frame of reference. The IMM displays a cursor on the interactive surface relative to the frame of reference that has been defined. The frame of reference can be selected relative to a nearest edge of the interactive surface (or other reference object associated with the interactive surface) or the orientation of the mouse-type device itself, and so on.

[0014] According to another illustrative aspect, the IMM allows a user to activate a touch mode of the mouse-type device, whereupon the cursor simulates a finger contact point.

[0015] According to another illustrative aspect, the IMM allows the user to modify a digital object using any combination of cursor contact points and finger contact points. For instance, the user can manipulate out-of-reach digital objects using one or more cursor contact points (e.g., as controlled by multiple input devices that are simultaneously placed on the interactive surface).

[0016] According to another illustrative aspect, the IMM can maintain a plurality of image representations of the interactive surface (and/or individual digital objects and/or physical objects that have been placed on the interactive surface) at different respective points in time. A user can retrieve these image representations to investigate the history of operations taken with respect to the interactive surface.

[0017] According to another illustrative implementation, an interactive management module (IMM) is described for allowing users to engage an interactive surface that contains a physical article ("article"), such as a tangible medium (e.g., a physical document) having information visually presented on its surface. In one illustrative implementation, the IMM operates by detecting the placement of an article on the interactive surface. The IMM then displays an interface object on the interactive surface for use in association with the article. The IMM detects a copy-related activation by a user of the interface object, and, in response, generates a digital copy of the article. The copy-related activation can correspond to a motion in which the user metaphorically drags the digital copy off the article by pulling on the interface object. The IMM deposits the digital copy at a location on the interactive surface identified by the user.

[0018] According to another illustrative aspect, the IMM can generate the digital copy by taking an image of the entire interactive surface, and then cropping the image of the entire surface to obtain an image of the article.

[0019] According to another illustrative aspect, the IMM can detect a user's selection of a particular part of the digital copy. In response, the IMM can highlight a corresponding part of the article. The same procedure can be performed in reverse, e.g., where the user selects a part of the article, prompting the IMM to highlight a corresponding part of the digital copy.

[0020] According to another illustrative aspect, the IMM can detect when the user makes a mark on the digital copy. In response, the IMM can apply a corresponding digital mark to the physical article. The same procedure can be performed in reverse, e.g., where the user makes a mark on the article, prompting the IMM to make a corresponding mark on the digital copy.

[0021] According to another illustrative aspect, the IMM can detect that the user has moved the digital copy to an editing region of the interactive surface. The IMM can next detect that user has applied a physical mark to the digital copy within the editing region. In response, the IMM can generate another digital copy of the article. This other digital copy includes a digital representation of the physical mark, along with its original content.

[0022] This Summary is provided to introduce a selection of concepts in a simplified form; these concepts are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Fig. 1 shows an illustrative interactive surface environment in which a plurality of users can engage an interactive surface.

[0024] Fig. 2 shows illustrative content-projection functionality and input functionality that can be used in the interactive surface environment of Fig. 1.

[0025] Fig. 3 shows an illustrative top-down view of an interactive surface for use in the illustrative interactive surface environment of Fig. 1.

5 [0026] Fig. 4 is a more detailed top-down view of part of the interactive surface shown in Fig. 3.

[0027] Fig. 5 is a flowchart that shows an illustrative procedure for determining a position of a cursor on an interactive surface.

[0028] Fig. 6 shows a first technique for determining a frame of reference for use in
10 positioning the cursor in the procedure of Fig. 5; here, the frame of reference is based on a nearest edge of the interactive surface.

[0029] Fig. 7 shows a second technique for determining a frame of reference for use in positioning the cursor in the procedure of Fig. 5; here, the frame of reference is based on an orientation of a mouse-type device which is used to control the cursor.

15 [0030] Fig. 8 is a flowchart (and accompanying example) that shows an illustrative procedure for generating a digital copy of an article that is placed on the interactive surface.

[0031] Fig. 9 is a flowchart (and accompanying example) that shows an illustrative procedure for placing a digital object on the interactive surface in a manner such that the digital object does not interfere with existing objects on the interactive surface.

20 [0032] Fig. 10 is a flowchart that shows an illustrative procedure for operating a mouse-type device in a touch mode; in this mode, a cursor controlled by the mouse-type device simulates a finger contact placed on the interactive surface.

[0033] Fig. 11 is a flowchart (and accompanying example) that shows an illustrative procedure for generating a new digital object when a device is placed on the interactive
25 surface.

[0034] Fig. 12 is a flowchart (and accompanying example) that shows an illustrative procedure for affiliating an existing digital object with a device when the device is placed on the interactive surface in proximity to the existing digital object.

[0035] Fig. 13 is a flowchart (and accompanying example) that shows an illustrative procedure for affiliating an existing digital object with a device when the existing digital object is moved in proximity to the device.

[0036] Fig. 14 is a flowchart (and accompanying example) that shows an illustrative procedure for affiliating a single digital object with two devices; this procedure also demonstrates how content provided by two respective digital objects (controlled by the two respective devices) can be merged by bringing the devices in proximity to each other.

[0037] Fig. 15 is a flowchart (and accompanying example) that shows an illustrative procedure for manipulating a digital object using different contact point scenarios.

[0038] Fig. 16 is a flowchart (and accompanying example) that shows an illustrative procedure for manipulating a digital object by placing a device on top of the digital object and metaphorically using the device as a handle to move the digital object or perform some other action on the digital object.

[0039] Fig. 17 is a flowchart (and accompanying example) that shows an illustrative procedure for creating a digital copy based on a physical article that is placed on the interactive surface.

[0040] Fig. 18 is a flowchart (and accompanying example) that shows an illustrative procedure for presenting a menu object in association with an article that is placed on the interactive surface.

[0041] Fig. 19 is a flowchart (and accompanying example) that shows an illustrative procedure for highlighting a part of an article based on a selection of a corresponding part of a digital object (or vice versa).

[0042] Fig. 20 is a flowchart (and accompanying example) that shows an illustrative procedure for creating a digital mark on a physical article based on a corresponding digital mark that is made to a digital copy.

[0043] Fig. 21 is a flowchart (and accompanying example) that shows an illustrative procedure for applying a physical mark to a digital copy of an article within an editing region of the interactive surface, followed by generating a new digital copy of the article which includes a digital representation of the mark.

[0044] Fig. 22 is a flowchart that shows an illustrative procedure for generating a series of representations of an interactive surface (and/or a series of representations of any individual object that has appeared on the interactive surface) at different respective times, and displaying any information regarding this series to a user.

[0045] Fig. 23 shows illustrative processing functionality that can be used to implement any aspect of the features shown in the foregoing drawings.

[0046] The same numbers are used throughout the disclosure and figures to reference like components and features. Series 100 numbers refer to features originally found in Fig. 1, series 200 numbers refer to features originally found in Fig. 2, series 300 numbers refer to features originally found in Fig. 3, and so on.

DETAILED DESCRIPTION

[0047] This disclosure sets forth an approach that allows users to engage an interactive surface using physical objects that are placed on the interactive surface. In one case, the physical objects may correspond to keyboard-type devices, mouse-type devices, or other types of input devices (or any combination of different types of input devices). The physical objects may also correspond physical documents (or the like) having information presented

on their respective surfaces. The approach also provides various mechanisms for managing the association between physical objects that are placed on the interactive surface and respective digital objects.

[0048] According to one scenario, the use of physical objects may facilitate a user's engagement with the interactive surface. For example, keyboard-type devices and mouse-type devices exhibit time-tested reliable behavior with which most users are readily familiar; the approach can leverage these beneficial features in the context of an interactive surface environment. Further, the approach may provide useful techniques for disambiguating the correspondence between physical objects placed on the interactive surface and digital objects associated with the physical objects. This aspect may help reduce confusion when multiple users are engaging the same interactive surface. Further, the approach provides tools which allow users to access and manipulate digital objects which are out-of-reach on the interactive surface. Further, the approach provides tools for allowing users to conveniently disseminate information to other users in a collaborative environment; the approach then allows users to collaboratively interact with the shared information in an efficient and user-friendly manner. More generally, the concepts disclosed herein may address one or more of the challenges or problems previously noted, but are not limited to addressing all or any of these challenges or problems.

[0049] This disclosure is organized as follows. Section A describes illustrative systems and tools that can be used to engage an interactive surface using physical objects. Section B describes illustrative applications of the systems and tools set forth in Section A. Section C describes illustrative processing functionality that can be used to implement any aspect of the features described in Sections A and B.

[0050] As a preliminary matter, some of the figures describe the concepts in the context of one or more components, variously referred to as functionality, modules, features,

elements, etc. The various components shown in the figures can be implemented in any manner, for example, by software, hardware, firmware, manual processing operations, and so on, or any combination of these implementations. In one case, the illustrated separation of various components in the figures into distinct units may reflect the use of corresponding
5 distinct physical components. Alternatively, or in addition, any single component illustrated in the figures may be implemented by plural physical components. Alternatively, or in addition, the depiction of any two or more separate components in the figures may reflect different functions performed by a single physical component. Fig. 23, to be discussed in turn, provides additional details regarding one illustrative implementation of the functions
10 shown in the figures.

[0051] Other figures describe the concepts in flowchart form. In this form, certain operations are described as constituting distinct blocks performed in a certain order. Such implementations are illustrative and non-limiting. Certain blocks described herein can be grouped together and performed in a single operation, certain blocks can be broken apart into
15 plural component blocks, and certain blocks can be performed in an order that differs from that which is illustrated herein (or can be performed in parallel). The blocks shown in the flowcharts can be implemented by software, firmware, hardware, manual processing, any combination of these implementations, and so on.

[0052] As to terminology, the phrase “configured to” encompasses any way that any kind
20 of functionality can be constructed to perform an identified operation. The functionality can be configured to perform an operation using, for instance, hardware, software, firmware, etc., and/or any combination thereof.

[0053] The term “logic” encompasses any functionality for performing a task. For instance, each operation illustrated in the flowcharts corresponds to logic for performing that
25 operation. In one case, logic may correspond to computer-readable instructions. In another

case, logic may correspond to discrete logic components, or a combination of computer-readable instructions and discrete logic components, etc.

A. Illustrative Systems and Tools

A.1. Overview of an Illustrative Interactive Surface Environment (Figs. 1-4)

5 **[0054]** Fig. 1 shows an illustrative interactive surface environment 100 in which a plurality of users 102 can engage an interactive surface 104. In the case most commonly evoked herein, the interactive surface 104 corresponds to flat horizontal table-top of any size. However, there is no limitation placed on what may constitute the interactive surface 104. In other cases, the interactive surface 104 can be mounted vertically (e.g., on a wall), or at any
10 other non-horizontal orientation. Alternatively, or in addition, the interactive surface 104 can have a curved surface, or any other kind of non-flat contour.

[0055] Broadly, any kind of content-projection functionality 106 can be used to project information onto the interactive surface 104. In one case, the content-projection functionality 106 can correspond to one or more video projectors which project information onto the
15 interactive surface 104. Such content-projection functionality 106 can be disposed above the interactive surface 104, below the interactive surface 104, or at any other orientation with respect to the interactive surface 104 (or at any combination of orientations). Alternatively, or in addition, the content-projection functionality 106 can be integrated with the interactive surface itself 104. The placement of the content-projection functionality 106 can be selected,
20 in part, based on the constraints associated with each application of the interactive surface 104. For instance, in certain cases, it may be appropriate to position the content-projection functionality 106 above the digital surface 104 because physical objects placed on the interactive surface 104 might otherwise occlude the digital content (e.g., if projected from below).

[0056] Input functionality 108 is used to receive input from the users as the users engage the interactive surface 104. Again, various types and combinations of input functionality can be used. In one case, the input functionality 108 can correspond to one or more remote sensors that sense the user's engagement with the interactive surface 104. For example, the input functionality 108 can include an infrared emitter-detector arrangement which can detect when a user touches or otherwise moves close to the interactive surface 104. The input functionality 108 can also provide imaging functionality which generates a high-resolution image of the interactive surface 104 for use as an input. Any such remote-sensing-type input functionality 108 can be disposed above the interactive surface 104, below the interactive surface 104, or at any other orientation with respect to the interactive surface 104 (or at any combination of orientations). Alternatively, or in addition, the input functionality 108 can be integrated with the interactive surface 104 itself. Again, the placement of the input functionality 108 can be selected, in part, based on the constraints associated with each application of the interactive surface 104. Further, as will be described in more detail below, one or more physical objects 110 can be placed on the interactive surface 104. A subset of these physical objects 110 can correspond to input-type devices. These input devices may receive input from the users as the users interact with the interactive surface 104, and thus form part of the suite of technology that constitutes the input functionality 108. Fig. 2 will provide additional details regarding one illustrative implementation of the content-projection functionality 106 and the input functionality 108.

[0057] An interaction management module (IMM) 112 corresponding to any functionality for managing the projection of content onto the interactive surface 104 and the processing of the user's inputs. More specifically, the IMM 112 can correspond to technology for performing the various procedures which will be described below, as illustrated in Figs. 5-22.

[0058] The IMM 112 interacts with one or more application-providing modules 114 (referred to in the plural below for brevity). The application modules 114 provide any type of functionality that the users can engage, such as search functionality, document processing functionality, communication functionality (e.g., Email functionality, instant messaging functionality, etc.), and so on. The application modules 114 can correspond to local application resources, remote (network-accessible) application resources, or some combination thereof. No limitation is placed on what may constitute an application module as this term is used herein. Moreover, while many of the examples developed herein will involve the use of multiple users 102 interacting with a common application module in collaborative fashion, multiple users can use the interactive surface 104 to simultaneously interact with different application modules 114. Further, a single user can engage the interactive surface 104.

[0059] Returning to the interactive surface 104 itself, as mentioned above, a user can place any combination of physical objects 110 onto its surface. The term “physical object” encompasses any type of tangible object that can be physically handled by the user. A “digital object,” by contrast, encompasses any type of object that is electronically projected onto the surface of the interactive surface 104 by the content-projection functionality 106. The general term “object” encompasses any class of objects, including physical objects and digital objects.

[0060] The physical objects 110 described herein encompass two types of objects: devices and articles. These terms are labels of convenience in this explanation and are to be construed broadly. A device encompasses any mechanism that serves a functional role in interacting with the interactive surface 104. For example, one type of device corresponds to a keyboard-type device which is traditionally used to enter text and other information by manually depressing its keys. Another type of device corresponds to a mouse-type device

which is traditionally used to control the movement of a cursor and perform other navigational functions within a graphical user interface (GUI) setting. These are only two examples. Other input devices can be used to interact with the interactive surface 104, such as game console-type devices, joystick-type devices, and so on.

5 **[0061]** The term physical article encompasses any physical object that can be imaged by the input functionality 108 for any purpose. In the case most commonly evoked herein, the term physical article corresponds to a tangible medium that visually presents information on its surface. For instance, in one concrete case, the physical article can correspond to a document having text and/or graphics and/or any other information on its surface. For
10 example, the physical article can correspond to a paper document or the like. In another case, the physical article can correspond to a screen or the like which projects information thereon. In other cases, the article can correspond to any other physical object, such as a three-dimensional model (e.g., a model house, a model car, a doll, etc.), a part of the human anatomy (e.g., a hand), and so on. No limitation is placed on what may constitute an article.
15 Indeed, an article may correspond to a device as described above. The term “article” will be used instead of “physical article,” except in those instances where it is appropriate to emphasize the distinction between a physical article and a digital copy of the physical article.

[0062] Fig. 2 shows one representative and non-limiting implementation of the content-projection functionality 106 and input functionality 108 that can be used in the interactive
20 surface environment 100 of Fig. 1. In this illustrative example, the interactive surface 104 corresponds to a flat horizontal surface (e.g., as provided by the top of a table). The physical objects 110 on its surface can correspond to one or more devices 202 (e.g., one or more keyboard-type devices, one or more mouse-type devices, etc.), and/or one or more articles 204 to be imaged (e.g., one or more documents, etc.).

[0063] The content-projection functionality 106 of Fig. 1 can correspond to one or more content-projection modules 206 (referred to in the plural below for brevity). For example, each of the content-projection modules 206 can project a $u \times v$ panel of image content onto the interactive surface 104. Taken together, the content-projection modules 206 can provide
5 a tiled mosaic of such $u \times v$ panels that spans the entire surface of the interactive surface 104. In one implementation, the content-projection modules 206 can be disposed above the interactive surface 104, projecting their content down onto the interactive surface 104.

[0064] The input functionality 108 of Fig. 1 can correspond to a suite of different mechanisms to receive information pertaining to a user's engagement with the interactive
10 surface 104. One such mechanism is one or more high-resolution imaging modules 208 (referred to below in the plural for brevity). The high-resolution imaging modules 208 can correspond to one or more high-resolution video cameras for forming a high-resolution image of the surface of the interactive surface 104. Section B will provide examples of circumstances in which the IMM 112 can generate images of the interactive surface 104
15 using the high-resolution imaging modules 208. In one implementation, the high-resolution imaging modules 208 can be disposed above the interactive surface 104.

[0065] The input functionality 108 can also include one or more position-detection modules 210 (referred to in the plural below for brevity). In one illustrative example, the position-detection modules 210 can correspond to one or more infrared (IR) emitter modules
20 212 in conjunction with one or more IR detector modules 214. The IR emitter modules 212 project electromagnetic signals in the infrared spectrum onto the interactive surface 104. The IR detector modules 214 receive the IR signals that are reflected by the interactive surface 104 and physical objects placed on (or near) its surface.

[0066] By virtue of changes in the reflectance of IR signals, the position-detection
25 modules 210 can detect when new physical objects are placed on the interactive surface 104

or when existing physical objects on the interactive surface 104 are moved (or removed). In one implementation, the position-detection modules 210 can be disposed below the interactive surface 104. In this example, the interactive surface 104 is constructed with a sufficient degree of opacity to “receive” images that are projected by the content-projection modules 206. In addition, the interactive surface 104 has a sufficient degree of transparency such that IR signals projected from beneath the interactive surface 104 can be used by the position-detection modules 210 in conjunction with the IMM 112 to detect the presence of objects placed on top of the interactive surface 104. One infrared detection system that can be used to implement the position-detection modules 210 is disclosed in U.S. Patent No. 7,204,428, naming the inventor of Andrew D. Wilson.

[0067] The devices 202 are also components of the suite of input functionality 108. In one case, the devices 202 can provide input information corresponding to key depression data, mouse-click data, mouse position data, and so on. The devices 202 can communicate such input information to the IMM 112 in any manner, such by using wireless communication. Although not shown in Fig. 2, the suite of input functionality 108 can also include soft-key input mechanisms that are projected by the content-projection modules 206 onto the interactive surface 104. The soft-key input mechanisms provide touch-selection data that indicates when users touch or otherwise engage the soft-key input mechanisms.

