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(54) **AUTOMATED IDENTIFICATION OF INPUT ELEMENTS IN A GRAPHICAL USER INTERFACE**

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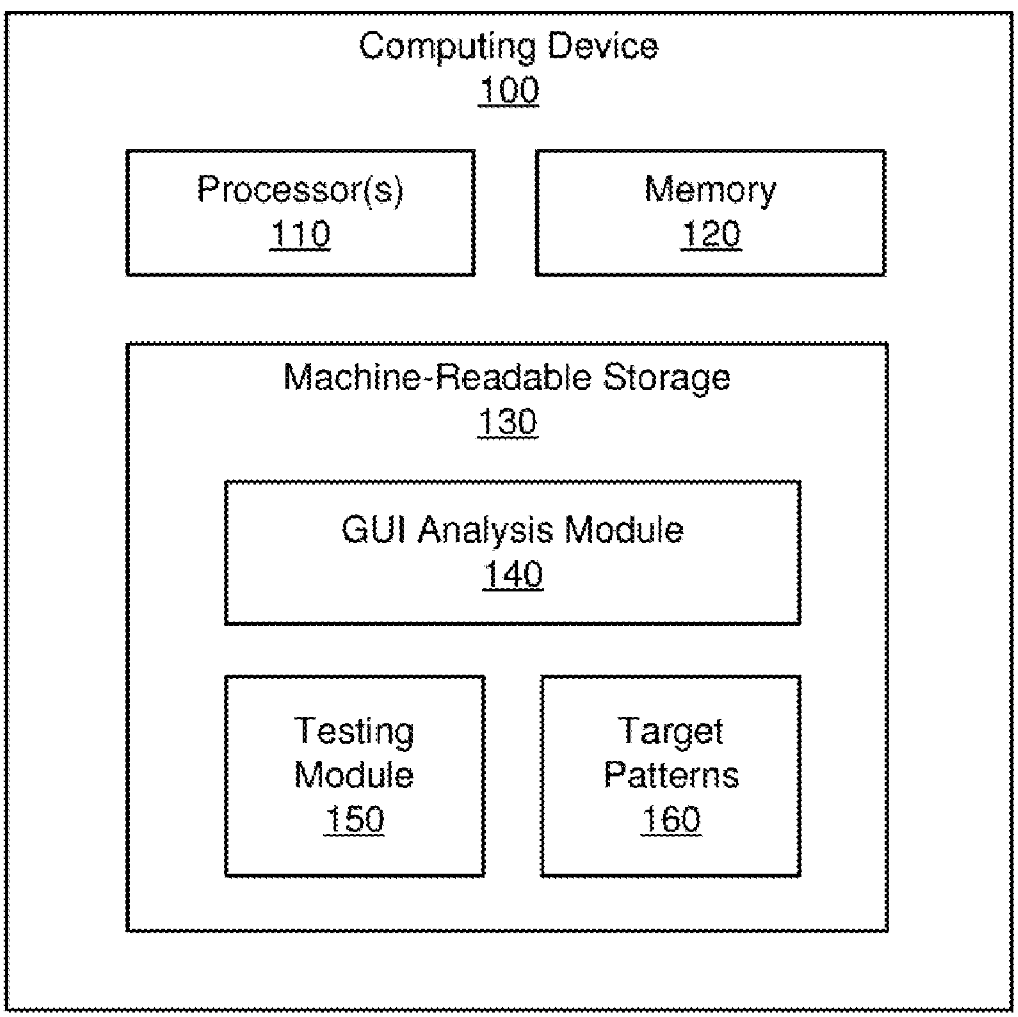
(57) **ABSTRACT**

A computing device includes a processor and a medium storing instructions. The instructions are executable by the processor to: identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI); determine a set of rows including potential input elements that are in a horizontal alignment and in a same size range; determine a set of columns including potential input elements that are in a vertical alignment and in a same size range; determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns; and perform automated testing of the GUI using the determined set of input elements.