[0068] Further, the IMM 112 can optionally employ edge detection functionality and/or shape detection functionality. This functionality analyzes an image of the interactive surface 104 to identify the profiles (contours) associated with the objects. The IMM 112 can apply this analysis to form a more accurate estimate of the positions and orientations of the objects placed on the interactive surface 104. The IMM 112 can also use this analysis to help identify the objects (e.g., to distinguish keyboard-type devices from mouse-type devices, to distinguish a physical object from a finger contact point, and so on).

[0069] Fig. 3 shows an illustrative top-down view of the interactive surface 104 for use in the interactive surface environment 100 of Fig. 1. In this example, the interactive surface 104 corresponds to a rectangular table-top of dimensions $M \times N$. But, as stated, the interactive surface 104 can have any shape, surface contour, orientation, and size.

5 [0070] In the particular case of Fig. 3, the interactive surface 104 is large enough to host a collaborative environment in which a plurality of users (302, 304, 306, 308, 310) can simultaneously engage the interactive surface 104. As mentioned above, the users may work on the same application provided by a single application module, or the users can work on separate applications provided by different respective application modules 114.

10 [0071] Note that the users engage the interactive surface 104 using a plurality of physical objects. A first class of physical objects corresponds to input devices. Such devices include keyboard-type devices and mouse-type devices (but, as stated, the users can use any kind of input device). For example, user 302 is using two mouse-type input devices (312, 314). User 304 is using a keyboard-type device 316 in combination with a mouse-type device 318.
15 Similarly, user 306 is using a keyboard-type device 320 in combination with a mouse-type device 322. User 308 does not operate any physical input device, but he or she can nevertheless manipulate digital objects using finger contacts (in a manner to be described below). User 310 uses a physical marking implement 324 (e.g., a pen, etc.) to create marks. A second class of physical objects includes articles. For example, user 310 is interacting with
20 a physical document 326.

[0072] The interactive surface 104 also provides a collection of digital objects which are projected onto its surface by the content-projection modules 206. For example, the user 302 is interacting with a digital copy 328 of the physical article 326. The user also can interact with cursors (330, 332) which are controlled by the respective mouse-type devices (312,
25 314). The digital copy 328 and the cursors (330, 332) are digital objects insofar as they are

not physical objects, but rather images projected onto the interactive surface 104 by the content-projection modules 206.

[0073] The user 304 is interacting with a display interface 334 which serves to display the information input by the user 304 using the keyboard-type device 316. The user 304 also interacts with an optional “soft key” input mechanism 336 that can be activated by the user 304 by pressing on its key(s) with a finger or stylus or using a cursor-simulated finger contact, etc. The user also interacts with a cursor 338 which is controlled by the mouse-type device 318. Again, all of these objects constitute digital objects that are projected onto the interactive surface 104.

[0074] In a similar manner, the user 306 is interacting with a display interface 340 that receives information input by the user using the keyboard-type device 320. The user 306 also interacts with a cursor 342 that is controlled by the mouse-type device 322. Further, the user 306 can interact with a joint display interface 344 which is shared with the user 304. That is, the joint display interface 344 can display the union of content entered by both user 304 and user 306.

[0075] User 308, like user 302, is interacting with a digital copy 346 of the physical article 326.

[0076] User 310 is currently not interacting with any digital objects.

[0077] Fig. 4 shows a more detailed depiction of the manner in which the user 304 can interact with the interactive surface 104. To repeat, the user 304 is using a keyboard-type device 316 and a mouse-type device 318 to engage the interactive surface 104. The keyboard-type device 316 is an example of one type of device for providing alphanumeric text entry. The interactive surface 104 provides three digital objects for use by the user 304, namely a display interface 334, an auxiliary a soft-key input mechanism 336, and a cursor 338.

[0078] In the illustrated scenario, the user 304 is using the keyboard-type device 316 to interact with a word processing program. The message that the user 304 is typing using the keyboard-type device 316 is displayed in the interface display 334. The user 304 may optionally use the soft-key input mechanism 336 to provide supplemental instructions that have a bearing on the task at hand. For example, the word processing program (in conjunction with the IMM 112) can provide a soft-key input mechanism 336 that allows the user 304 to perform actions on the message that he or she is typing. For example, the user 304 can use the soft-key input mechanism 336 to print the message, send the message to another user, and so on.

[0079] In another scenario (not shown), the IMM 112 can use the soft-key input mechanism 336 to establish a context for use in interpreting the information that the user 304 inputs through the keyboard-type device 316 (or some other input device). For example, if the user 304 is performing a search, the soft-key input mechanism 336 can be used to identify the data store to which the user's 304 search selection is to be applied. For instance, the soft-key input mechanism 336 can be used to specify whether the search selection is to be directed to a local database, an organizational database, or a remote public database, and so on.

[0080] As can be appreciated from the illustrative scenario shown in Fig. 3, in a multi-user setting, the interface surface 104 can easily become relatively cluttered with physical objects and digital objects. It may thus become confusing as to which user controls which object(s). To address this potential challenge, the IMM 112 provides a suite of mechanisms to help disambiguate "ownership" of objects.

[0081] According to one technique, the IMM 112 displays the digital objects near the devices which are associated with the digital objects. For example, as shown in Fig. 4, the IMM 112 can present the display interface 334 directly above the keyboard-type device 316 (although, in other implementations, the IMM 112 can present the display interface 334 at

other locations relative to the keyboard-type device 316). Further, the IMM 112 can present the digital objects with an orientation that generally matches the orientation of the devices which are associated with the digital objects. For example, the orientation of the display interface 334 matches the orientation of the keyboard-type device 316. If the user changes the position and/or orientation of the keyboard-type device 316, the position and/or orientation of the display interface 334 will change in a corresponding manner. Further note that the orientation of the cursor 338 matches the orientation of the mouse-type device 318.

[0082] Fig. 4 also shows that the digital objects can be tagged with a visual attribute which helps the user 304 keep track of the digital objects which he or she “owns” or controls.

For example, the IMM 112 can display a border 402 around the display interface 334 and a border 404 around the cursor 338. The IMM 112 can also optionally display a border 406 around the keyboard-type device 316 and a border 408 around the mouse-type device 318. The borders (402, 404, 406, 408) can be displayed in a single color which differs from respective colors assigned to other users, thus helping the user 304 keep track of the group of digital objects and devices which belong to him or her. The use of color borders is illustrative of one implementation. Alternatively, or in addition, the entire surfaces of the objects can be tinted in a telltale color. Alternatively, or in addition, the objects can be tagged with distinguishing information (such as distinguishing textual information, distinguishing symbolic information, etc.), and so on. Alternatively, or in addition, connecting lines can be drawn between the physical devices and their associated digital objects. For example, as shown in Fig. 4, the IMM 112 can project a line 410 that connects the mouse-type device 318 with its associated cursor 338.

[0083] The IMM 112 can establish associations between devices and digital objects in different ways. According to one representative mechanism, each physical input device can include an identifying tag on its underside (e.g., the side which contacts the interactive

surface 104). For example, the tag may correspond to a bar code or other kind of machine-readable information. The position-detection modules 210 can read this tag to determine the identity of the physical device. This information, in turn, allows the IMM 112 to correlate the physical device with the digital objects that are associated with the device. Additional
5 information regarding techniques for reading identifying information from devices placed on an interactive surface 104 can be found in U.S. Patent No. 7,204,428, naming the inventor of Andrew D. Wilson.

[0084] Returning to Fig. 3, this figure encompasses many different usage scenarios that are described in detail in Section B below. Before delving into those scenarios, the remainder
10 of this section provides additional information regarding base tools and mechanisms that can allow the IMM 112 to perform the functions that will be described in Section B.

A.2. Illustrative Cursor-Positioning Mechanisms (Figs. 5-7)

[0085] Fig. 5 is a flowchart that shows an illustrative procedure 500 for determining a position of a cursor on an interactive surface 104.

15 **[0086]** In block 502, the IMM 112 determines the orientation and absolute position of a mouse-type device (or other type of input device that can be used to control a cursor). This information can be obtained from any of the input mechanisms described above, such as the position-detection modules 210.

[0087] In block 504, the IMM 112 determines a frame of reference for use in positioning
20 the cursor. More specifically, a typical mouse-type device provides positional offset information that positions a cursor relative to a frame of reference. Block 504 determines this frame of reference. Figs. 6 and 7 will provide two illustrative techniques for determining the frame of reference.

[0088] In block 508, the IMM 112 places the cursor at a position that is based the frame
25 of reference determined in block 506. The placement of the cursor thus reflects the

contribution of both a global (absolute) measurement (e.g., provided by the position-detection modules 210) and a relative offset measurement (e.g., provided by the mouse-type device itself). The relative offset measurement is generally more precise and responsive compared to the global measurement.

5 **[0089]** The placement of the cursor may also be based on a user-definable control display (CD) ratio. The CD ratio is a scaling factor that defines how far a cursor will advance on the interactive surface 104 in response to a corresponding movement of the mouse-type device. In one illustrative technique, the IMM 112 can display an auxiliary soft-key-type input mechanism in proximity to the mouse-type input device (not shown) that allows the user to
10 adjust the CD ratio. For example, the auxiliary input mechanism can comprise a slider-mechanism or other tunable control mechanism that allows the user to adjust the CD ratio.

[0090] Fig. 6 shows a first technique for determining a frame of reference for use in positioning the cursor in the procedure of Fig. 5. In this technique, the IMM 112 determines the absolute position of a mouse-type device 602 and then determines the edge 604 of the
15 interactive surface 104 that is closest to the position of the mouse-type device 602. The IMM 112 then defines a frame of reference 606 which is based on axes associated with the nearest edge 606. Alternatively, or in addition, any other stationary feature(s) of the interactive surface 104 can be used as a reference object or reference objects, such as one or more reference lines (not shown) on the interactive surface 104.

20 **[0091]** Fig. 7 shows a second technique for determining a frame of reference for use in positioning the cursor in the procedure of Fig. 5. In this technique, the IMM 112 determines both the absolute position and the orientation of the mouse-type device 602. The IMM 112 then defines a frame of reference 702 which corresponds to the determined orientation of the mouse-type device 602 itself. In this case, the frame of reference dynamically changes as the
25 user moves the mouse-type device 602 on the interactive surface 104.

[0092] The two techniques described in Figs. 6 and 7 are representative; the IMM 112 can apply yet additional techniques or combinations of different techniques to position the cursor.

[0093] In the above examples, the goal of the procedure 500 is to determine a frame of reference with respect to which relative placement of the cursor can be defined. The IMM 112 can also apply the information collected in the procedure 500 to provide a measurement of the absolute position of the mouse-type device 602 itself. For example, the IMM 112 can use the position-detection modules 210 or other global (i.e., surface-wide) position sensing mechanism to determine an absolute position of the mouse-type device 602. The IMM 112 can then use the relative position measurement provided by the mouse-type device 602 to adjust the above-determined absolute position as the mouse-type device 602 is moved.

[0094] It is possible to use just the position-detection module 210 to determine the absolute position of the mouse-type device 602, but it may be beneficial to determine the absolute position using the combination of measurements in the manner described above; this is because, for instance, the relative position measurement provided by the mouse-type device may be more responsive (and may potentially have a higher resolution) than the global measurement made by the position-detection modules 210. Similar benefits apply to the scenario shown in Fig. 5, where the goal is to determine the relative offset of the mouse-type device 602 with respect to a frame of reference. It is possible to use just the global measurements to determine the movement of the mouse-type device 602, but it may be desirable to use a combination of global measurements and local measurements; this is because the local measurements provided by the mouse-type device 602 may be more responsive and have a greater resolution compared to the global measurements.

A.3. Illustrative Image Acquisition Mechanisms (Fig. 8)

[0095] Fig. 8 is a flowchart (and accompanying example) that shows an illustrative procedure for forming a digital copy of an article or other kind of object that is placed on the interactive surface 104. Fig. 8 will be explained in the context of a specific scenario (depicted to the right of the flowchart operations), but it will be appreciated that this procedure 800 has general application to any image acquisition scenario.

[0096] In block 802, the IMM 112 detects an instruction to generate a digital copy of the article. Section B will describe representative occasions on which block 802 may be executed. For example, the IMM 112 can execute block 802 when a user activates an interface object associated with the article (e.g., by executing a dragging motion on the interface object).

[0097] In block 804, the IMM 112 receives the image of the entire interactive surface 104. Fig. 8 depicts this image as illustrative “entire surface image” 806. The entire surface image 806 includes a target image 808 as a component part thereof. The target image 808 corresponds to the article that is placed on the interactive surface 104.

[0098] In block 810, the IMM 112 crops the entire surface image 806 so that all the image content is effectively discarded except the target image 808. The target image 808 provides a digital copy of the article that can then be projected back onto the interactive surface 104 in a manner that will be described in Section B. The IMM 112 can use different techniques to crop the entire surface image 806. In one technique, the IMM 112 can use edge detection to determine the boundaries of the target image 808; the IMM 112 can then remove all of the image content outside these boundaries using cropping.

A.4. Illustrative Digital Object Placement Mechanisms (Fig. 9)

[0099] Fig. 9 is a flowchart (and accompanying example) that shows an illustrative procedure 900 for placing a digital object on the interactive surface 104 in a manner such that the digital object does not interfere with existing objects on the interactive surface 104. In

the merely representative example of Fig. 9, the IMM 112 may seek to place an $L \times M$ digital object 902 onto the interactive surface 104 such that the digital object 902 does not interfere with a collection of existing objects 904. For example, assume that the user has just placed a new keyboard-device 906 on the interactive surface 104. The IMM 112 responds by placing the digital object 902 onto the interactive surface 104. (In the specific scenario of Fig. 9, the display object 902 acts as a display interface for the keyboard-type device 906.) Fig. 9 will be explained in the specific context of the above-described scenario (involving digital object 902), but it will be appreciated that this procedure 900 has general application to any object placement scenario.

10 [00100] In block 908, the IMM 112 determines the characteristics of the digital object 902 that it wishes to place on the interactive surface 104. The characteristics of the digital object 902 may correspond to the dimensions of the digital object 902, or more generally, the shape of the perimeter of the digital object 902. In the representative example of Fig. 9, the IMM 112 determines that the object 902 has dimensions of $L \times M$.

15 [00101] In block 910, the IMM 112 identifies at least one placement constraint. Each placement constraint corresponds to a rule which acts as a constraint to be satisfied in placing the digital object 902. For example, one rule that may apply to the scenario set forth above is that the digital object 902 is to be placed above the keyboard-device 906 (relative to the position of the user) and preferably as close as possible to the keyboard-type device 906 (or a few inches above the keyboard-type device 906, etc., depending on environment-specific placement factors). In one implementation, one or more of these constraints are defined as mandatory constraints that are required to be satisfied in the placement of the digital object 902. Alternatively, or in addition, one or more of these constraints are defined as preference-type constraints that are to be satisfied to an extent possible in the placement of the digital object 902. In yet other implementations, the IMM 112 can permit a user to attach a weight

25

to each constraint which determines the relative importance of the constraint in the placement of the digital object 902. The IMM 112 can use these weights to prioritize the various considerations that go into placing the digital object 902, particularly in the case in which all of the constraints cannot be fully satisfied.

5 **[00102]** In block 912, the IMM 112 generates a mask (e.g., mask 914) of the entire surface of the interactive surface 104. The IMM 112 can form the mask 914 in any way or combination of ways, e.g., by using the position detection modules 210 to determine the placement of physical objects on the interface surface 104. As shown in Fig. 9, the mask 914 reveals the presence of the collection of pre-existing objects 904 on the interactive surface
10 104. These objects 904 may correspond to pre-existing physical objects and/or digital objects (note that the IMM 112 has a priori knowledge regarding the placement of digital objects because the IMM 112 is the agent which places these objects). Alternatively, or in addition, block 912 can use the high-resolution imaging modules 208 to form the mask 914.

[00103] In block 916, the IMM 112 determines the placement of the digital object 902
15 based on all the information discussed above, namely: a) the characteristics of the digital object 902 to be placed (as determined in block 908); b) the placement constraint(s) (as determined in block 910); and c) the positions of the existing objects 904 on the interactive surface 104 (as determined in block 912). The IMM 112 can use any algorithm for determining the placement of the object 902. In one representative case, the IMM 112 uses
20 an integral image technique to determine an appropriate placement of the digital object 902 on the interactive surface 104. The IMM 112 applies the integral image technique by first forming an integral image table in a known manner. The integral image table can be used to investigate a plurality of placement possibilities in an efficient manner.

[00104] Fig. 9 shows that the $L \times M$ display object 902 is placed on the interactive surface
25 104 such that it does not overlap with any of the existing objects 904. Further, this placement

at least partially satisfies the above-identified placement constraint(s), e.g., because the display object 902 is placed relatively close to user's keyboard-type device 906. However, the placement of the object 902 may not be optimal (from the standpoint of the placement constraints) due to the constraining presence of nearby object 918.

5 A.5. Illustrative Mechanisms for Using a Cursor as a Contact Point (Fig. 10)

[00105] A contact point corresponds to a point at which the user may engage the interactive surface 104 to manipulate a digital object that is presented on the interactive surface 104 or to perform some other action. In one case, the user can engage the interactive surface 104 by placing a finger (or other body part, such as an entire hand, etc.) or a physical
10 pointing instrument (such as, a stylus, etc.) on or near the interactive surface 104. This type of contact point is broadly referred to herein as a finger contact point. In another case, a user can use a cursor which is controlled by a mouse-type input device as a simulated finger contact point. That is, the cursor can operate as a surrogate for the user applying a finger at the location defined by the cursor. The type of contact point associated with a cursor is
15 referred to as a cursor contact point. Here, the term cursor encompasses any digital object that can be manipulated by the user; in one non-limiting case, a cursor corresponds to an arrow-shaped digital object.

[00106] Fig. 10 is a flowchart that shows an illustrative procedure 1000 for operating a mouse-type device in a touch mode. In the touch mode, the cursor controlled by the mouse-
20 type device simulates a finger contact placed on the interactive surface 104 in the manner described above. When not acting in the touch mode, the mouse-type device functions in a traditional manner by moving the location of the cursor without performing any supplemental image-manipulation functions.

[00107] In block 1002, the IMM 112 determines whether the user has activated the touch
25 mode of the mouse-type device. In one merely illustrative case, the user can activate this

mode by clicking on a specially-assigned mouse button or other control. So long as the user holds this button down, the device operates in the touch mode. When the user releases the button, the touch mode is de-activated. Consider the example in which the user depresses the button of the mouse-type device, and then, with the button depressed, moves the cursor from a first location to a second location. At the second location, the user releases the button. This operation is functionally equivalent to a user pressing his or her finger down on the interactive surface 104 and dragging it from the first location to the second location.

[00108] In block 1004, the IMM 112 operates the mouse-type device in the touch mode if this mode has been activated.

[00109] In block 1006, the user may perform any type of image manipulation operation within the touch mode of the mouse-type device. For example, the user can move a digital object, rotate a digital object, change the size of a digital object, and so forth. Section B provides examples of the types of actions that can be taken when the mouse-type device is operating in the touch mode of operation.

[00110] In block 1008, the IMM 112 detects that the user has de-activated the touch mode.

[00111] In block 1010, the mouse-type device transitions to a traditional mode in which it is used to control the movement of the cursor in a traditional manner of operation.

B. Illustrative Applications of Systems and Tools

[00112] Figs. 11-22 provide several scenarios which describe how the systems and tools described in Section A can be used by users to engage the interactive surface 104. These scenarios are illustrative; the systems and tools described above can be used to perform many other operations that are not specifically enumerated in this section.

B.1. Mechanisms for Affiliating Digital Objects with Physical Objects (Figs. 11-14)

[00113] Figs. 11-14 show various scenarios that indicate how the IMM 112 can manage the affiliation between physical devices and digital objects. In the scenarios set forth in this

subsection, the digital objects correspond to display interfaces. These display interfaces are used to present information that is entered by the users using physical devices, such as keyboard-type devices. However, the principles described here are applicable to any type of digital object and any type of physical device.

5 [00114] Starting with Fig. 11, this figure is a flowchart (and accompanying example) that shows an illustrative procedure 1100 for generating a new digital object when a device is placed on the interactive surface 104. Namely, in this case, the user has placed a device 1102 onto the interactive surface 104; it is the goal of the procedure 1100 to display a digital object 1104 onto the interactive surface 104. In this illustrative case, the digital object 1104
10 provides a display interface for use in association with the device 1102 (as mentioned above).

[00115] In block 1106, the IMM 112 detects that the user has placed the device 1102 onto the interactive surface 104. The IMM 112 can make this determination based on input information provided by the position-detection modules 210, and/or any other input mechanism described above. The IMM 112 can distinguish the device 1102 from a physical
15 article (such as a physical document) by noting that the device 1102 includes a telltale code on its underside. In addition, or alternatively, the IMM 112 can distinguish the device 1102 from the physical article (or a finger contact point and the like) based on contour analysis.

[00116] In block 1108, the IMM 112 displays the digital object 1104 on the surface just above the device 1102. More specifically, the placement procedure 900 described above (in
20 connection with Fig. 9) can be used to determine the position (and orientation) at which to place the digital object 1104. In one case, the IMM 112 can display the digital object 1104 immediately after it detects that the user has placed the device 1102 onto the interactive surface 104. In another case, the IMM 112 can display the digital object 1104 in response to the detection that the user has begun to interact with the device 1102; for example, the IMM
25 112 can display the digital object 1104 when the user enters a first keystroke using the device

1102. Still other factors can play a role in determining the timing at which to present the digital object 1104. In one case, the IMM 112 can remove (e.g., turn off) the digital object 1104 when it detects inactivity with respect to the device 1102 for a prescribed period of time.

5 [00117] In block 1110, the IMM 112 detects that the user has removed the device 1102 from the interactive surface 104.

[00118] In block 1112, in response to the removal of the device 1102, the IMM 112 removes the digital object 1104 from the interactive surface 104.

[00119] Fig. 12 is a flowchart (and accompanying example) that shows an illustrative
10 procedure 1200 for affiliating an existing digital object with a device when the device is placed on the interactive surface 104 in proximity to the existing digital object. For example, assume that the interactive surface 104 already includes a digital object 1202. In one particular illustrative scenario, this digital object 1202 is being used by one or more users to interact with an application module. A new user may wish to join the others and also interact
15 with the application module via the digital object 1202.

[00120] In block 1204, the IMM 112 detects that the new user has placed a device 1206 (or other type of input device) onto the interactive surface 104 in proximity to the existing digital object 1202.

[00121] In block 1208, the IMM 112 detects whether one or more device-object affiliation
20 considerations are satisfied. These conditions determine whether the new device 1206 is permitted to form an association with the digital object 1202. One consideration, for example, indicates whether the new user has placed the device 1206 close enough to the digital object 1202 to warrant automatic association of the device 1206 with the digital object 1202. Another consideration indicates whether the user is permitted to join in and contribute
25 to the task. This consideration, in turn, can depend on any number of environment-specific

factors, such as the nature of the task being performed, the identity of the user, and so on. No limitation is placed on what may constitute a device-object affiliation consideration.

[00122] In block 1210, the IMM 112 forms an association between the device 1206 and the digital object 1202 if the consideration(s) identified in block 1208 are satisfied. Fig. 12 shows that the display interface 1202 can be presented with a visual attribute 1212 (such as a colored border) to indicate that the digital object 1202 is now associated with the device 1206. The IMM 112 can use other techniques to signify device-object affiliation, that is, instead of the visual attribute 1212, or in addition to the visual attribute 1212. For example, the IMM 112 can project a line (not shown) that connects the device 1206 to the digital object 1202. (The same type of device-to-object visual correlation mechanism(s) can applied to the scenario shown in Fig. 11, although not shown.)

[00123] Fig. 13 is a flowchart (and accompanying example) that shows an illustrative procedure 1300 for affiliating an existing digital object with a device when the existing digital object is moved in proximity to the device. That is, Fig. 13 shows a scenario that is complementary to the scenario described in Fig. 12. In Fig. 13, the user moves an existing digital object 1302 to a device 1304, whereas, in Fig. 12, the user moves the existing device 1206 to the digital object 1202.

[00124] In block 1306, the IMM 112 detects that the user (or some other agent) has placed the existing digital object 1302 in proximity to the device 1304.

[00125] In block 1308, the IMM 112 determines whether the device-object affiliation consideration(s) are met. These considerations define whether it is appropriate to associate the digital object 1302 with the device 1304. Exemplary such considerations were described in the context of the discussion of block 1208 of Fig. 12.

[00126] In block 1310, the IMM 112 associates the digital object 1302 with the device 1304 if the conditions defined in block 1308 are satisfied. In one case, the IMM 112 can

display a visual attribute 1312 (such as a colored border) to indicate that the digital object 1302 is now associated with the device 1304.

[00127] Fig. 14 is a flowchart (and accompanying example) that shows an illustrative procedure 1400 for affiliating a single digital object with two devices; this procedure also demonstrates how operations being performed using two respective digital objects (which are controlled by the two respective devices) can be merged by bringing the devices near to each other.

[00128] For example, in one scenario, assume that a first user is using a first device 1402 and an associated display object 1404 to interact with a search application module. A second user is using a second device 1406 and associated digital object 1408 to interact with the same search application module. At an initial point of time, these users are interacting with the interactive surface 104 at locations that are relatively far apart from each other; further, these two users are performing independent search operations. Next assume that the users move their devices (1402, 1406) relatively close to each other so that they can work together on a common search task. For example, these two users may correspond to users 304 and 306 shown in Fig. 3. In this scenario, the IMM 112 can be used to combine the operations performed by these users in the manner described below.

[00129] In block 1410, the IMM 112 detects placement of the two devices (1402, 1406) in proximity to each other on the interactive surface 104.

[00130] In block 1412, the IMM 112 determines whether one or more device-device affiliation considerations are satisfied. These considerations define one or more rules that govern whether the operations being performed by one user are to be merged with the operations being performed by another user. Exemplary such considerations were described in the context of the discussion of Figs. 12 and 13.

[00131] In block 1414, the IMM 112 merges the functions being performed by the two users if the considerations set forth in block 1412 are satisfied. This merging operation can take different forms depending on various environment-specific factors and other considerations. In the merely illustrative example shown in Fig. 14, the IMM 112 combines
5 the digital objects (1404, 1408) that were separately being used by the devices (1402, 1406) into a single digital object 1416. Both users are permitted to engage the joint display object 1416 using their respective devices (1402, 1406).

[00132] Further, the IMM 112 can optionally combine the search selections that were independently made by the two users into a joint search selection. For example, assume that
10 the first user has entered the search selection “Seattle” and the second user has entered the search selection “Condo” before these users moved their devices (1402, 1406) close together. Upon moving close together, the IMM 112 can form a combined search selection that represents the logical union of the independent search selections (such as by forming the combined search selection of “Seattle AND Condo”). (In other scenarios, other rules can
15 determine the manner in which separate selections are logically combined together.) The IMM 112 can forward this combined search selection to an appropriate application module and then display the results provided by the application module in the unified display interface 1416, as graphically illustrated in Fig. 14 by the arrow pointing to the label “(Output of Joint Search).”

[00133] To repeat, the specific example developed in Fig. 14 is representative of many possible scenarios in which digital objects and corresponding operations can be merged based on various triggering events. In another example, two users can take independent notes at a meeting using independent digital objects to display those notes. Upon moving close together, the IMM 112 can merge the notes taken by these users into a common document
25 that is displayed by a common digital object. In this scenario, the IMM 112 can optionally

provide user tags of any type to indicate the contributions made by respective users to the common document. In general, the nature of the merging operation that is performed will depend, in part, on the nature of the functions being performed by the users, in combination with one or more environment-specific factors. In one case, the IMM 112 can maintain
5 privilege information which governs, on a user-by-user basis, the object-combining and operation-combining behavior of the IMM 112. For instance, a meeting administrator may wish to prohibit certain users from contributing to a joint task, thereby locking out the behavior set forth in procedure 1400 for certain users.

[00134] Fig. 14 was described in the illustrative context of two users. But the principles
10 set forth above can be applied to any number of users who wish to interact with a shared digital object.

B.2. Mechanisms for Manipulating Digital Objects (Figs. 15 and 16)

[00135] The next series of figures shows illustrative techniques for manipulating digital objects. Starting with Fig. 15, this figure is a flowchart (and accompanying example) that
15 shows an illustrative procedure 1500 for manipulating a digital object using different contact point scenarios. As set forth above, a contact point corresponds to a point at which a user engages (e.g., makes contact with) the surface of the interactive surface 104. This function can be performed in different ways. First, the user can create a contact point by pressing his or her finger (or other body part) or a physical instrument against the interactive surface 104;
20 this action defines a finger contact point. Or the user can create a contact point by activating the touch mode of a mouse-type device, as described in procedure 1000 of Fig. 10; this action defines a cursor contact point.

[00136] In block 1502, the IMM 112 detects that the user has engaged a digital object using multiple contact points.

[00137] In block 1504, the IMM 112 manipulates the digital object in a manner instructed by the user (such as by moving the digital object, changing the orientation of the digital object, changing the size of the digital object, and so on).

[00138] Fig. 15 presents three representative (and non-exhaustive) scenarios that explain how the procedure 1500 can be performed. In scenario A, the user engages a digital object 1506 using two finger contact points (1508, 1510). In this merely illustrative example, the user can use the finger contact points to touch two opposing corners of the digital object 1506. The user can then manipulate the digital object 1506 by moving the finger contact points (1508, 1510) in a clockwise or counterclockwise direction to rotate the digital object 1506 (optionally with one contact point fixed as a pivot), or by moving the finger contact points (1508, 1510) towards or away from each other to change the size of the digital object 1506, and so on.

[00139] In scenario B, the user engages the digital object 1506 with a finger contact point 1512 and a cursor contact point 1514. The user can execute any manipulation described above in the context of scenario A using these contact points.

[00140] In scenario C, the user engages the digital object 1506 with two cursor contact points (1516, 1518). The user can execute any manipulation described above in the context of scenario A using these contact points. The type of manipulation shown in scenario C is particularly appropriate in those situations in which the user seeks to manipulate an object that he or she cannot reach by hand. For example, the user 302 of Fig. 3 can use two mouse-type devices (312, 314) to control two associated cursors (330, 332). By operating the mouse-type devices (312, 314) in the touch mode, the user can manipulate the digital copy 328 in the manner described above, even though the digital copy 328 is physically out of the reach of the user 302.

[00141] Although not shown, a user can also use a single contact point to manipulate a digital object. For example, the user can use a single finger contact point or a single cursor contact point to move any digital object from a first location on the interactive surface 104 to a second location.

5 [00142] Fig. 16 is a flowchart (and accompanying example) that shows an illustrative procedure 1600 for manipulating a digital object by placing a device on top of the digital object and metaphorically using the device as a handle to move the digital object or perform some other action on the digital object.

[00143] In block 1602, the IMM 112 detects the movement of the device over a digital
10 object.

[00144] In block 1604, the IMM 112 manipulates the digital object using the device as a handle, in a manner instructed by the user.

[00145] For example, consider the scenario depicted to the right of the flowchart blocks in procedure 1600. Here, a user has placed a mouse-type device 1606 over the top of a digital
15 object 1608 of any type that is displayed on the interactive surface 104. The user can then manipulate the digital object 1608 in any manner using the mouse-type device 1606, e.g., by rotating the digital object 1608, sliding the digital object 1608 to another position, and so on. The association between the mouse-type device 1606 and the digital object 1608 can be broken when the user lifts the mouse-type device 1606 off the interactive surface 104.
20 Alternatively, or in addition, the handle-like capabilities of the mouse-type device 1606 can be activated and deactivated by pressing and releasing a mouse button that is assigned to this function.

B.3. Mechanisms for Creating and Manipulating Digital Copies (Figs. 17-21)

[00146] The next series of flowcharts show various techniques for generating copies of
25 any type of physical article, such as, but not limited to, a tangible (e.g., "hard-copy")

document. The flowcharts also show techniques for interacting with the digital copies that have been generated. The generation and manipulation of digital copies is particularly useful in a collaborative environment. For example, as shown in Fig. 3, the user 310 is interacting with a physical article 326. The user 310 can generate digital copies of this physical article 326 (e.g., digital copies 328 and 346) for distribution to other users (e.g., users 302, 308). This makes it easy for the other users (302, 308) to examine the information imparted by the physical article 326, e.g., without requiring the user's (302, 308) to crowd around the user 310 to examine the original physical article 326, and without requiring the users (302, 308, 310) to circulate the physical article 326 amongst themselves in the traditional temporally-successive manner. Further, actions taken by any user with respect to a digital copy can automatically cause corresponding operations to be performed on the physical article, and vice versa. This also facilitates the collaborative nature of the environment, e.g., by providing a convenient mechanism whereby any user can point out a feature of interest to one or more other users stationed at different locations about the perimeter of the interactive surface 104.

[00147] Starting with Fig. 17, this figure is a flowchart (and accompanying example) that shows an illustrative procedure 1700 for creating a digital copy 1702 based on a physical article 1704 that is placed on the interactive surface 104.

[00148] In block 1706, the IMM 112 detects that the user has placed the physical article 1704 on the interactive surface 104. This detection operation can be performed based on the output of the position-detection modules 210, or by using some other input mechanism or combination of input mechanisms. The IMM 112 can distinguish the physical article 1704 from a finger contact point (and other objects) using contour analysis. The IMM 112 can distinguish the physical article 1704 from an input device by noting the lack of a telltale marking on the physical article 1704 that identifies an object as an input device.

[00149] In block 1708, the IMM 112 presents an interface object 1710 in association with the physical article 1704. The interface object 1710 is a digital object which allows the user to interact with the physical article 1704, e.g., to make digital copies of the physical article 1704 and perform other operations. In the merely representative example of Fig. 17, the interface object 1710 corresponds to a halo or a border that is formed around the physical object 1704. Any other type of interface object can be used to accomplish the functions of procedure 1700. For example, another interface object (not shown) can correspond to one or more digital pull tabs that protrude from a corner (or corners) of the physical article 1704.

[00150] In block 1712, the IMM 112 detects that the user has engaged the interface object 1710 in a manner indicative of an intent to create a digital copy of the physical article 1704. In one case, assume that the use touches the interface object 1710 with a finger and then, while maintaining the finger pressed against the interactive surface 104, drags the finger away from the physical article 1704. The IMM 112 can interpret this motion as an instruction to create a digital copy of the physical article 1704. This motion resembles the act of sliding a topmost card off of a deck of cards. The same movement can be performed using a cursor contact point instead of a finger contact point. Further, to repeat, other interface objects and associated telltale movements can be used to instruct the IMM 112 to create a digital copy. The IMM 112 can detect the telltale movement using any one or more of the detection mechanisms described above (e.g., using the position-detection modules 210 and/or the high-resolution imaging modules 208, etc.).

[00151] In block 1714, the IMM 112, having detected the type of telltale movement described above, creates the digital copy 1702 of the physical article 1704. In one case, the IMM 112 can “deposit” the digital copy 1702 at a location at which the user terminates his or her finger-dragging motion and lifts his or her finger from the interactive surface 104. Although not shown, the IMM 112 can also allow the user specify various attributes which

govern the copying operation, e.g., by specifying a number of copies to be produced, a size-scaling ratio to be used, a copying density to be used, and so on.

[00152] Different environment-specific considerations can be used to determine the exact timing at which the IMM 112 captures the image of the physical article 1704. In one non-limiting case, the IMM 112 captures the image of the physical article 1704 when the user removes his or her finger from the interactive surface 104, e.g., at the end of the dragging operation. This timing can reduce the likelihood that the IMM 112 will capture part of the user's body when taking a picture of the physical article 1702.

[00153] Fig. 18 is a flowchart (and accompanying example) that shows an illustrative procedure 1800 for presenting a menu object 1802 in association with a physical article (e.g., physical article 1804) that is placed on the interactive surface 104. More specifically, in addition to serving as a tool to perform the copying operation (described in Fig. 17), the interface object 1710 can be activated to perform other operations, such as the presentation of the menu object 1802.

[00154] In block 1804, the IMM 112 identifies an action by the user that is indicative of the user's desire to engage the interface object 1710 to perform a task other than the creation of a digital copy of the physical article 1704. For example, in one merely illustrative case, the user may tap on the interface object 1710 twice in rapid succession with a finger or with a simulated finger contact point (controlled by a mouse-type device). In the example of Fig. 18, the IMM 112 interprets this action as a request to activate the menu object 1802.

[00155] In block 1806, the IMM 112 presents the menu object 1802 to the user. The IMM 112 can display this menu object 1802 in any location, such as at the periphery of the interface object 1710. The menu object 1802 can provide any number of options for performing any number of operations with respect to the physical article 1704, such as printing a digital copy of the physical article 1704, saving a digital copy of the physical

article 1704, and so on. Alternatively, or in addition, the menu object 1802 can serve as a tool which allows the user to adjust the settings which govern the copying operation (of Fig. 17).

[00156] Fig. 19 is a flowchart (and accompanying example) that shows an illustrative procedure 1900 for highlighting a part of a physical article 1902 based on a selection of a corresponding part of a digital copy 1904 (or vice versa).

[00157] In block 1906, the IMM 112 detects that the user has selected a part 1908 of the digital copy 1904. For example, the user may point to the particular part 1908 of the digital copy 1904 using a finger, a stylus, a cursor, or other contact point.