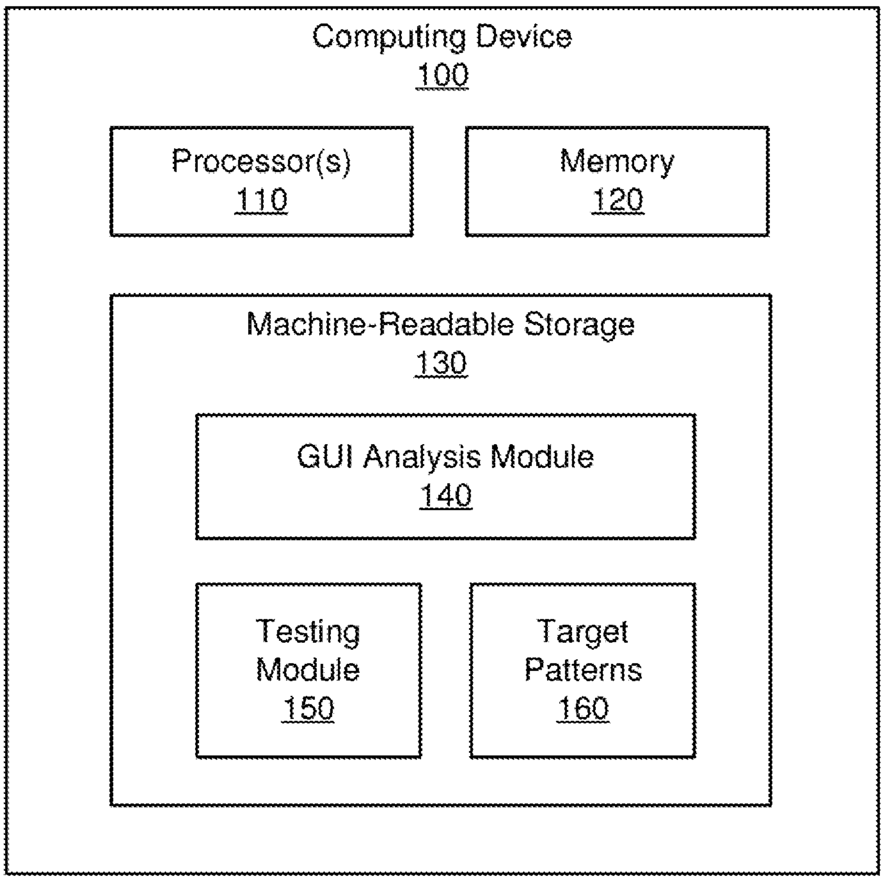

Computing Device
100
Processor(s)
110
Memory
120
Machine-Readable Storage
130
GUI Analysis Module
140
Testing
Module
150
Target
Patterns
160

FIG. 1

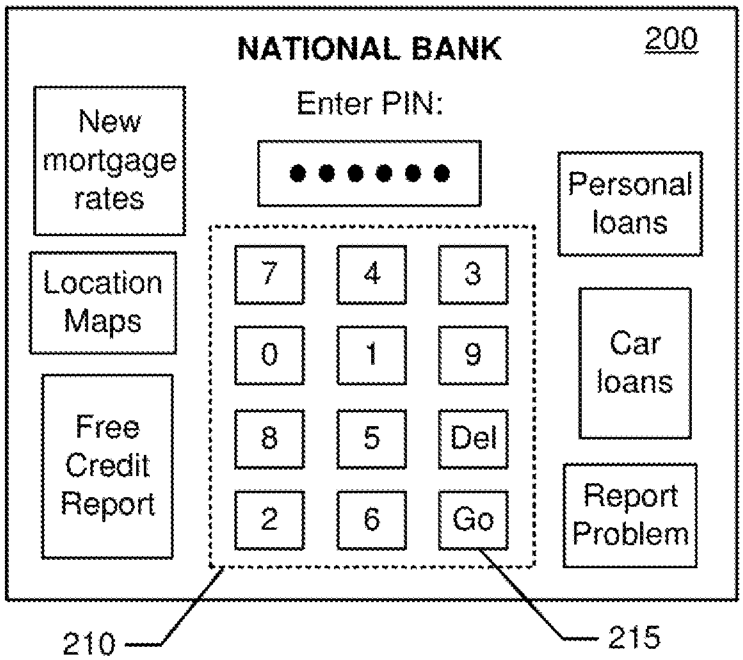

NATIONAL BANK
200
Enter PIN:
New mortgage rates
Location Maps
Free Credit Report
Personal loans
Car loans
Report Problem
7
4
3
0
1
9
8
5
Del
2
6
Go
210
215

FIG. 2A

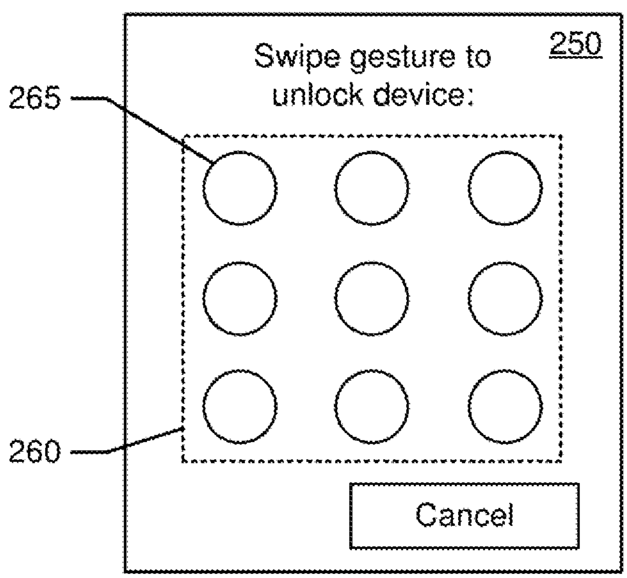

Swipe gesture to unlock device:
250
265
260
Cancel

FIG. 2B

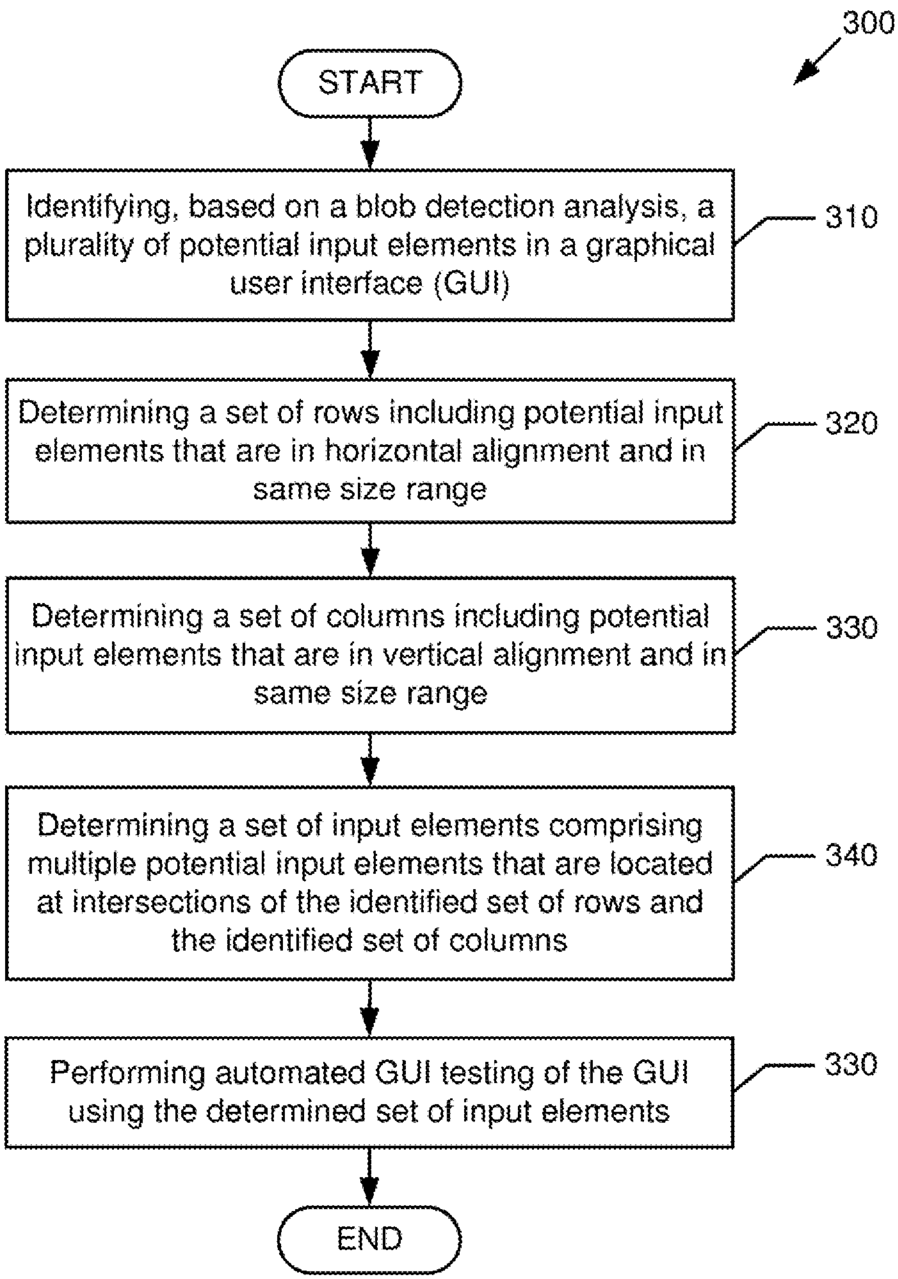

300
START
Identifying, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI)
310
Determining a set of rows including potential input elements that are in horizontal alignment and in same size range
320
Determining a set of columns including potential input elements that are in vertical alignment and in same size range
330
Determining a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns
340
Performing automated GUI testing of the GUI using the determined set of input elements
330
END