[00158] In block 1910, the IMM 112 can provide highlighting 1912 to a part 1914 of the physical article 1902. The part 1914 corresponds to the selected part 1908 of the digital copy 1904. The IMM 112 can perform this function by mapping positions in the digital copy 1904 to corresponding positions in the physical article 1902. The IMM 112 can highlight the part 1914 of the physical copy 1902 in any way, such as by projecting an image of a border around the part 1914, projecting an arrow (or the like) which points out the part 1914, projecting a light beam which brightens the part 1914, and so on.

[00159] In block 1916, the IMM 112 detects that the user has de-selected the part 1908 of the digital copy 1904, e.g., by removing his or her finger from the part 1908.

[00160] In block 1918, the IMM 112 removes the highlighting 1912 from the corresponding part 1914 of the physical article 1902.

[00161] Although not shown, the user can select a part of the physical article 1902 in the manner described above, which prompts the IMM 112 to add highlighting to a corresponding part of the digital copy 1904. As before, the IMM 112 can remove the highlighting when the user de-selects the previously selected part of the physical article 1902. In this scenario, the input functionality 108 can include another position-detection system (not shown) which has

the capability of detecting actions taken by the user directly above the physical article 1902. For instance, the input functionality 108 can include a remote sensing mechanism of any type that is positioned above the interactive surface 104. Alternatively, or in addition, the input functionality 108 can include a touch-sensitive input mechanism that is integrated (e.g.,
5 internal to) the interactive surface 104 itself.

[00162] In other cases, the IMM 112 can give the user the option of preserving the highlighting applied to the physical article 1902 or the digital copy 1904 after the user has de-selected a previously selected part. For example, instead of adding an impermanent highlighting to the digital copy 1904 in the manner described above, the user can add a digital
10 mark to the digital copy 1904. This causes the IMM 112 to add a corresponding digital mark to the physical article 1902. The digital mark applied to the physical article 1902 could remain after the user has finished engaging the digital copy 1904 (but it is also possible to give the user the option of “erasing” digital marks applied to the physical article 1904).

[00163] Fig. 20 expands on the above-identified concept; namely, Fig. 20 is a flowchart
15 (and accompanying example) that shows an illustrative procedure 2000 for creating a digital mark 2002 on a physical article 2004 based on a corresponding digital mark 2006 that is made to a digital copy 2008.

[00164] In block 2010, the IMM 112 detects that the user has placed the digital mark 2006 on the digital copy 2008. The user can create this digital mark 2006 using any mechanism
20 2012, such as a finger, stylus, cursor, and so on. In the merely illustrative scenario of Fig. 20, the user uses a finger to circle a particular part 1214 of the digital copy 2008. The IMM 112 can detect the creation of the digital mark 2006 using any one or more of the detection mechanisms described above (e.g., using the position-detection modules 210 and/or high-resolution imaging modules 208, etc.).

[00165] In block 2016, the IMM 112 applies a corresponding digital mark 2002 to a corresponding part 2018 of the physical article 2004. Unlike the case of Fig. 19, the digital mark 2002 remains on the physical article 2004, although it is also possible to provide a mechanism that allows a user to “erase” such digital marks 2002.

5 [00166] The procedure 2000 shown in Fig. 20 can be performed in reverse, e.g., by detecting that a user has made a physical mark (or digital mark) to the physical article 2004, and then, in response, adding a corresponding digital mark to the digital copy 2008. In this scenario, the IMM 112 can determine that a physical mark has been added by forming a difference image which reflects the difference between the physical article at time t_1 (before
10 the physical mark was added) and time t_2 (after the physical mark was added). The digital counterpart of the physical mark can be obtained based on this difference image.

[00167] Fig. 21 is a flowchart (and accompanying example) that shows an illustrative procedure 2100 for applying a mark 2102 to a digital copy 2104 of a physical article (not shown), followed by generating a new digital copy which includes a digital mark 2108 that is
15 a digital representation of the physical mark 2102.

[00168] In block 2110, the IMM 112 detects that the user has moved a digital copy 2104 of a physical article over an editing region 2112. The editing region 2112, in one illustrative case, may correspond to a white board section of the interactive surface 104. Or the editing region 2112 can correspond to a piece of paper (or the like) placed on the surface of the
20 interactive surface 104. The users can draw on this editing region 2112, e.g., using a pen, pencil, marker, etc. The editing region 2112 has a defined size. In one case, the IMM 112 can “snap” the digital copy 2104 to the size of the editing region 2112 when the digital copy 2104 is moved over the editing region 2112, that is, by modifying the size of the digital copy 2104 such that it conforms to the size of the editing region 2112. Once the digital copy 2104
25 has become associated with the editing region 2112, the digital copy 2104 can remain

“attached” to the editing region 2112. Thus, when (and if) the editing region 2112 is moved on the interactive surface 104 (e.g., by moving a whiteboard or paper associated with the editing region 2112), the digital copy 2104 is moved along with it. This mechanism provides another way of moving a digital copy on the interactive surface 104, e.g., by metaphorically using the editing region 2112 as a plate on which to move the digital copy 2104.

[00169] In block 2114, the IMM 112 detects that the user has created a physical mark 2102 “on” the digital copy 2104 (e.g., using the detection technique described above with respect to Fig. 20). The physical mark 2102 is physically formed on the underlying substrate provided by the editing region 2112. In this merely illustrative case, the user uses an instrument 2116 to circle a part 2118 of the digital copy 2104.

[00170] In block 2120, the IMM 112 generates a new digital copy 2106 of the previous digital copy 2104. The new digital copy 2106 includes a digital mark 2108 which is the digital counterpart to the physical mark 2102 drawn “on” the previous version of the digital copy 2104. In the example of Fig. 21, the user has also moved the new digital copy 2106 away from the editing region 2112, which reveals the “naked” original physical mark 2102 placed on the editing region 2112.

[00171] The IMM 112 can perform the operation of block 2118 in various ways. According to one technique, the IMM 112 can take another picture of the digital copy 2104 (with mark 2102 added thereto), potentially with a different exposure to account for the fact that the IMM 112 is now taking a picture primarily of an image (with the exception of the physical mark 2102), rather than the original physical document. In another technique, the IMM 112 can momentarily turn off the projection of the digital copy 2104, which will reveal the naked physical mark 2102. The IMM 112 can capture an image of the physical mark 2102 and then digitally composite the image of the physical mark 2102 with the original

digital copy 2104 to generate the new digital copy 2106. Still other techniques can be used to generate the new digital copy 2106.

[00172] The procedure 2100 described above can be repeated one or more times. For each iteration, the user may provide additional annotations to the digital object in the manner described above.

[00173] More generally, any of the techniques described in subsection B.3 can be combined together in any manner.

[00174] Moreover, in the above examples, the physical article corresponds to a physical document, such as a paper document. But the procedures described above can be applied to any physical object. For example, in another case, the physical object corresponds to a three-dimensional object. In another case, the physical object includes a screen which displays information thereon. In another case, the physical object comprises (or includes) a part of the user's anatomy. For example, in the procedure 1700 of Fig. 17, the user may wish to create a digital copy of a document in which the user is physically pointing to a particular passage in the document. Still other applications are possible.

B.4. Mechanisms for Capturing a History of Actions and Performing Other Surface Management Functions

[00175] Fig. 22 is a flowchart that shows an illustrative procedure 2200 for generating a series of representations of the interactive surface 104 at different respective times, and displaying any information regarding this series to a user.

[00176] In block 2202, the IMM 112 can take a picture of the entire interactive surface 104 at a time t_n . The IMM 112 can form this picture in different ways, such as by taking a single picture of the interactive surface 104 with both physical objects and digital objects placed thereon. Or the IMM 112 can form a composite image in the manner described above in the context of the explanation of Fig. 21, e.g., by turning the projection off, taking a picture of

the physical articles on the interactive surface 104, and then combining that picture with the digital objects that are projected onto the interactive surface 104.

[00177] Different events can trigger the image capture operation. In one case, the IMM 112 periodically captures an image of the interactive surface 104 (e.g., at every n seconds or at every n minutes, and so on). Alternatively, or in addition, the user can expressly instruct the IMM 112 to capture images at various times of interest. Alternatively, or in addition, the IMM 112 can automatically capture images when it independently detects that something noteworthy is happening on the interactive surface 104, such as when a user adds a new device to the interactive surface 104, or when a user moves an existing device or digital object on the interface surface 104, and so on. Upon repetition, block 2202 establishes a plurality of images of the interactive surface taken at different respective times. The IMM 112 can archive the images in a suitable data store or stores (not shown).

[00178] In block 2204, the user can instruct the IMM 112 to show any of the images that it has previously recorded in block 2202. In one case, the user can ask the IMM 112 to show a selected image or selected images. In another case, the user can ask the IMM 112 to display a sequence of the recorded images in the order in which these images were captured over an identified time span. In this latter scenario, the IMM 112 can present the images in an animated manner or a pseudo (roughly) annotated manner.

[00179] Procedure 2200, as described above can be used to form a series of representations of the entire interactive surface 104. Alternatively, or in addition, the procedure 2200 can be used to form a series of representations of parts of the interactive surface 104, such as individual objects placed on the interactive surface 104 (including physical objects and/or digital objects), even though the user may not have expressly requested that these representations be formed). For example, the procedure 2200 can be used to show the evolution of changes made to an individual copy of a physical document or the like. The

IMM 112 can obtain representations of physical objects using, for example, the masking procedure of Fig. 8 or the like. The IMM 112 has immediate access to digital objects that it projects onto the interactive surface 104.

[00180] The IMM 112 can provide various interface mechanisms for use in conjunction with the procedure 2200 of Fig. 22. For example, the IMM 122 can display a container-type digital object (not shown) on the interactive surface 104. The container-type digital object acts as an interface to a collection of digital objects (associated with individual items that have appeared on the interactive surface 104 and/or representations of the entire interface surface 104). The user can organize the digital objects in the container-type digital object using one or more views. A first view allows the user to arrange the digital objects in a grid format or other spatial organization format. A second view allows the user to arrange the digital objects in a flip-book format, e.g., as a temporal sequence of objects. In one case, the user can also manipulate any digital object via the container-type digital object, such as by scaling the digital object, rotating the digital object, and so on.

[00181] The IMM 112 can also include mechanisms that allow a user to “clean up” the interactive surface 104, e.g., by removing digital objects from the interactive surface. In one case, the IMM 112 can provide a command which allows the user to delete (e.g., remove) all digital objects from the interface surface 104. In addition, or alternatively, the IMM 112 can provide a command that allows a user to delete identified digital objects.

C. Representative Processing Functionality

[00182] Fig. 23 sets forth illustrative electrical data processing functionality 2300 (simply “processing functionality” below) that can be used to implement any aspect of the functions described above. With reference to Fig. 1, for instance, the type of processing functionality 2300 shown in Fig. 23 can be used to implement any aspect of the interactive surface

environment 100. In one case, the processing functionality 2300 may correspond to any type of computing device.

[00183] The processing functionality 2300 can include volatile and non-volatile memory, such as RAM 2302 and ROM 2304, as well as one or more processing devices 2306. The processing functionality 2300 also optionally includes various media devices 2308, such as a hard disk module, an optical disk module, and so forth. The processing functionality 2300 can perform various operations identified above when the processing device(s) 2306 execute instructions that are maintained by memory (e.g., RAM 2302, ROM 2304, or elsewhere). More generally, instructions and other information can be stored on any computer-readable medium 2310, including, but not limited to, static memory storage devices, magnetic storage devices, optical storage devices, and so on. The term “computer-readable medium” also encompasses plural storage devices. The term “computer-readable medium” also encompasses signals transmitted from a first location to a second location, e.g., via wire, cable, wireless transmission, etc.

[00184] The processing functionality 2300 also includes an input/output module 2312 for receiving various inputs from a user (via input modules 2314), and for providing various outputs to the user (via output modules 2316). Figs. 1 and 2 describe various types of such input modules 2312 and output modules 2314 (e.g., corresponding to the input functionality 108 and content-projection functionality 106, respectively). The processing functionality 2300 can also include one or more network interfaces 2318 for exchanging data with other devices via one or more communication conduits 2320. One or more communication buses 2322 communicatively couple the above-described components together.

[00185] In closing, the description may have described various concepts in the context of illustrative challenges or problems. This manner of explication does not constitute an

admission that others have appreciated and/or articulated the challenges or problems in the manner specified herein.

[00186] More generally, although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the
5 subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

CLAIMS

What is claimed is:

1 A method (1100) for engaging an interactive surface, comprising:

detecting (1106) placement of an input device at a selected location and orientation on

5 the interactive surface, the input device configured to provide alphanumeric text entry; and

displaying (1108) a digital object on the interactive surface in positional association
with the input device,

the digital object providing a display interface that presents a visual representation of
information entered by a user using the input device.

10

2. The method of claim 1, further comprising displaying a visual attribute which
associates the input device with the digital object.

3. The method of claim 1, wherein the digital object comprises a first digital object,

15 and wherein the interactive surface also displays a second digital object, the method further
comprising:

detecting placement of any input device in proximity to the second digital object, or
placement of the second digital object in proximity to said any input device; and

automatically associating said any input device with the second digital object.

20

4. The method of claim 1, wherein the input device comprises a first input device,
the method further comprising:

detecting placement of a second input device on the interactive surface in proximity to
the first input device; and

in response to the detecting, automatically associating the second input device with the digital object, such that both the first input device and the second input device are associated with the digital object.

5 5. The method of claim 1, wherein the input device comprises a first input device and the digital object comprises a first digital object, the method further comprising:

detecting placement of a second input device on the interactive surface, the interactive surface displaying a second digital object in positional association with the second input device;

10 detecting movement of the second input device in proximity to the first input device or the movement of the first input device in proximity to the second input device; and

in response to detecting the movement, merging content provided by the first digital object with content provided by the second digital object.

15 6. The method of claim 1, wherein the displaying of the digital object comprises:

placing the digital object on the interactive surface at a location which: a) satisfies at least one placement constraint to an extent deemed appropriate; and b) reduces interference between the digital object and other existing objects on the interactive surface.

20 7. A computer-readable medium (2310) for storing computer-readable instructions, the computer-readable instructions providing an interaction management module when executed by one or more processing devices, the computer-readable instructions comprising:

logic (502) configured to detect a user's placement of a mouse-type device on an interactive surface;

25 logic (502) configured to determine an absolute position of the mouse-type device and an orientation of the mouse-type device;

logic (504) configured to define a frame of reference based on the absolute position and the orientation of the mouse-type device; and

logic (506) configured to display a cursor on the interactive surface relative to the frame of reference that has been defined.

5

8. The computer-readable medium of claim 7, wherein said logic configured to define the frame of reference is operative to define the frame of reference relative to:

a reference object on the interactive surface; or

an orientation of the mouse-type device.

10

9. The computer-readable medium of claim 7, further comprising logic configured to display a visual attribute which associates the mouse-type device and the cursor.

10. The computer-readable medium of claim 7, further comprising:

15 logic configured to detect that the user has activated a control provided by the mouse-type device; and logic configured to operate the mouse-type device in a touch mode, wherein, in the touch mode, the cursor serves as a simulated contact point that engages the interactive surface.

20 11. An interactive management module (112) for managing an interactive surface (104), comprising:

logic (1706) configured to detect placement of an article (1704) on the interactive surface (104);

25 logic (1708) configured to display an interface object (1710) on the interactive surface (104) for use in association with the article (1704);

logic (1712) configured to detect a copy-related activation by a user of the interface object (1710); and

logic (1714) configured to generate, in response to the activation, a digital copy (1702) of the article (1704) and display the digital copy (1702) of the article (1704) on the
5 interactive surface (104) at a location identified by the user.

12. The interactive management module of claim 11, wherein the copy-related activation by the user corresponds to a dragging motion executed by the user by pulling on the interface object.

10

13. The interactive management module of claim 11, further comprising:

logic configured to detect a selection by the user of a particular digital part of the digital copy; and

logic configured to highlight or mark a physical part of the article that is a counterpart
15 to the particular digital part of the digital copy.

14. The interactive management module of claim 11, further comprising:

logic configured to detect that the user has moved the digital copy to an editing region of the interactive surface;

20 logic configured to detect a physical mark applied by the user to the digital copy within the editing region; and

logic configured to generate another digital copy of the article, the other digital copy including a digital representation of the physical mark.

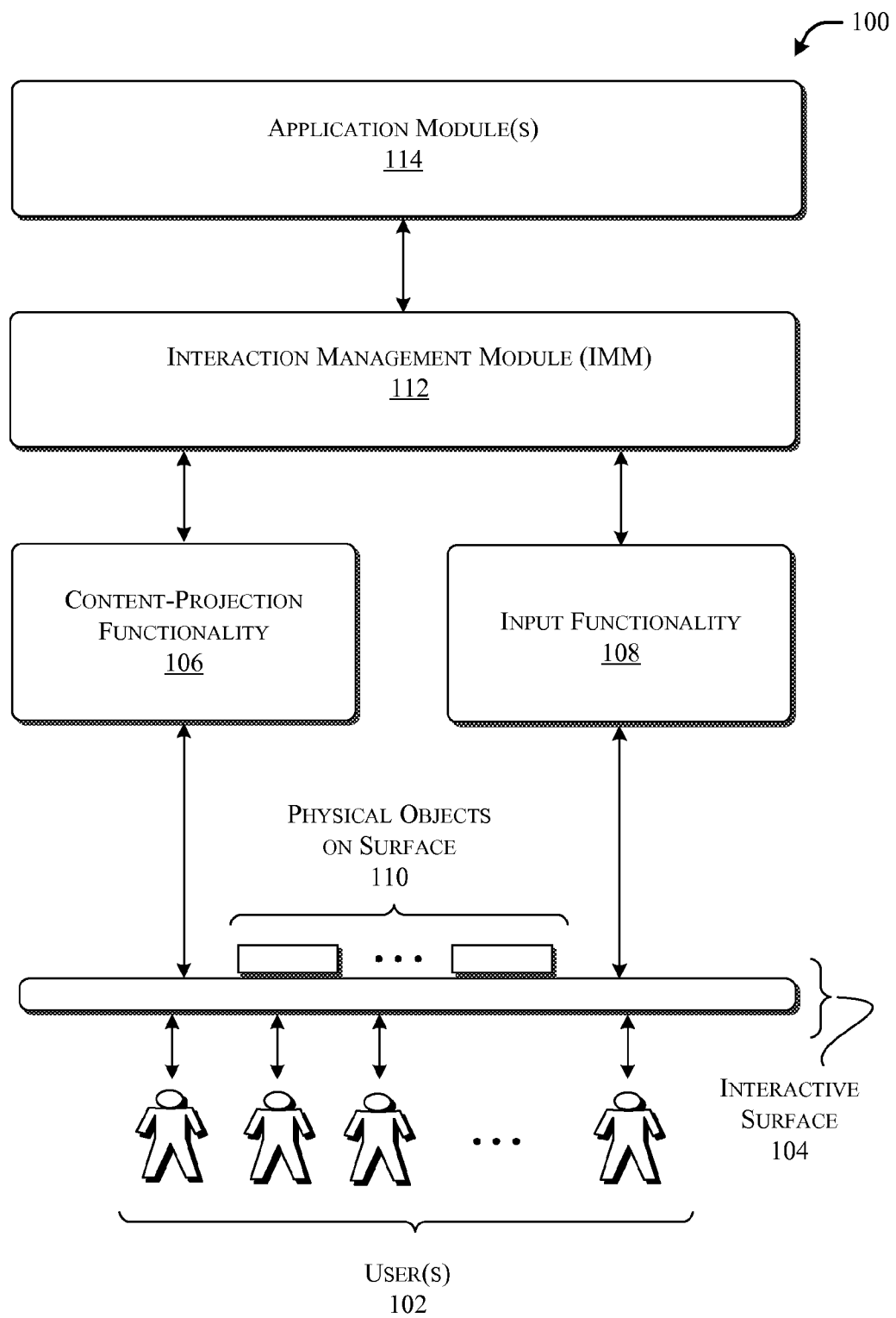
15. The interactive management module of claim 11, further comprising logic configured to record a plurality of representations of at least part of the interactive surface at different respective points in time, and logic configured to present information pertaining to the plurality of representations.