FIG. 3

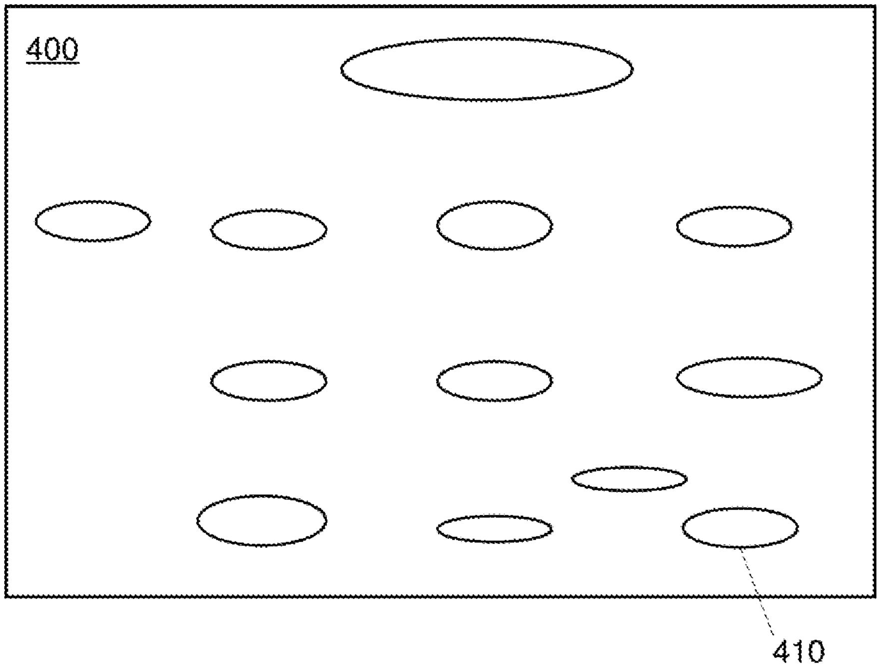


FIG. 4A

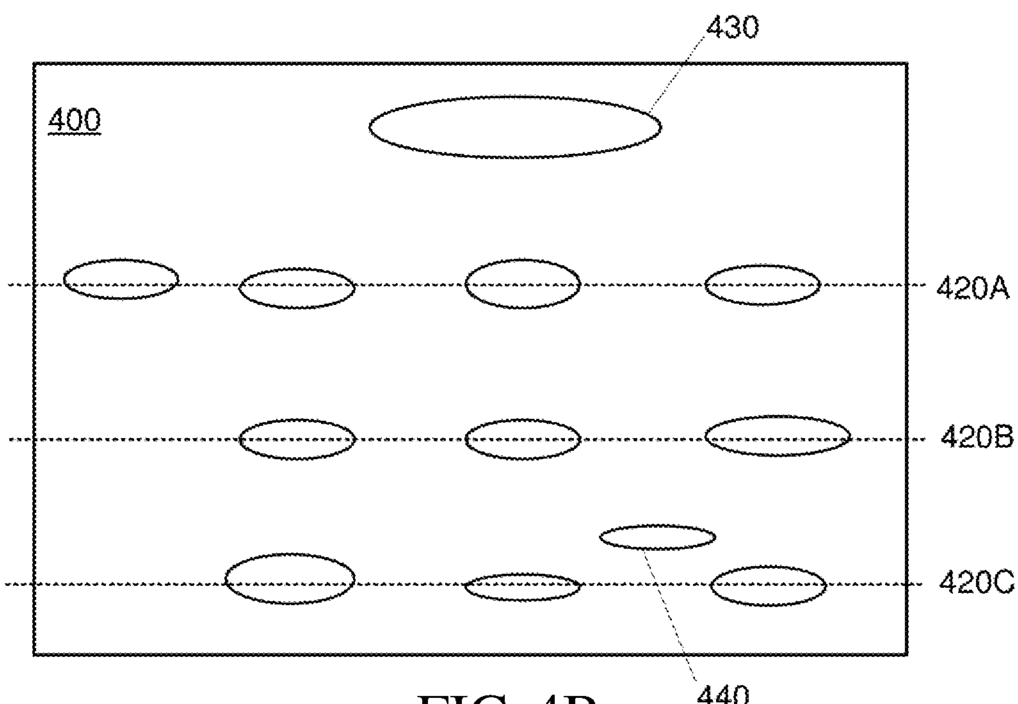


FIG. 4B

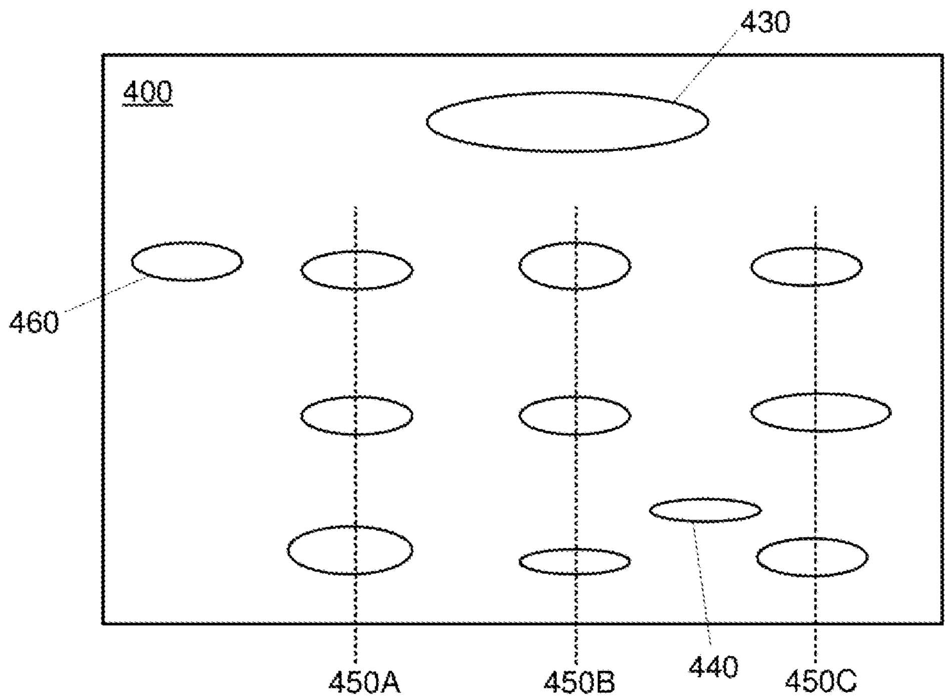

430
400
460
450A
450B
440
450C

FIG. 4C

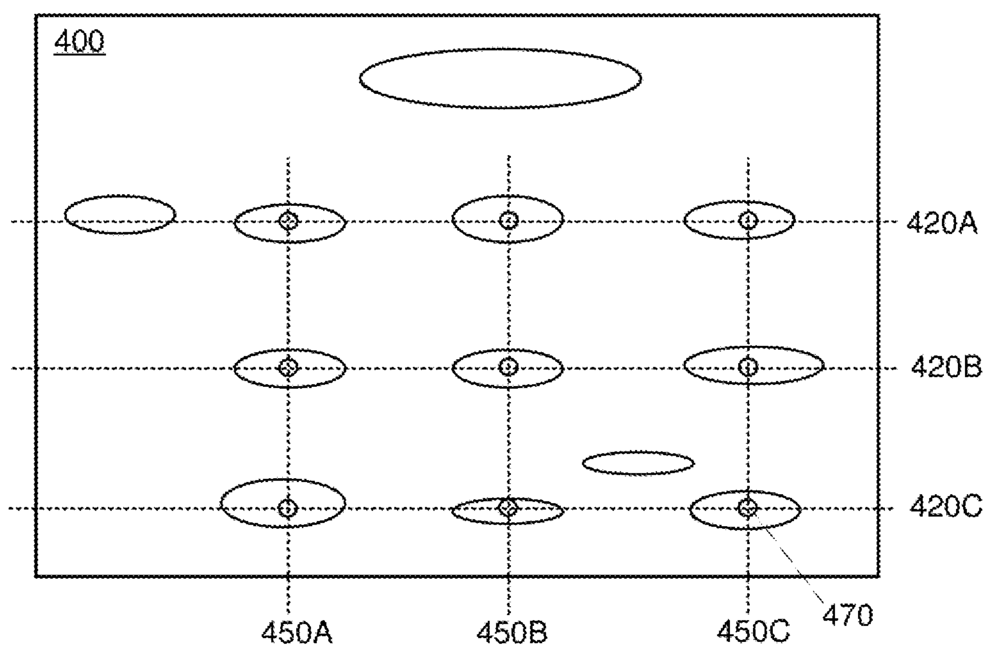

400
420A
420B
420C
470
450A
450B
450C

FIG. 4D

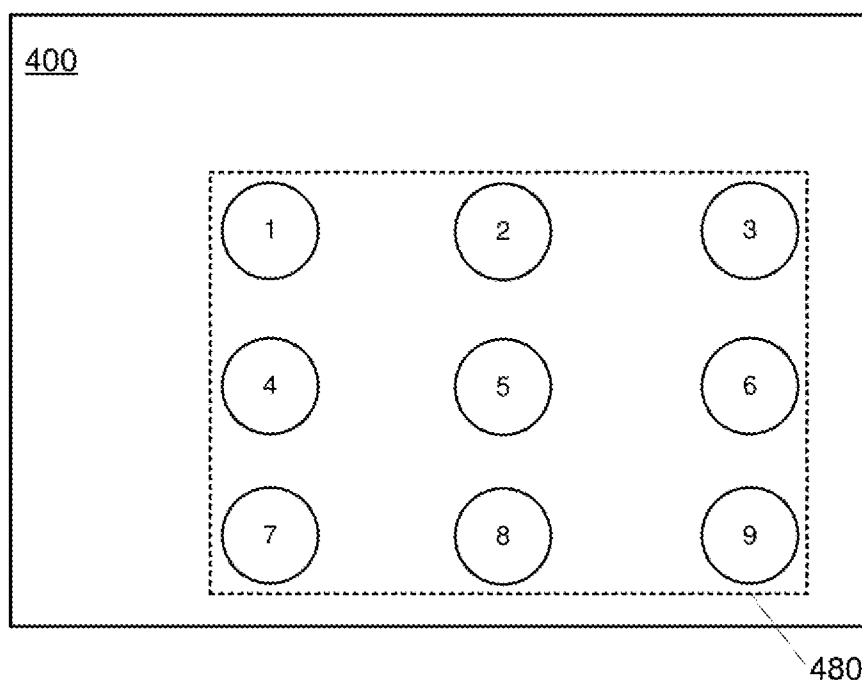


FIG. 4E

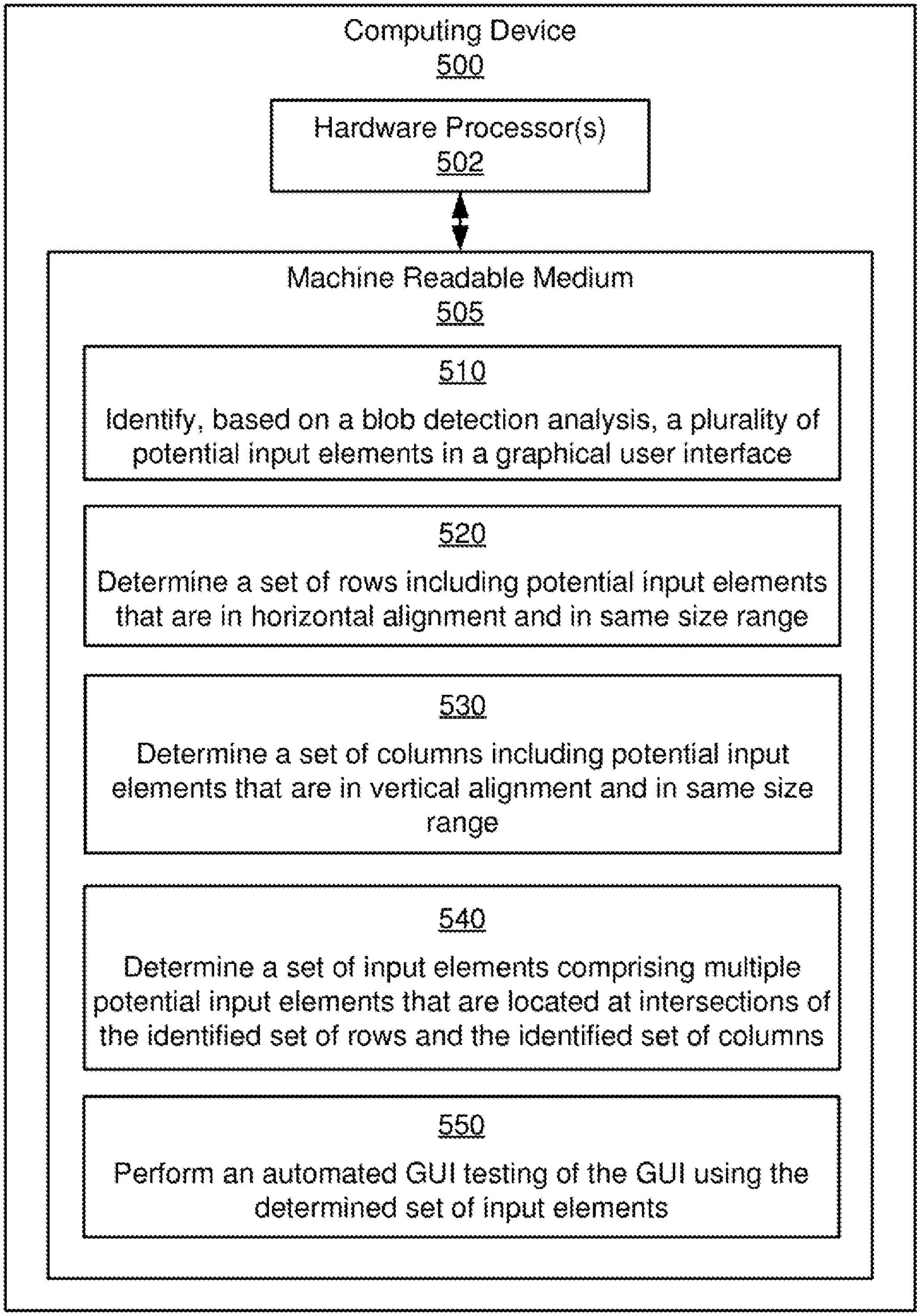

Computing Device
500
Hardware Processor(s)
502
Machine Readable Medium
505
510
Identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface
520
Determine a set of rows including potential input elements that are in horizontal alignment and in same size range
530
Determine a set of columns including potential input elements that are in vertical alignment and in same size range
540
Determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns
550
Perform an automated GUI testing of the GUI using the determined set of input elements

FIG. 5

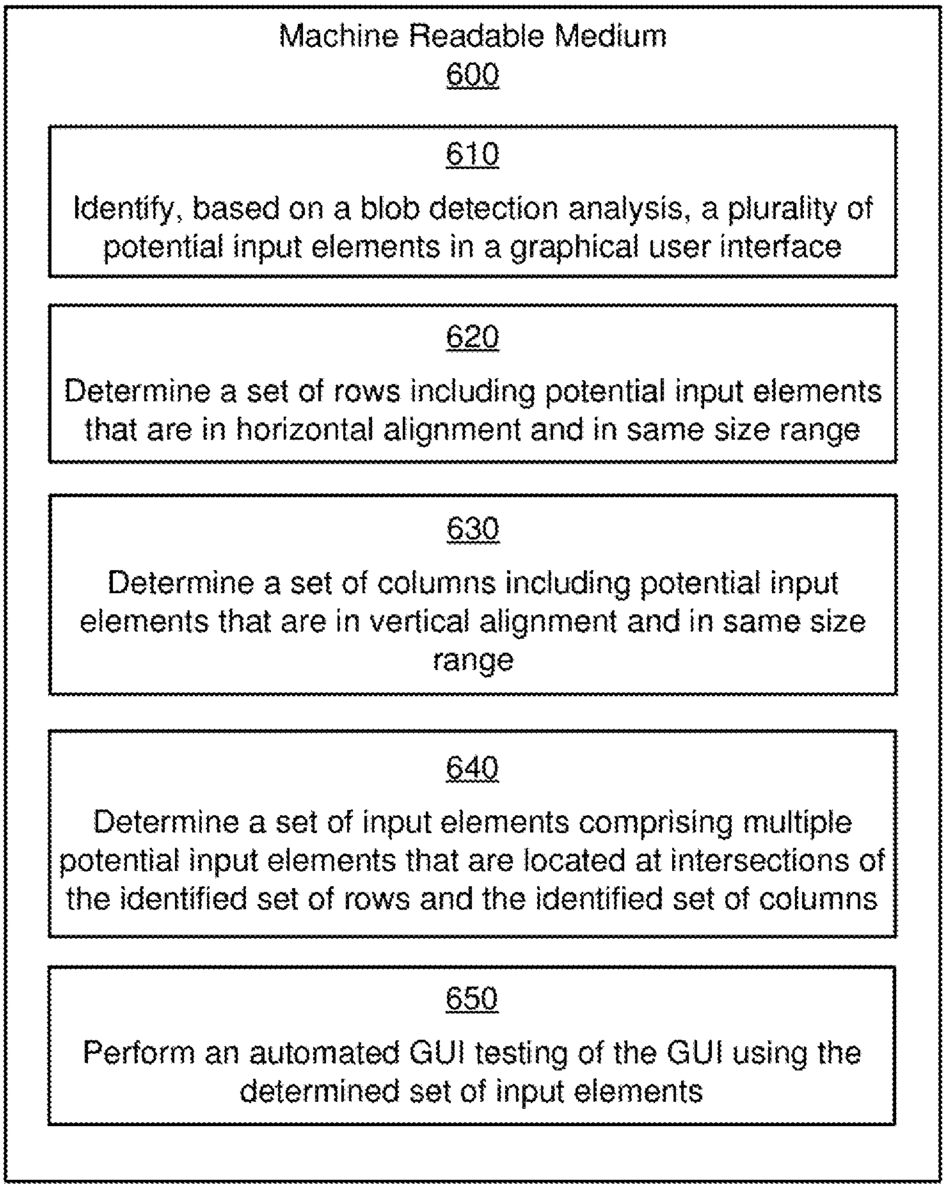

Machine Readable Medium
600
610
Identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface
620
Determine a set of rows including potential input elements that are in horizontal alignment and in same size range
630
Determine a set of columns including potential input elements that are in vertical alignment and in same size range
640
Determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns
650
Perform an automated GUI testing of the GUI using the determined set of input elements

FIG. 6

AUTOMATED IDENTIFICATION OF INPUT ELEMENTS IN A GRAPHICAL USER INTERFACE

BACKGROUND

[0001] With increasing use of computer systems, it becomes increasingly important to have reliable software. As such, software applications are often subjected to extensive testing to detect and eliminate errors. For software application with graphical user interfaces (GUIs), such testing may involve interacting with screen elements in different combinations and/or scenarios. For example, a tester may use a computer mouse to select various screen elements such as buttons, sliders, hyperlinks, menus, and so forth.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Some implementations are described with respect to the following figures.