5

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**FIG. 1**

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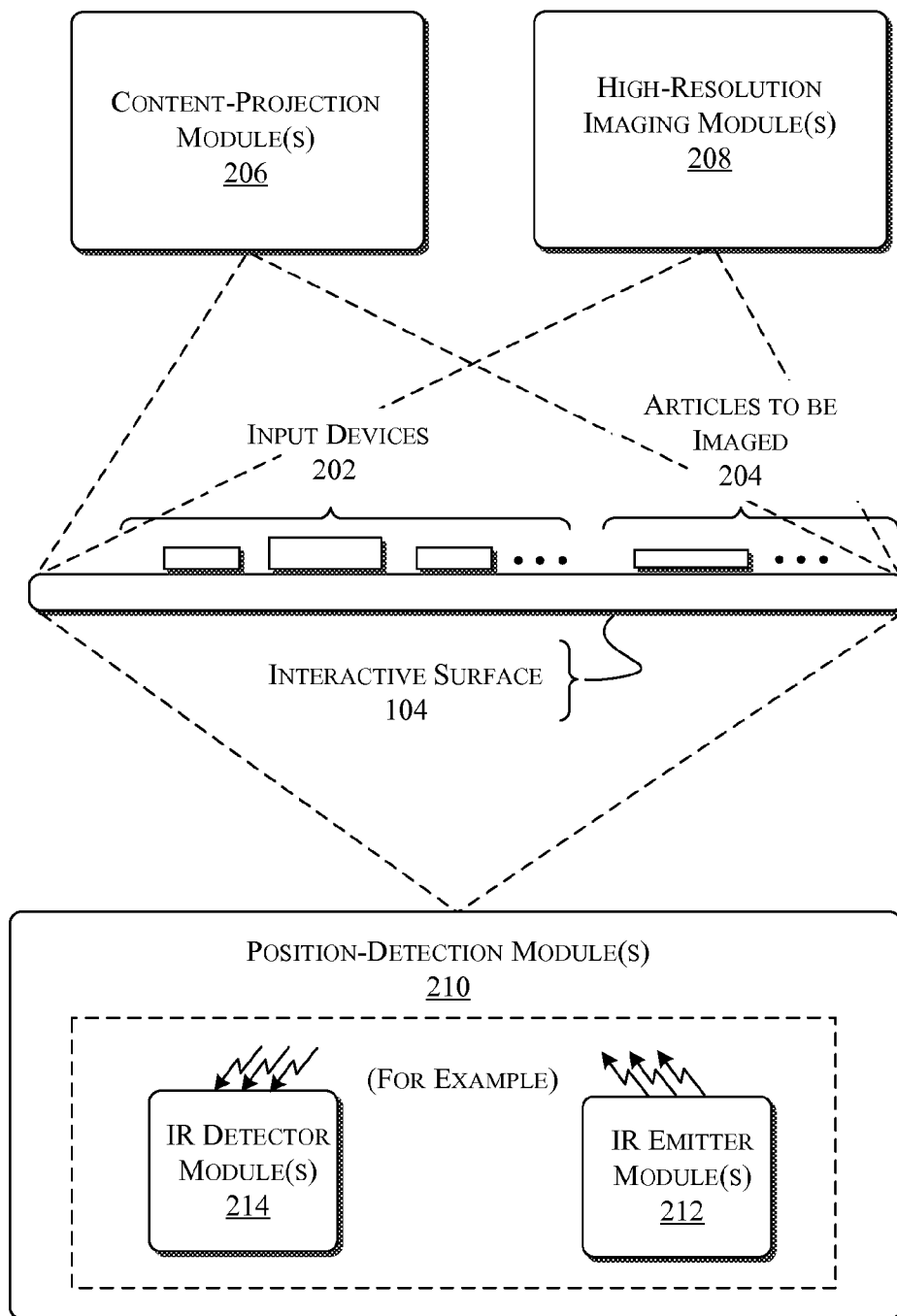


FIG. 2

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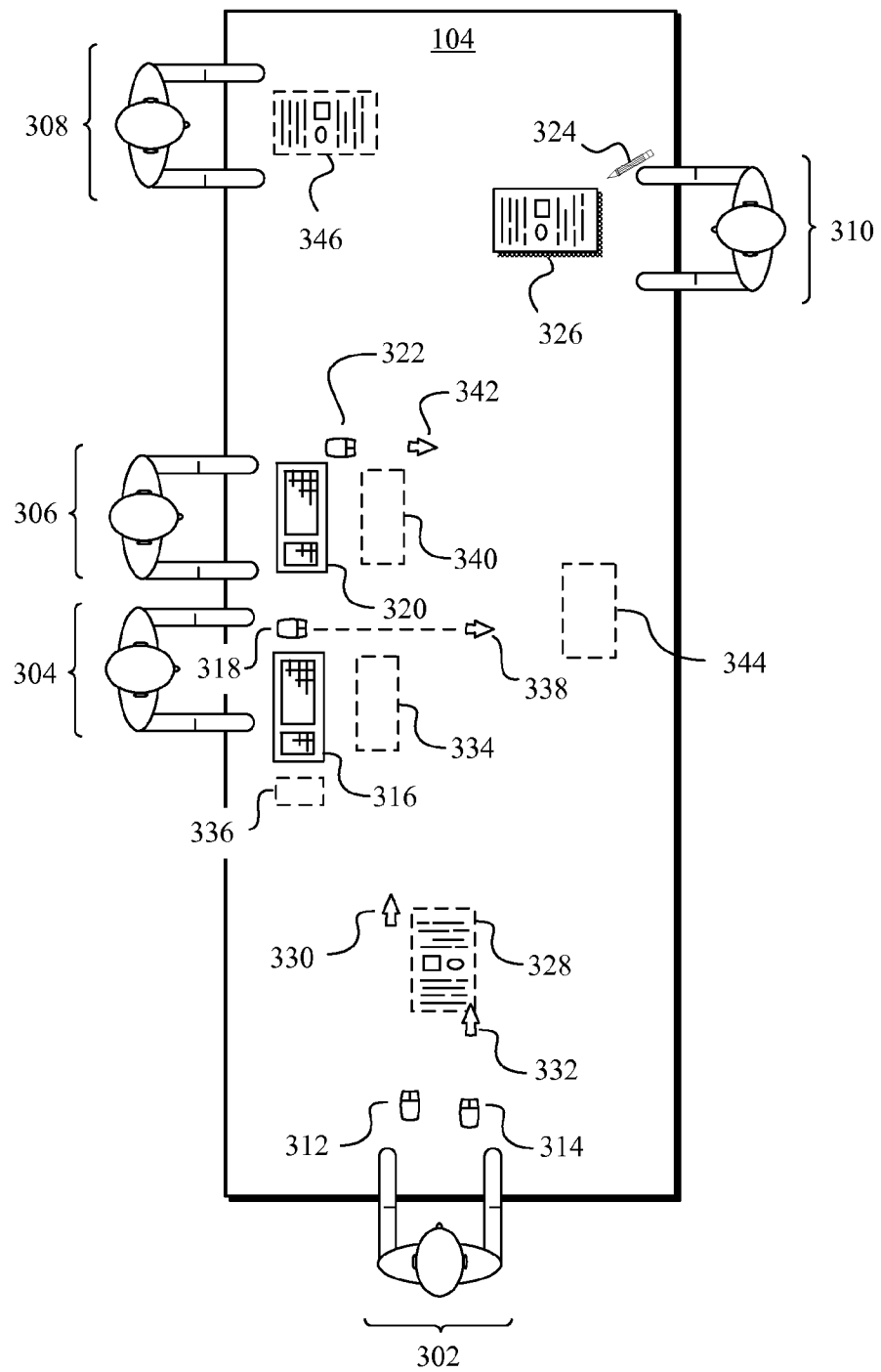
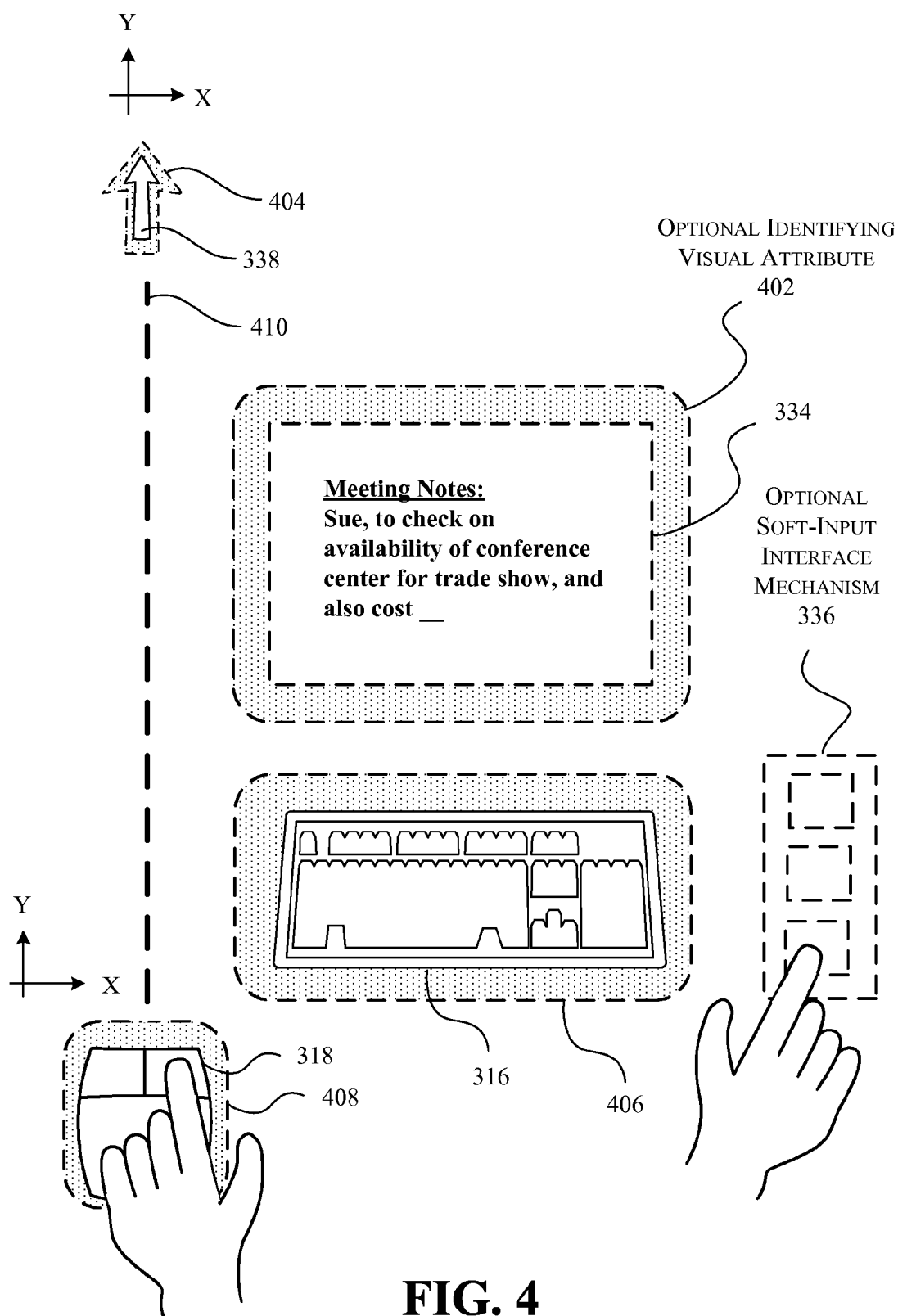
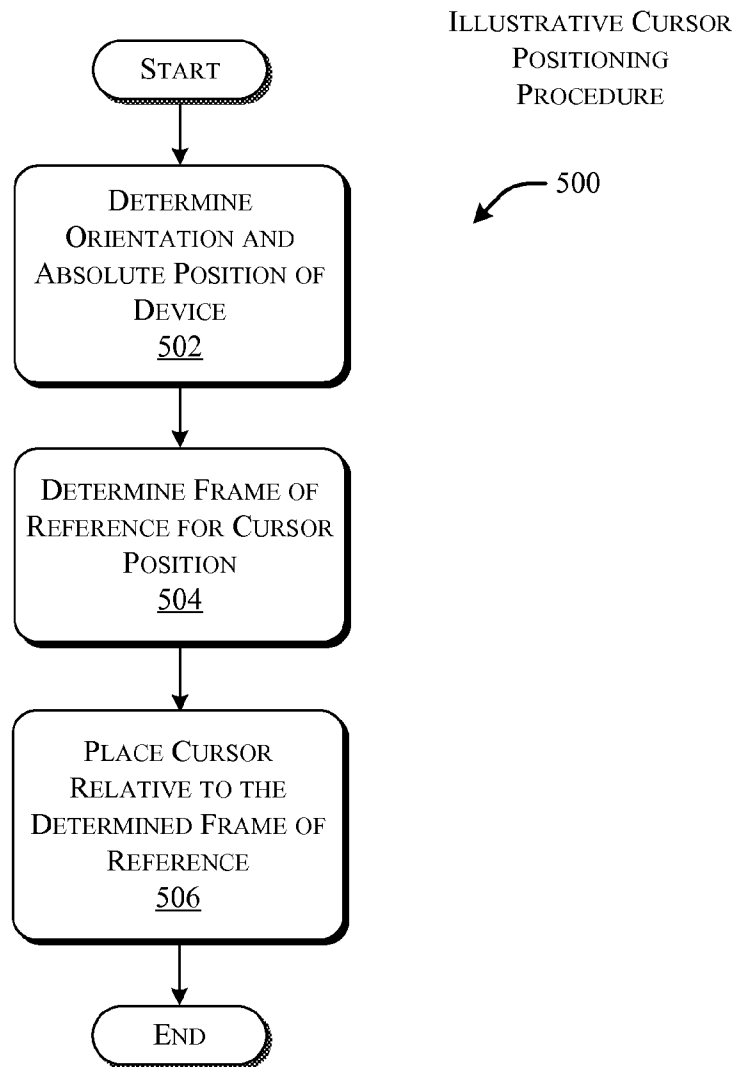


FIG. 3

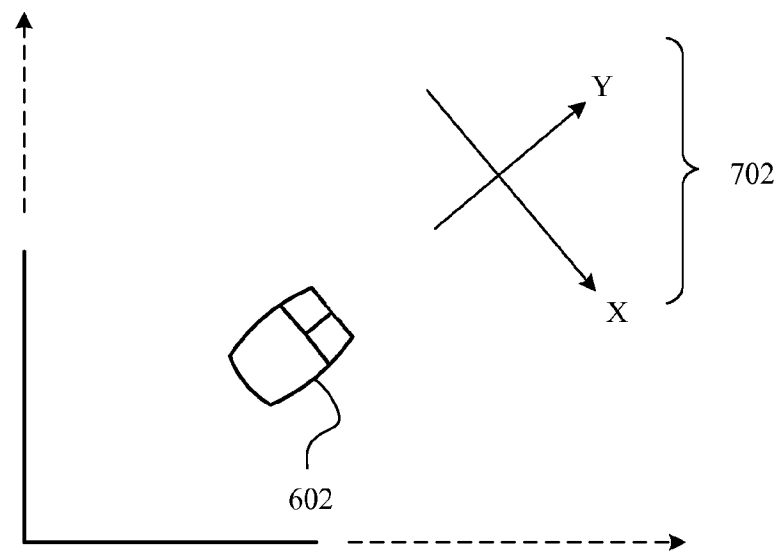
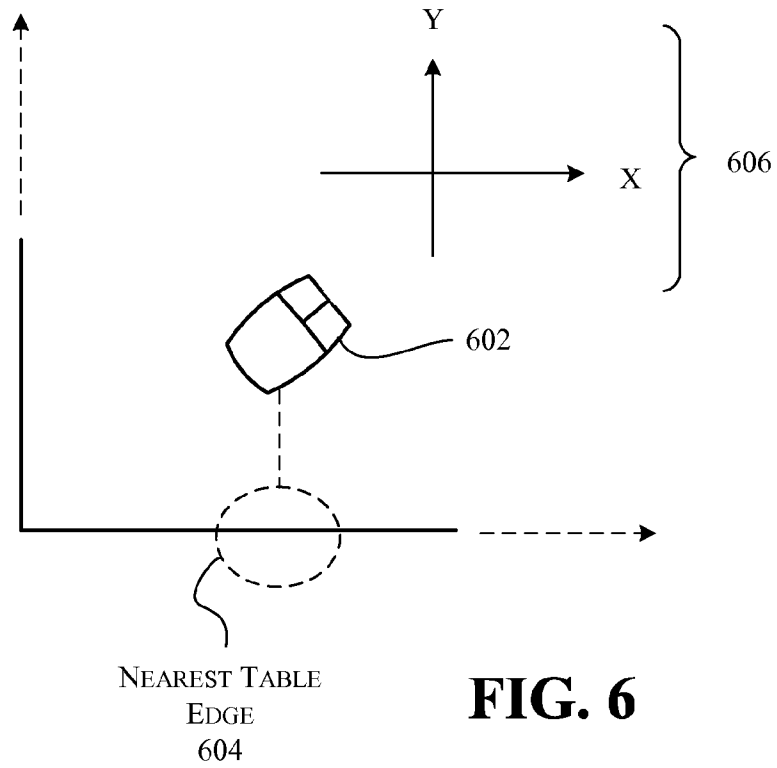
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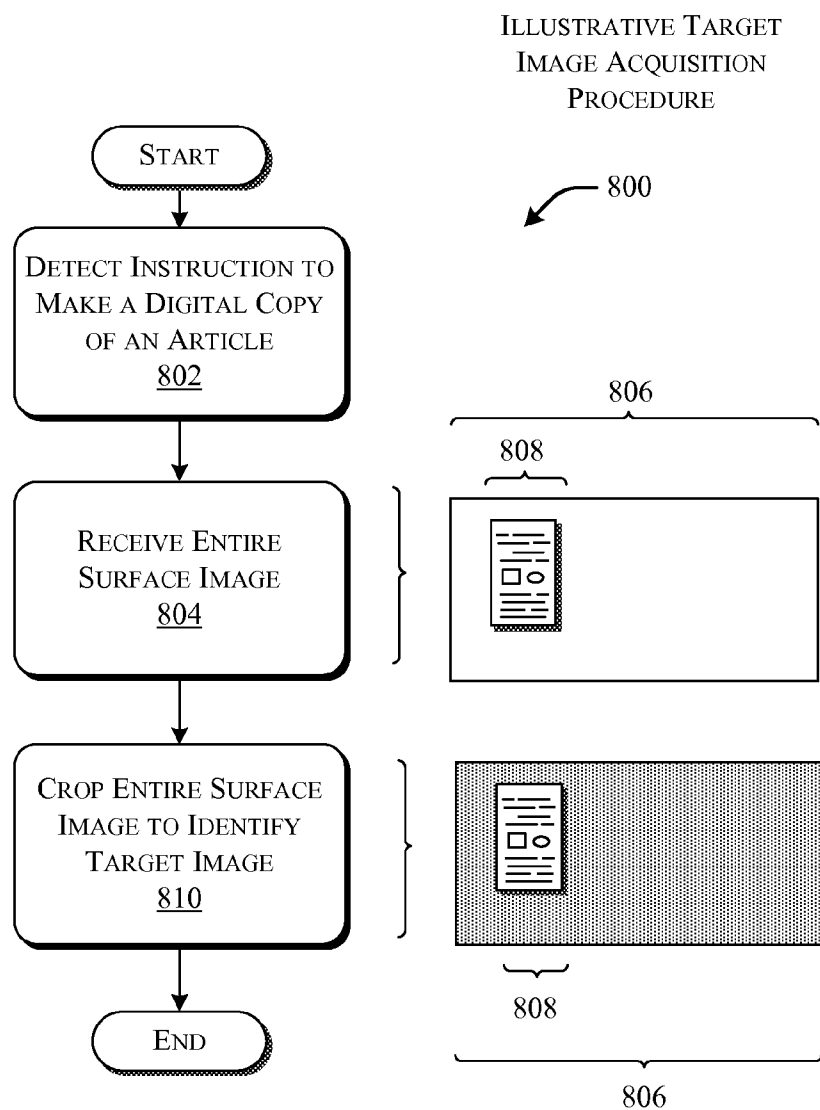
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**FIG. 5**

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**FIG. 8**

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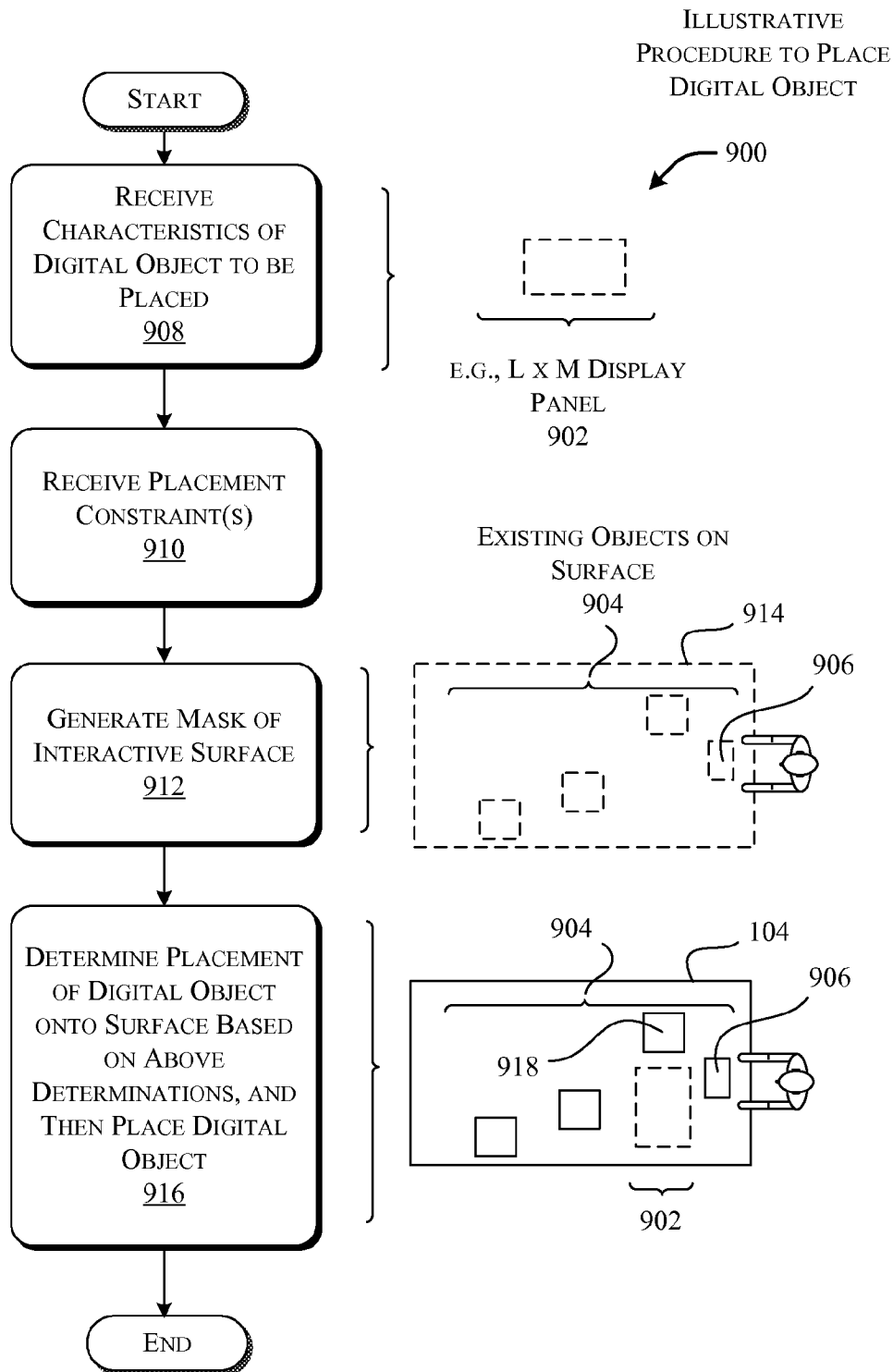
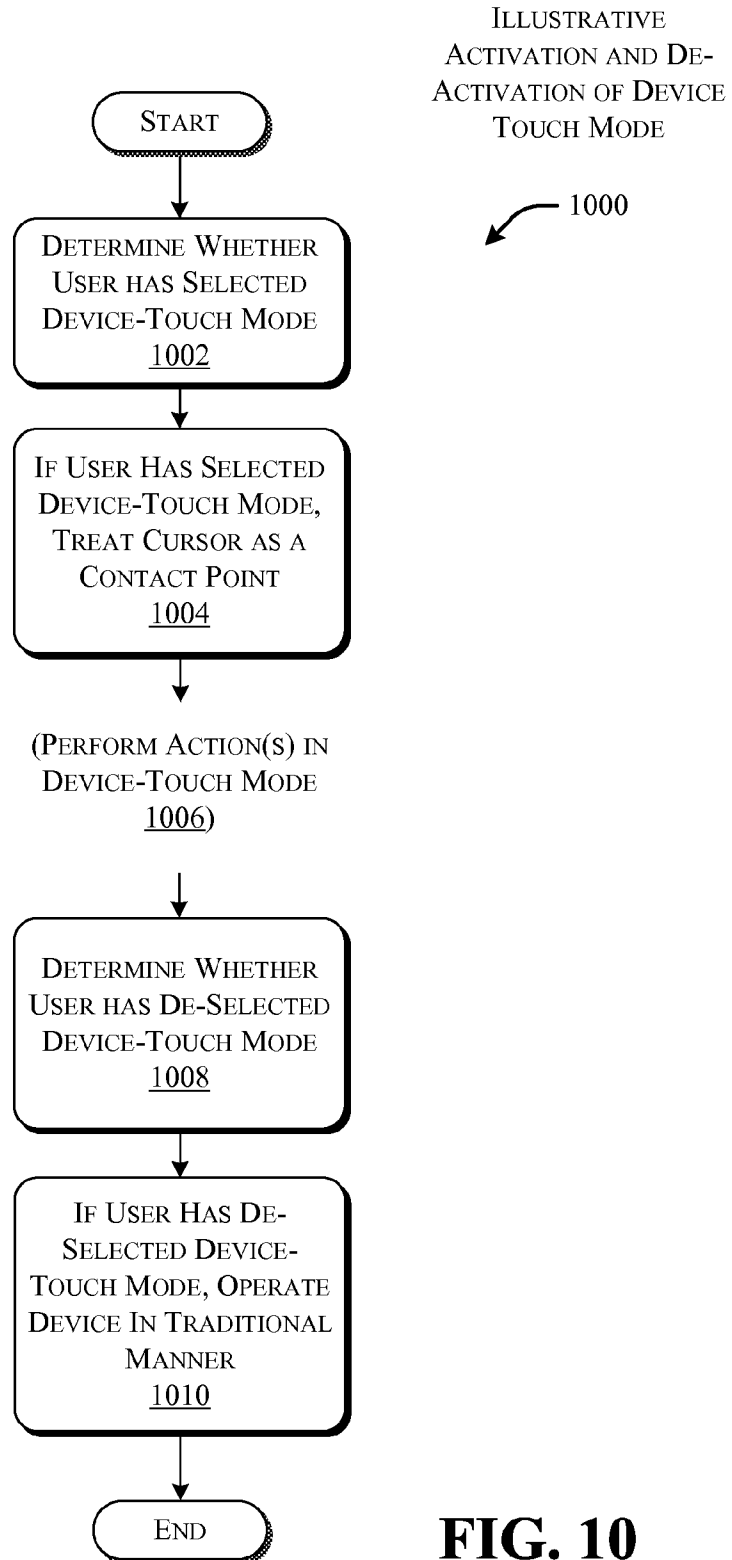


FIG. 9

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**FIG. 10**

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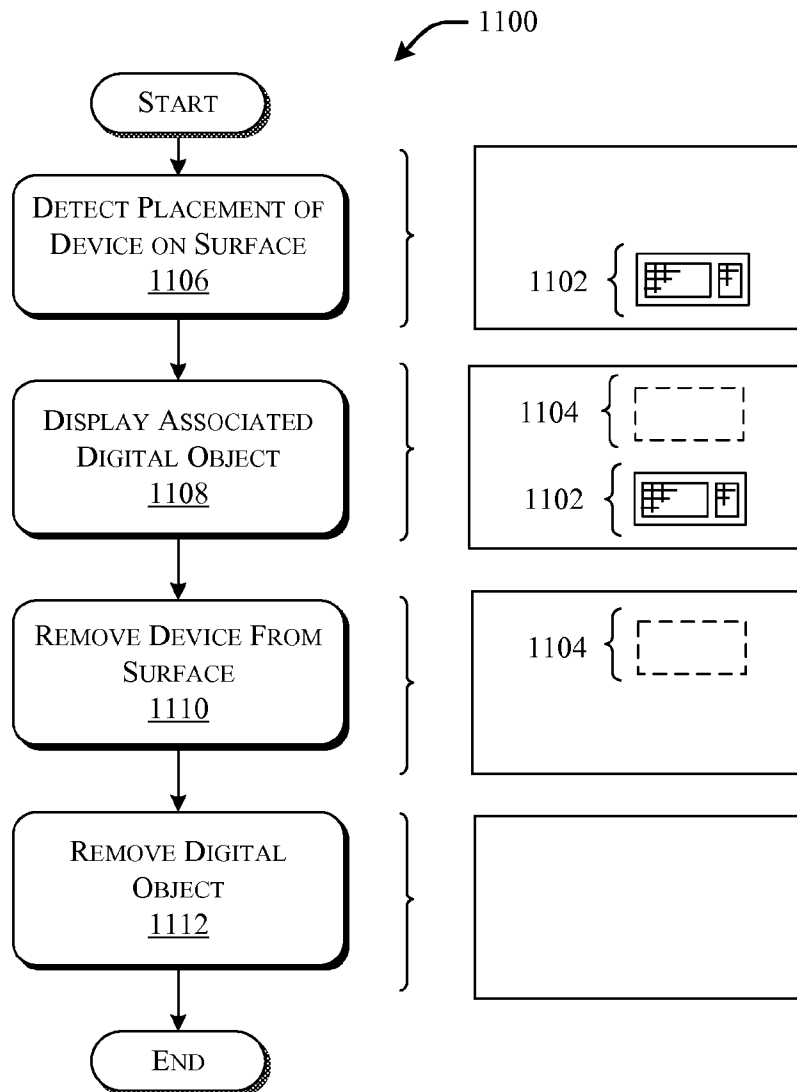
ILLUSTRATIVE DEVICE-OBJECT
AFFILIATION PROCEDURE 1

FIG. 11

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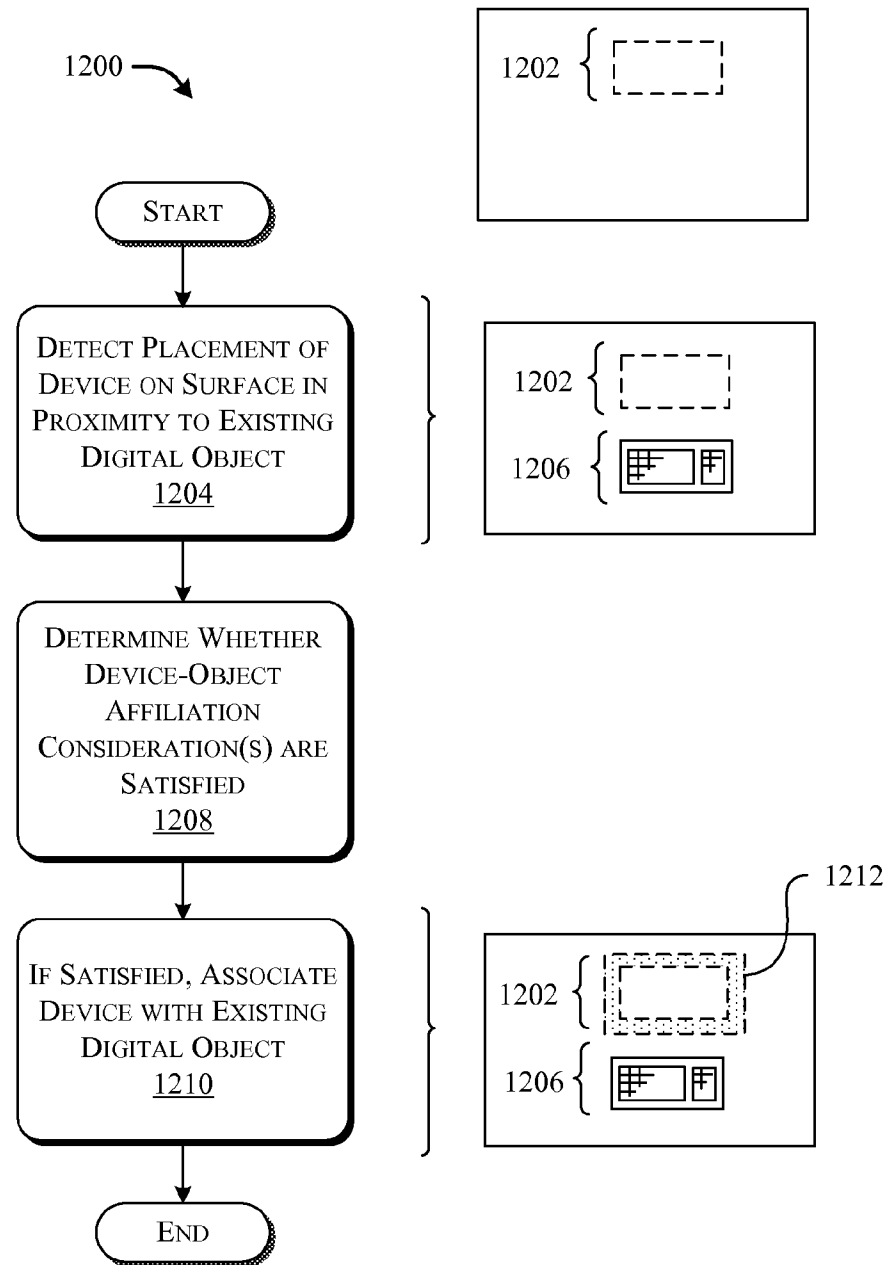
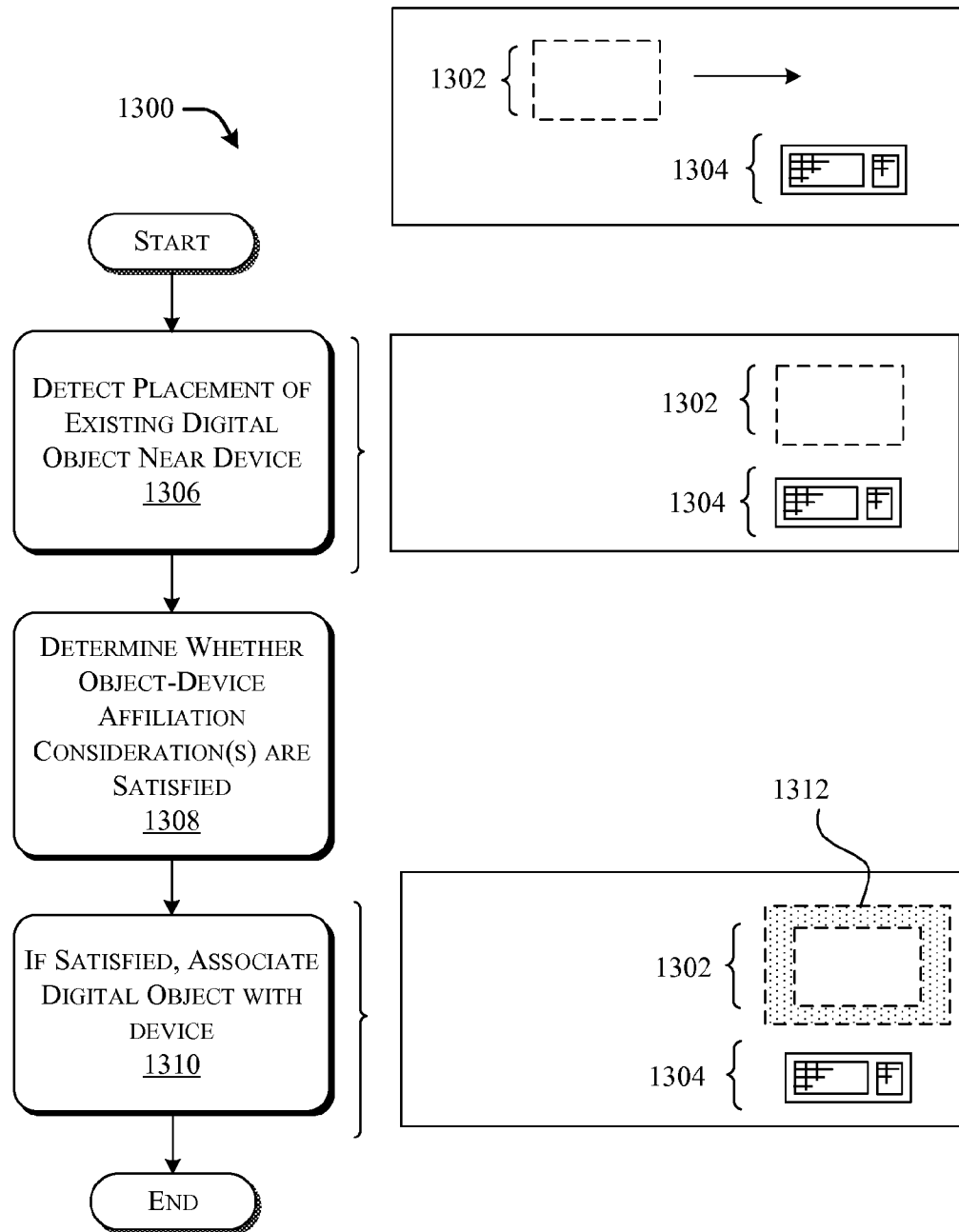
ILLUSTRATIVE DEVICE-OBJECT
AFFILIATION PROCEDURE 2