[0003] FIG. **1** is a schematic diagram of an example system, in accordance with some implementations.

[0004] FIGS. **2**A-**2**B are illustrations of example graphical user interfaces, in accordance with some implementations.

[0005] FIG. **3** is a flow diagram of an example process, in accordance with some implementations.

[0006] FIGS. **4**A-**4**E are illustrations of an example mapping of potential input elements, in accordance with some implementations.

[0007] FIG. **5** is a schematic diagram of an example computing device, in accordance with some implementations.

[0008] FIG. **6** is a diagram of an example machine-readable medium storing instructions in accordance with some implementations.

DETAILED DESCRIPTION

[0009] Testing of computer applications with graphical user interfaces (GUIs) can be time-consuming and expensive. For example, human testers may have to manually perform various GUI input commands, such as mouse clicks, keyboard inputs, and so forth. As such, the ability to automate the testing of GUIs may reduce the time and cost associated with software validation. Such automated testing may require information about the screen locations of the GUI elements that receive user inputs. However, some GUIs may include input elements that do not have pre-defined screen locations. Accordingly, it may be difficult to perform automated testing of GUIs with input elements that do not have pre-defined screen locations.

[0010] As described further below with reference to FIGS. **1**-**6**, some implementations may provide a technique for automated identification of input elements in a GUI. In some examples, the identification technique may include performing a blob detection analysis on an image of the GUI. The blob detection analysis may identify a set of screen elements that could possibly be input elements (referred to as "potential input elements"). Further, the identification technique may include forming rows and columns across at least some of the potential input elements, and determining the intersections of the rows and columns. In some implementations, the potential input elements that are located at the intersections may be identified as the set of input elements that are used for automated testing of the GUI. Accordingly, some implementations may provide improved automated testing of GUIs.

[0011] FIG. **1** is a schematic diagram of an example computing device **100**, in accordance with some implementations. The computing device **100** may be, for example, a computer, a portable device, a server, a network device, a communication device, etc. Further, the computing device **100** may be any grouping of related or interconnected devices, such as a blade server, a computing cluster, and the like. Furthermore, in some implementations, the computing device **100** may be a dedicated device or appliance for automated analysis and/or testing of GUIs.

[0012] As shown, the computing device **100** can include processor(s) **110**, memory **120**, and machine-readable storage **130**. The processor(s) **110** can include a microprocessor, microcontroller, processor module or subsystem, programmable integrated circuit, programmable gate array, multiple processors, a microprocessor including multiple processing cores, or another control or computing device. The memory **120** can be any type of computer memory (e.g., dynamic random access memory (DRAM), static random-access memory (SRAM), etc.).

[0013] In some implementations, the machine-readable storage **130** can include non-transitory storage media such as hard drives, flash storage, optical disks, etc. As shown, the machine-readable storage **130** can include a GUI analysis module **140**, a testing module **150**, and target patterns **160**.

[0014] As shown in FIG. **1**, in some implementations, the modules **140**, **150** may be implemented as executable instructions stored in the machine-readable storage **130**. However, the modules **140**, **150** can be implemented in any suitable manner. For example, some or all of the modules **140**, **150** could be hard-coded as circuitry included in the processor(s) **110**. In other examples, some or all of the modules **140**, **150** could be implemented on a remote computer (not shown), as web services, and so forth. In another example, the modules **140**, **150** may be implemented in one or more controllers of the computing device **100**. In some implementations, the target patterns **160** may store data in one or more organized structures (e.g., relational tables, extensible markup language (XML) files, flat files, and so forth).

[0015] In one or more implementations, the GUI analysis module **140** may automatically identify input elements within a GUI screen. In some examples, the GUI analysis module **140** may identify input elements in GUIs having some characteristics that may interfere with automated identification of input elements. Examples of such GUIs are described below with reference to FIGS. **2**A-**2**B.

[0016] In one or more implementations, the GUI analysis module **140** may perform a blob detection analysis to identify potential input elements of a GUI. As used herein, "blob detection" refers to computer image analysis that detects regions that are different from surrounding regions in terms of one or more properties (e.g., brightness, color, etc.). For example, blob detection may be based on differential analysis (e.g., using derivatives of a function relative to position), on the local maxima and minima of a function, and so forth. The term "blob" may refer to a detected region that is different from its surrounding regions. In some implementations, the detected blobs may be identified as screen elements that could possibly be input elements (referred to as "potential input elements"). In one or more implementations, the GUI analysis module **140** may form rows and columns based on subsets of potential input elements, and may determine the intersections of the rows and columns. Furthermore, the GUI analysis module **140** may identify the intersections as the set of input elements to be used for testing. In some implementations, the testing module **150** may perform automated testing of a GUI using the identified set of input elements. The functionality of the GUI analysis module **140** is described further below with reference to FIGS. **2A-4E**, which show various non-limiting examples.