FIG. 12

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ILLUSTRATIVE DEVICE-OBJECT
AFFILIATION PROCEDURE 3**FIG. 13**

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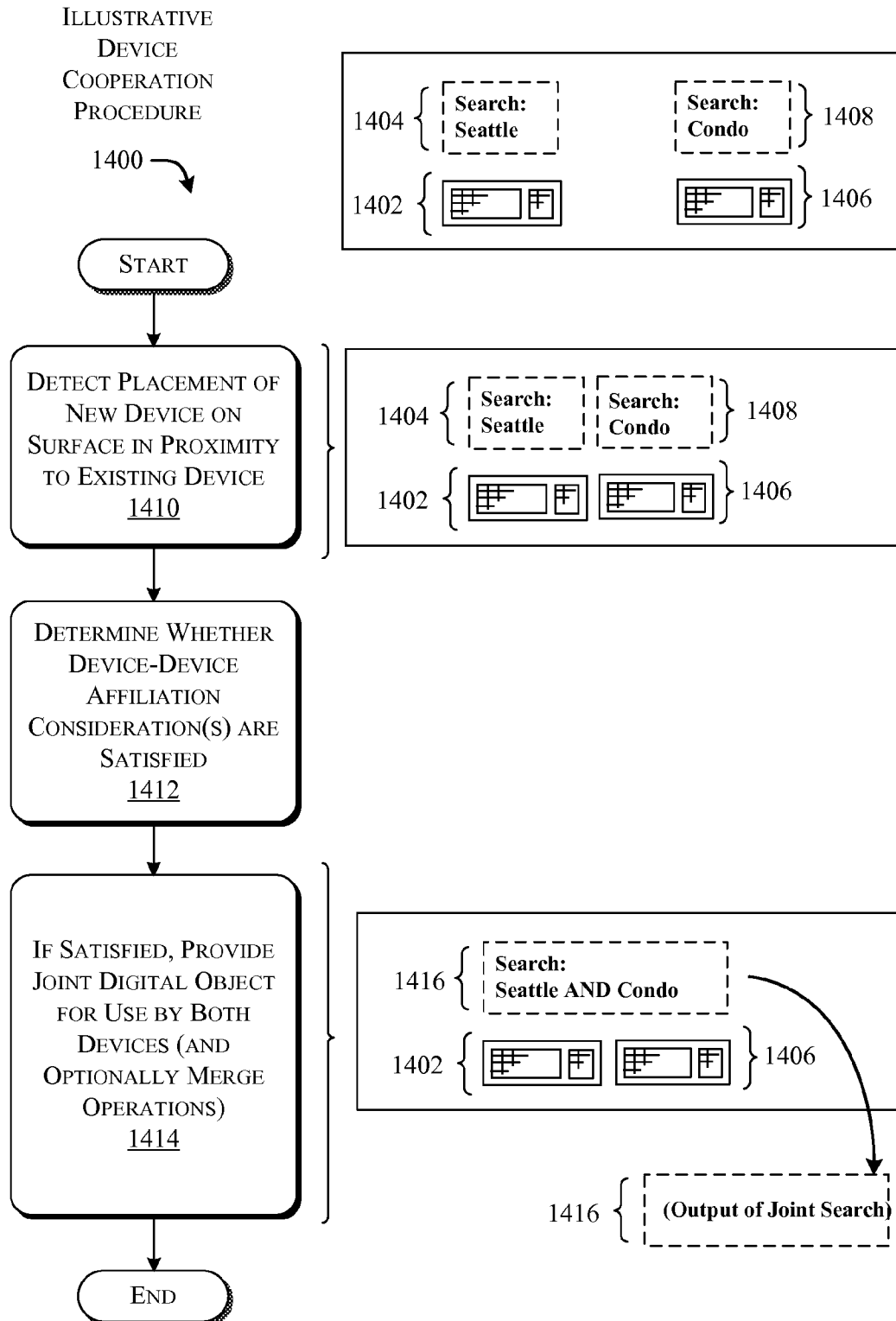


FIG. 14

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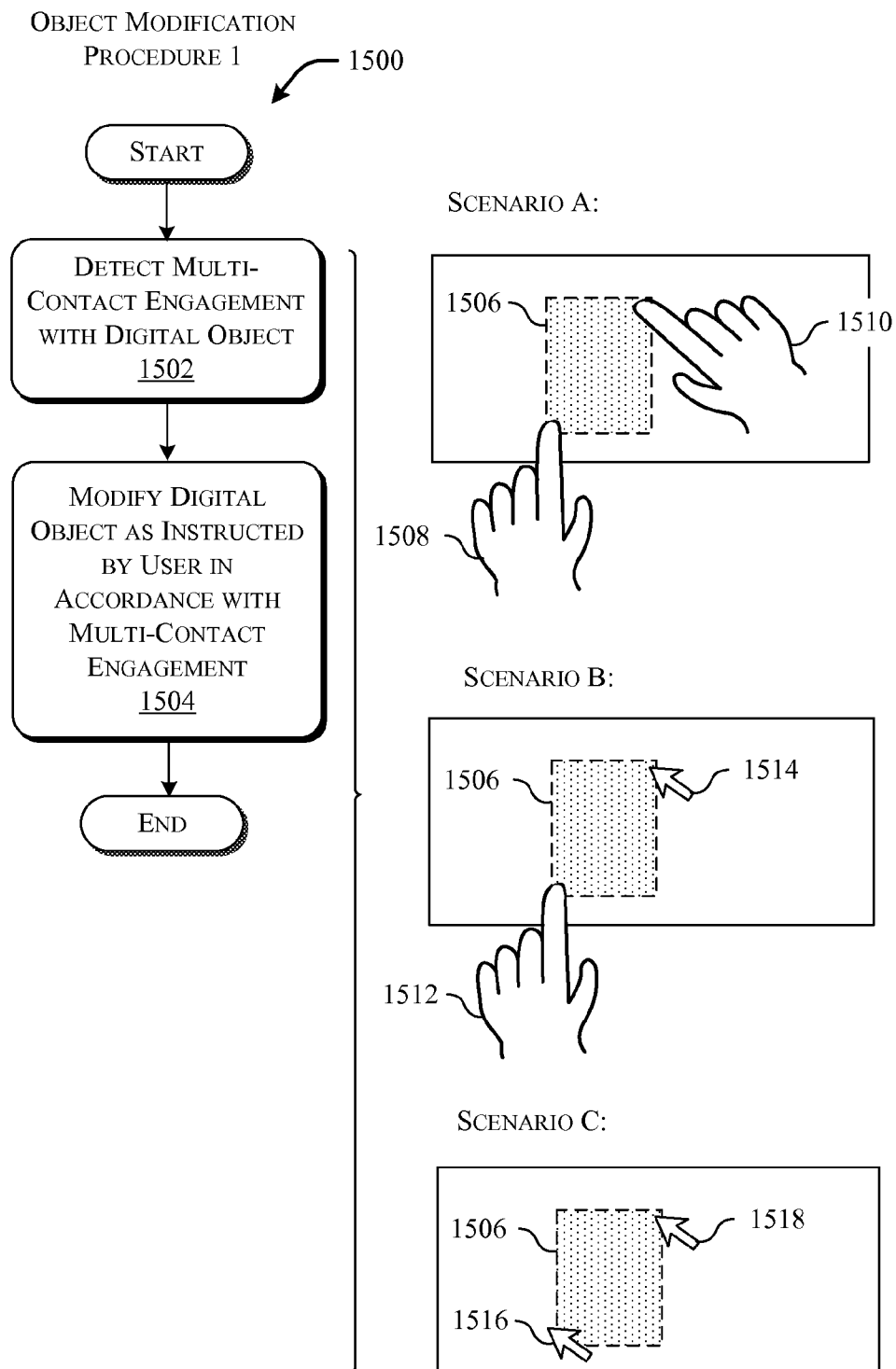
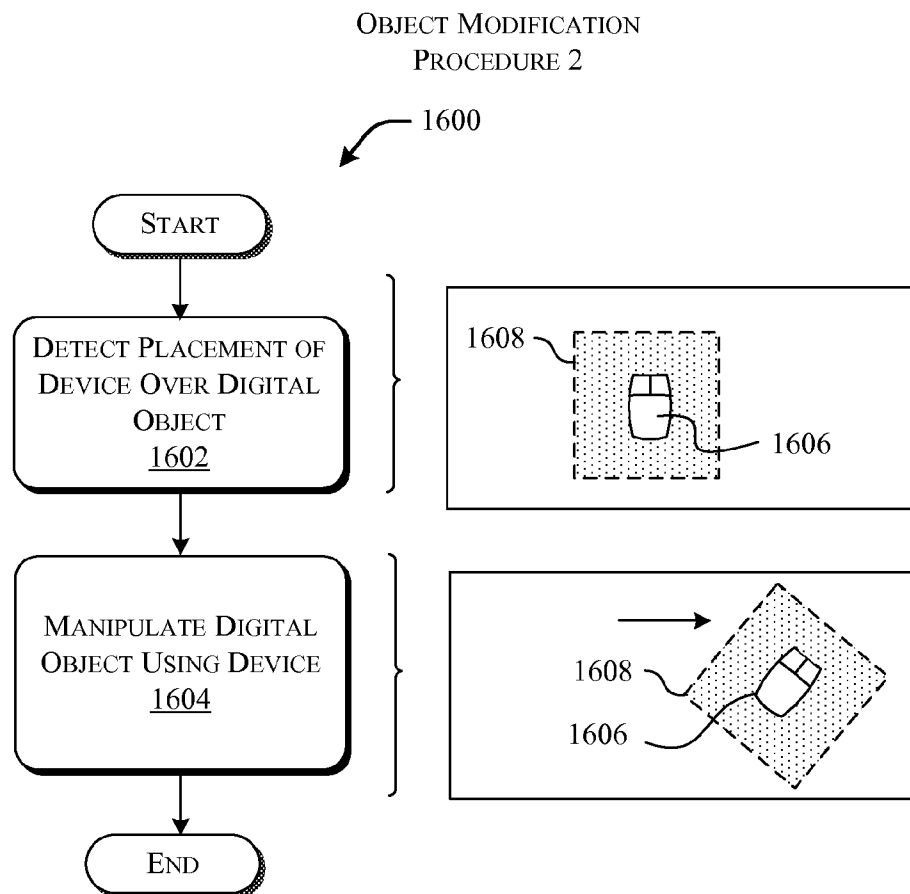


FIG. 15

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**FIG. 16**

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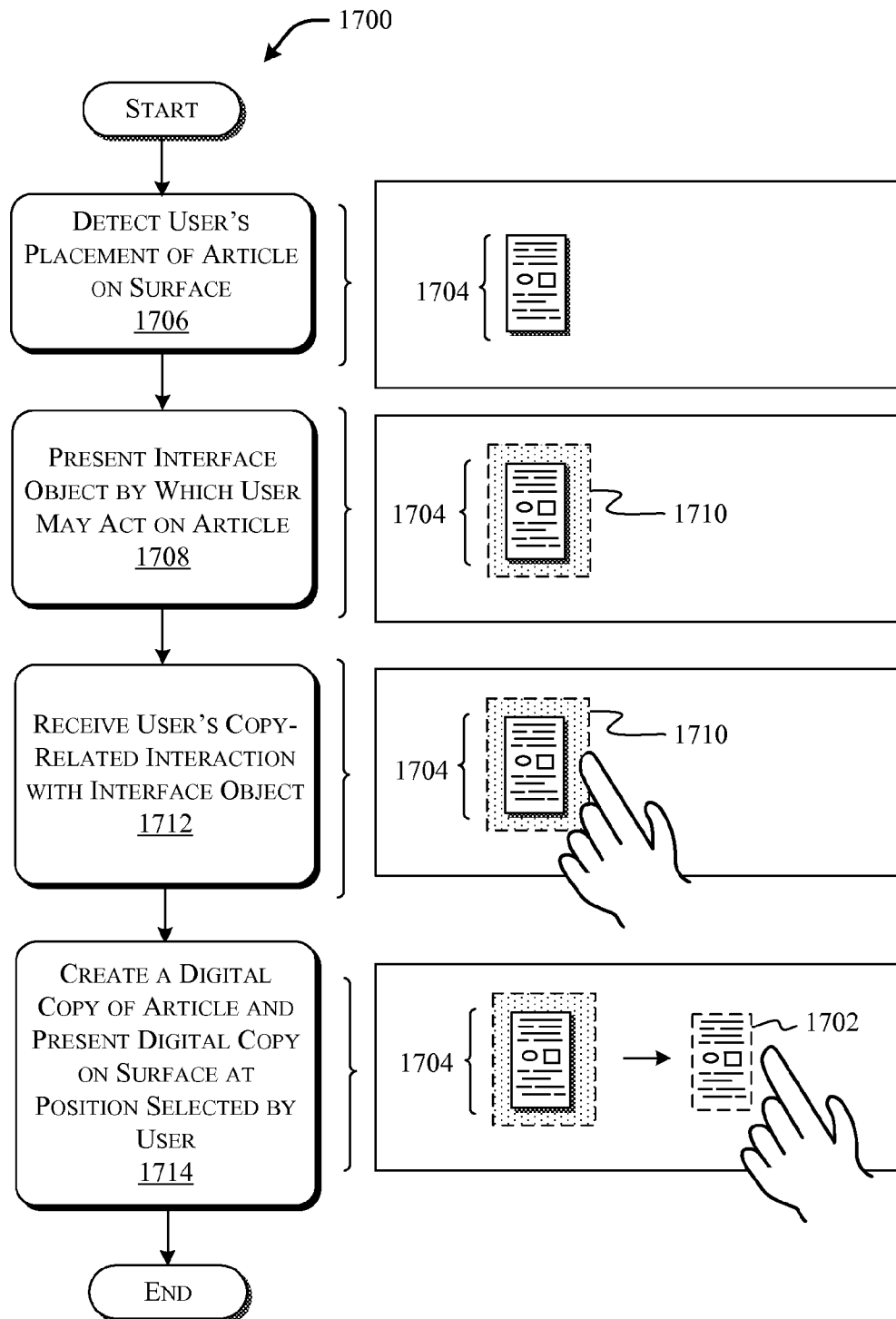
ILLUSTRATIVE ARTICLE COPYING
PROCEDURE

FIG. 17

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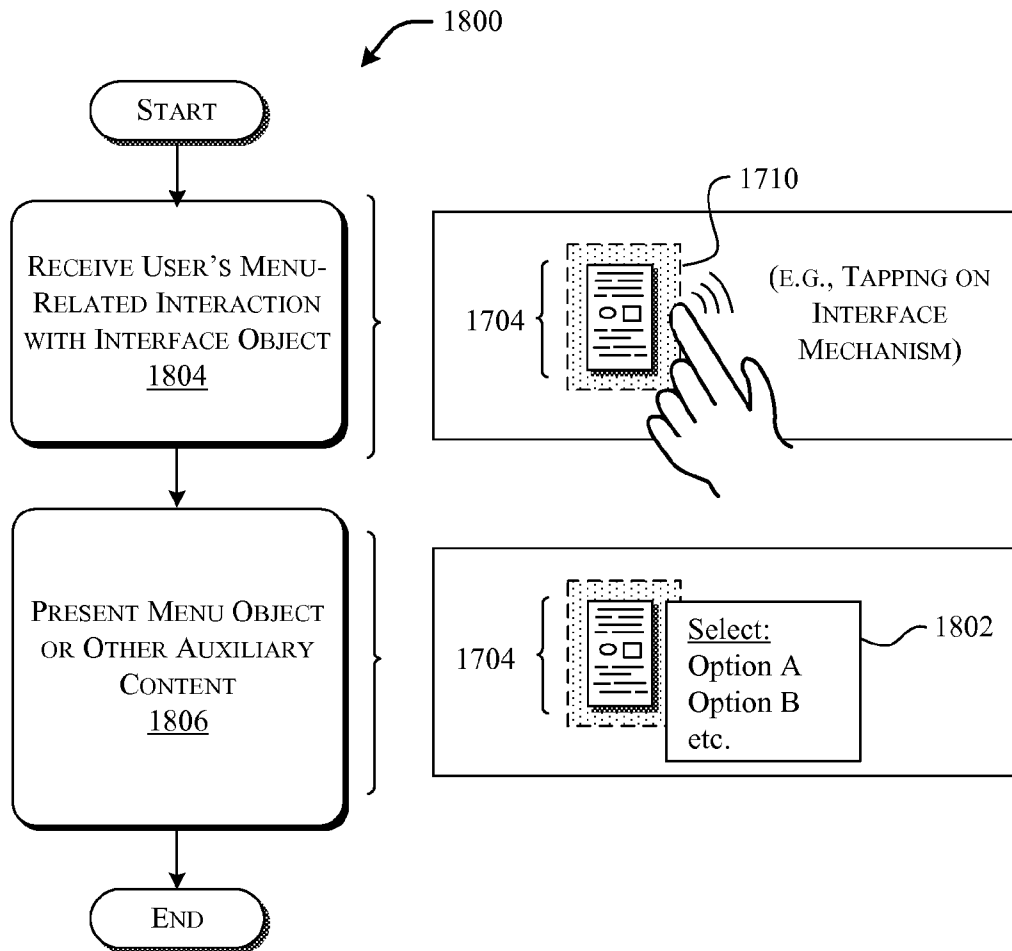
ILLUSTRATIVE MENU
PRESENTATION PROCEDURE

FIG. 18

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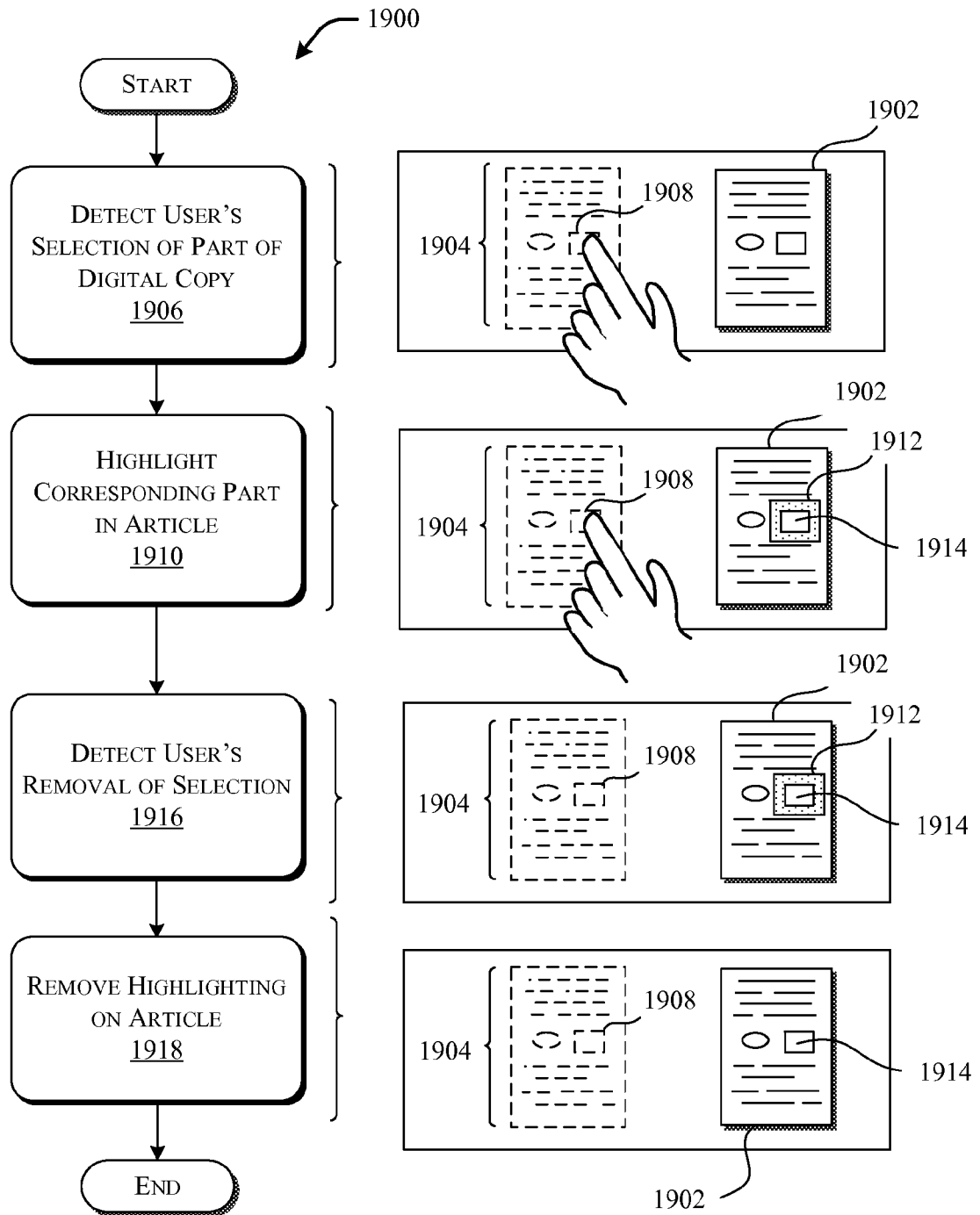
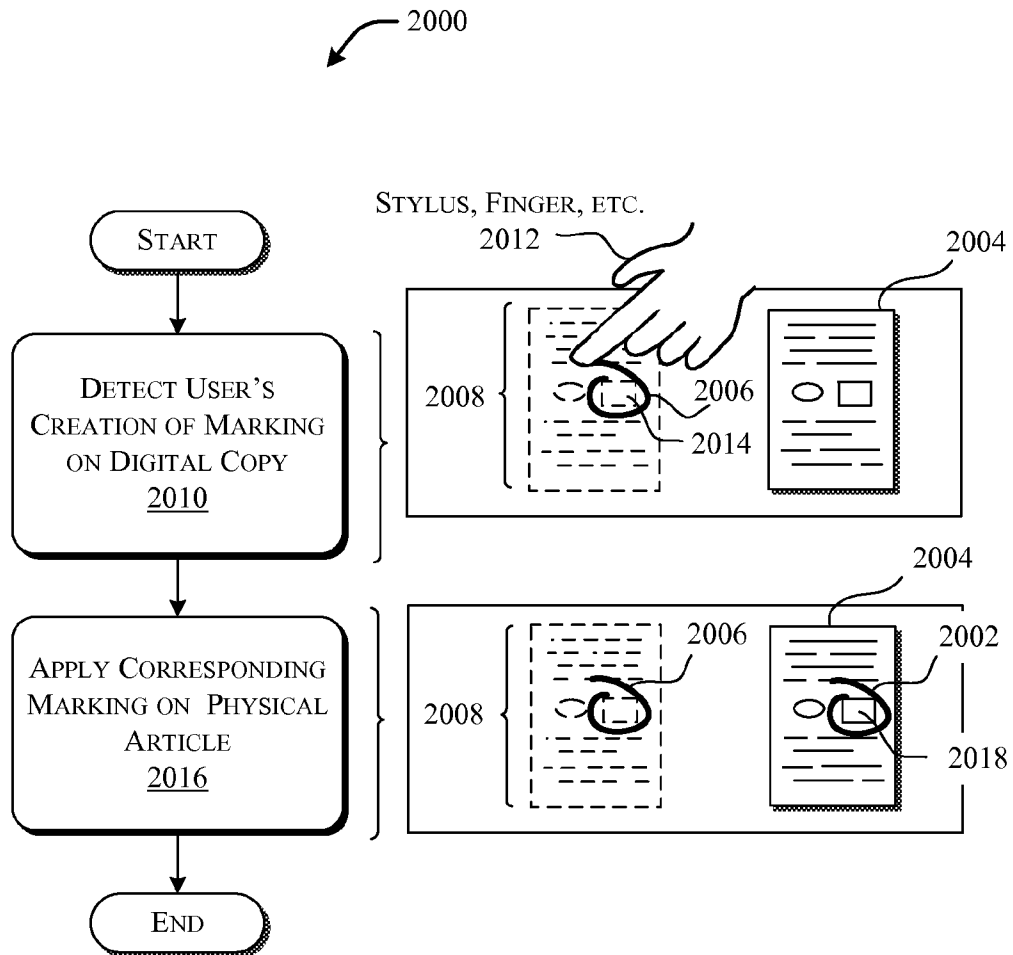
ILLUSTRATIVE REMOTE HIGHLIGHTING
PROCEDURE

FIG. 19

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ILLUSTRATIVE REMOTE MARKING
PROCEDURE**FIG. 20**

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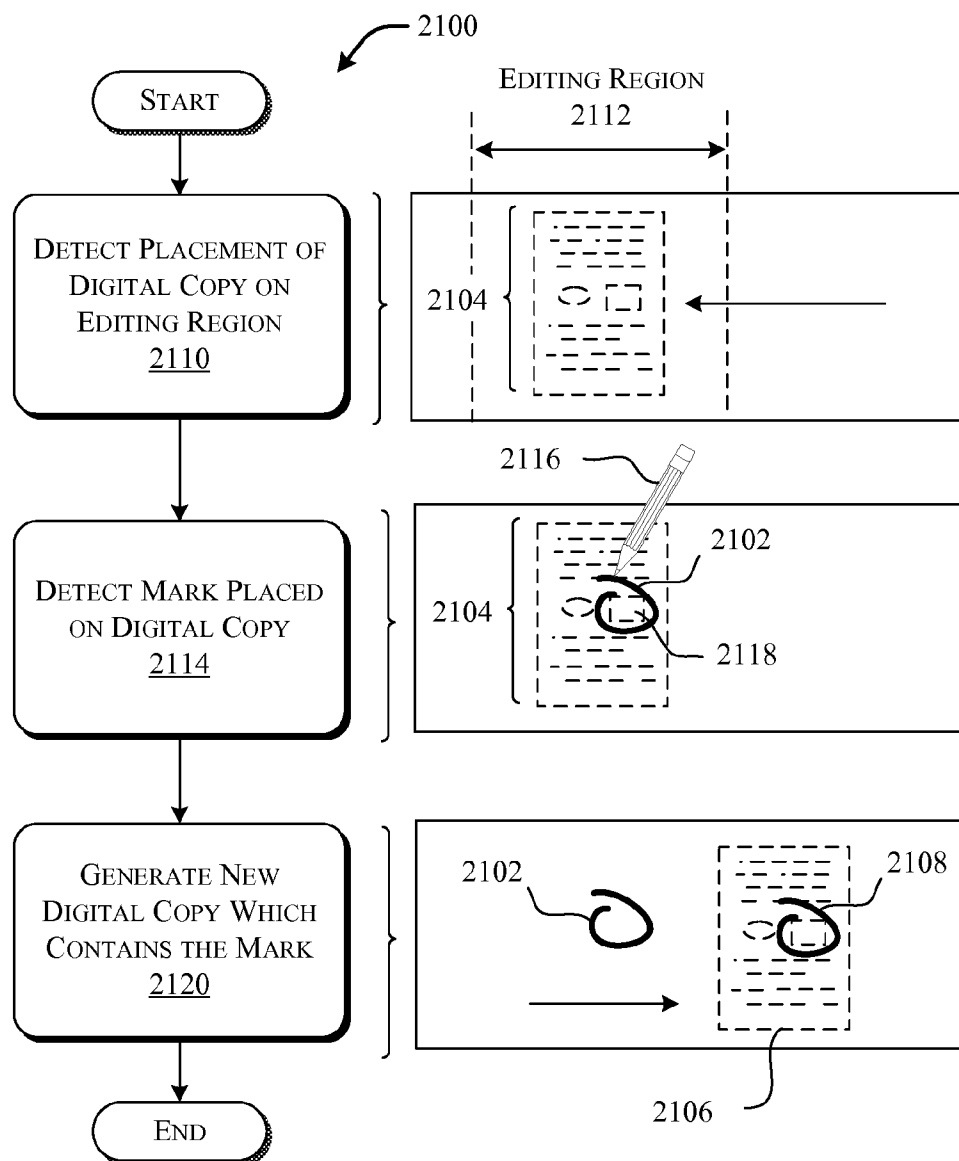
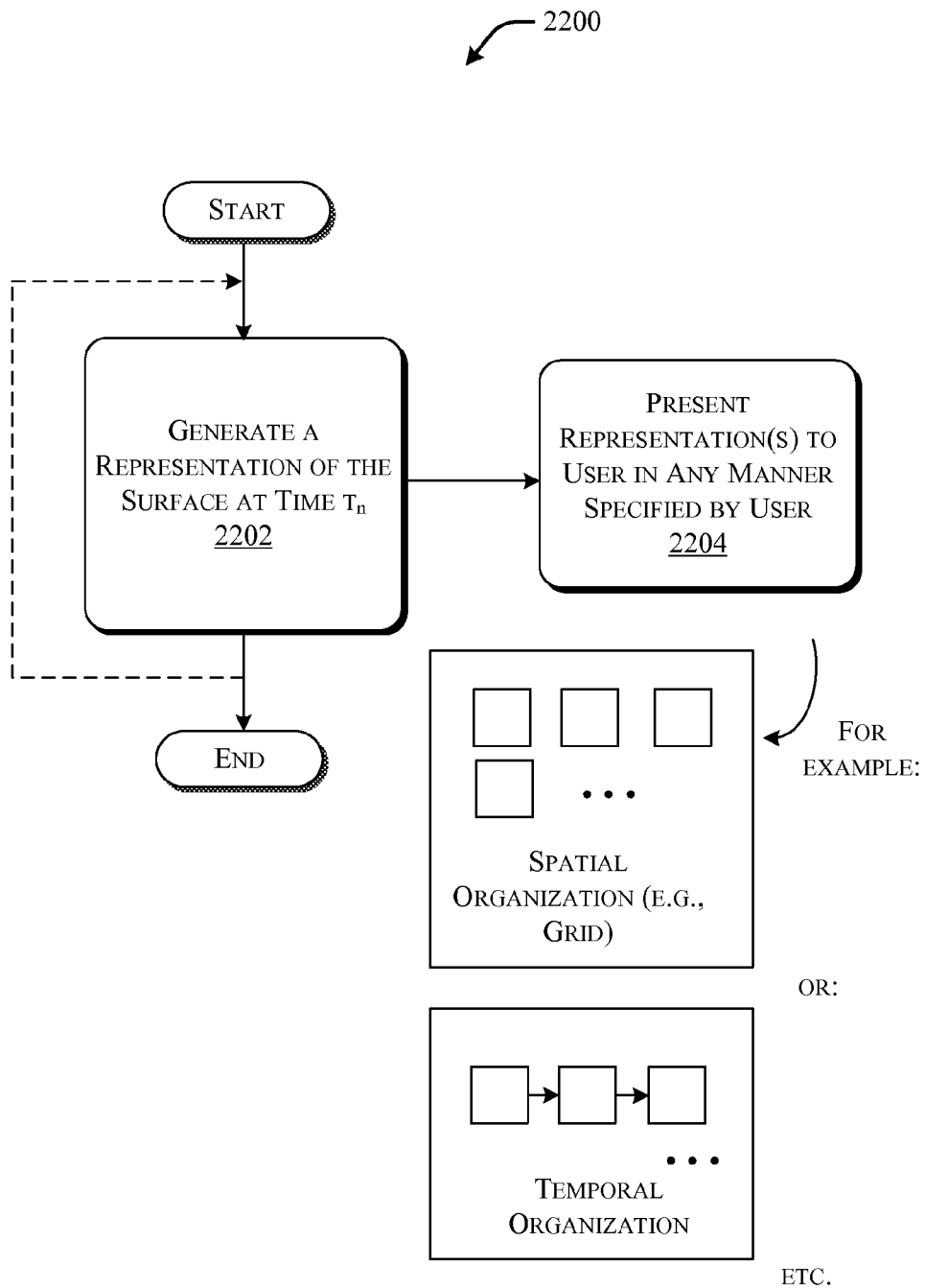
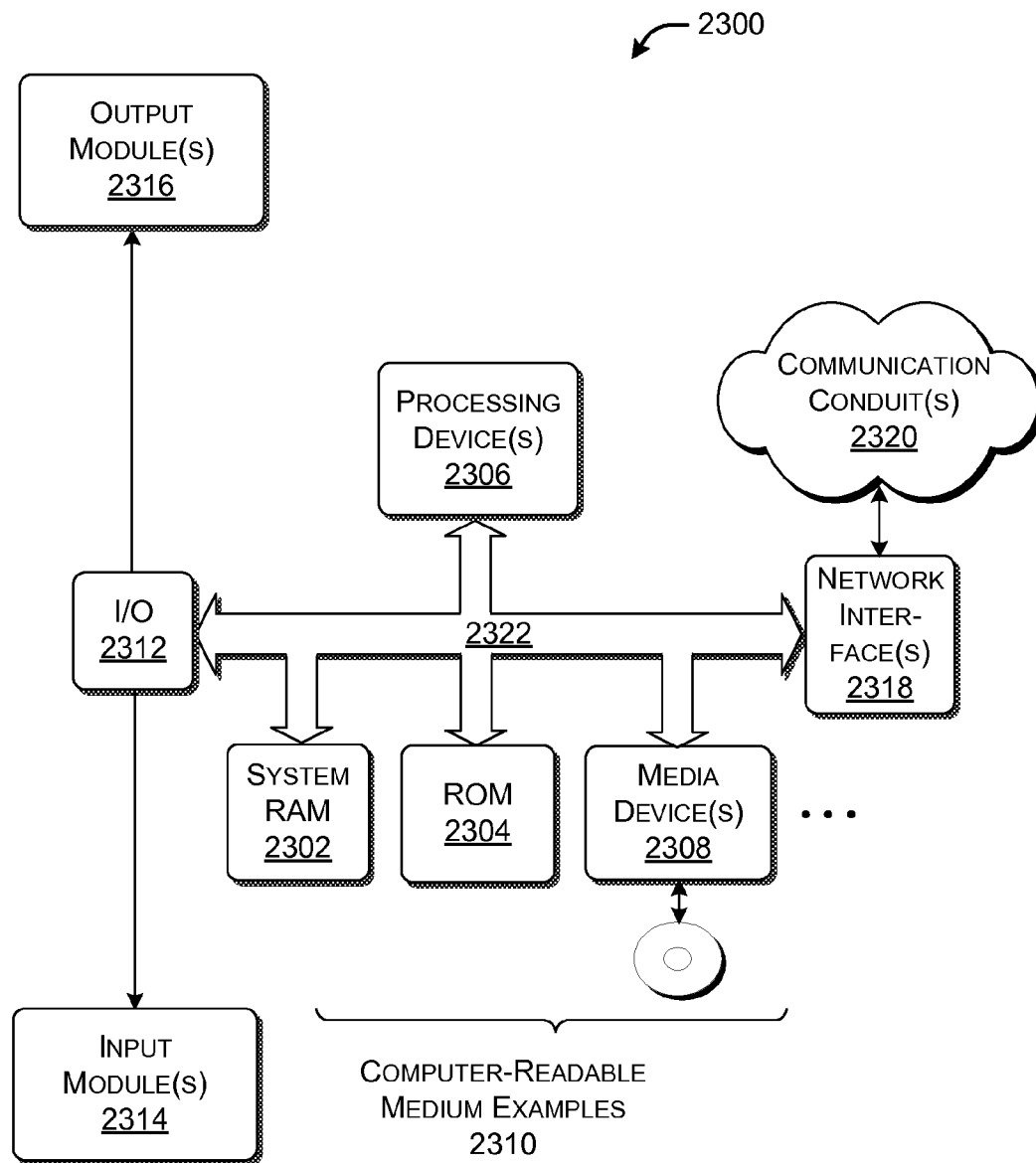
ILLUSTRATIVE REMOTE MARKING
PROCEDURE 2

FIG. 21

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ILLUSTRATIVE REPRESENTATION LOGGING
AND PRESENTATION PROCEDURE**FIG. 22**

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**FIG. 23**