[0017] Referring now to FIGS. **2A-2B**, shown are example GUI screens **200**, **250**, in accordance with some implementations. For example, referring to FIG. **2A**, the GUI **200** may be, for example, an interface screen for a website or automatic teller machine (ATM) of a particular bank. As shown, the GUI **200** may present a region **210** including multiple input elements **215** to receive user inputs. Further, the GUI **200** may include numerous screen elements surrounding the region **210**, such as advertisements, hyperlinks, data entry field, screen title, and so forth.

[0018] Assume that one or more characteristics of the GUI **200** may cause difficulty in performing automated testing. For example, the input elements **215** may be numeric keys that are displayed in a randomized order each time the GUI **200** is displayed. Such randomization may be performed to improve password security (e.g., to make it difficult to determine the PIN code based on observations of inputs on various portions of the GUI **200**). However, because the numeric keys are not presented in consistent locations, it may be difficult to automate the entry of numeric codes in the GUI **200**. Further, the presence of other screen elements that are not related to entry of the numeric code may interfere with the automatic determination of the locations of the input elements **215**. For example, a computer vision algorithm may incorrectly identify an advertisement as an input element, thereby causing errors during automated testing.

[0019] Referring now to FIG. **2B**, the GUI screen **250** may be, for example, a touch screen for receiving a swipe gesture to unlock a device (e.g., a tablet or smartphone). As shown, the GUI **250** may present a region **260** including multiple input elements **265** to receive a swipe gesture (e.g., a swipe that forms a particular pattern and/or sequence overlaid on the input elements **265**). Further, the GUI **250** may include other elements surrounding the region **260**, such as a screen title and a "Cancel" command button.

[0020] Assume that one or more characteristics of the GUI **260** may cause difficulty in performing automated testing. For example, the separations between the input elements **265** may vary when the GUI **260** on device screens of different sizes, aspect ratios, and/or resolutions. Accordingly, because the input elements **265** are not presented in consistent locations, it may be difficult to automate the entry of swipe gestures that are defined according to the input elements **265**. Further, the presence of other screen elements that are not related to entry of swipe gestures may interfere with the automatic determination of the locations of the input elements **265**.

[0021] Referring now to FIG. **3**, shown is an example process **300**, in accordance with some implementations. In some examples, the process **300** may be performed by some or all of the computing device **100** shown in FIG. **1**. The process **300** may be implemented in hardware and/or machine-readable instructions (e.g., software and/or firmware). The machine-readable instructions are stored in a non-transitory computer readable medium, such as an optical, semiconductor, or magnetic storage device. For the sake of illustration, details of the process **300** may be described below with reference to FIGS. **1**, **2A-2B**, and **4A-4E**, which shows examples in accordance with some implementations. However, other implementations are also possible.

[0022] Block **310** may include identifying, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI). For example, referring to FIGS. **1-2A**, the GUI analysis module **140** may perform a blob detection analysis of the GUI **200**. The blob detection analysis may identify blobs corresponding to each distinct element, including the input elements **215**, advertisements, hyperlinks, data entry field, screen title, and so forth.

[0023] In one or more implementations, the detected blobs may be used to define a set of potential input elements (i.e., candidate regions that could potentially be input elements of the GUI screen). For example, a potential input element may be defined in terms of the location, shape, and/or size of a detected blob. In some examples described herein, the potential input elements may be represented by a mapping to respective regions of the GUI screen.

[0024] Referring now to FIGS. **4A-4E**, shown is an example mapping **400** of potential input elements **410**, in accordance with one or more implementations. Specifically, the FIGS. **4A-4E**, shown is an example mapping **400** during various operations of automated identification of input elements (e.g., by GUI analysis module **140**). As shown in FIG. **4A**, the mapping **400** may illustrate each potential input element **410** as a detected blob having a particular location, shape, and size. Note that the mapping **400** is not intended to correspond to GUIs **200**, **250** (shown in FIG. **2A-2B**), and thus the potential input elements **410** do not correspond to the screen elements of GUIs **200**, **250**.

[0025] Referring again to FIG. **3**, block **320** may include determining a set of rows including potential input elements that are in a horizontal alignment and in a same size range. For example, referring to FIGS. **1** and **4B**, the GUI analysis module **140** may identify rows **420A-420C** in the potential input elements (i.e., identified at block **310**) that are in a horizontal alignment and have a similar size. In one or more implementations, the determination of size and/or horizontal alignment may be based on specified thresholds. For example, the GUI analysis module **140** may determine the row **420A** by identifying a group of four elements that are within a defined vertical range. In some implementations, the defined vertical range may be bounded by a distance or proportion above a horizontal fit line, and by a distance or proportion below the horizontal fit line (e.g., no more than 5 pixels above or below a horizontal line fit through the elements, no more than 10 percent above or below the horizontal line fit, and so forth). Further, the GUI analysis module **140** may determine the row **420A** if the identified group of four elements that are within the vertical range are also determined to within a defined size range (e.g., between 10 to 20 pixels), within a defined size variation (e.g., size does not differ from the other elements by more than plus or minus 30 percent), and so forth. Similarly, the GUI analysis module **140** may determine the rows **420B**, **420C** by identifying two groups of elements that share a similar size and are in a horizontal alignment. Assume that, in the example of FIG. **4B**, the element **440** is determined to not be in horizontal alignment with other elements, and thus is not included in any row. Assume further that the element **430** is determined to not be of similar size or in horizontal alignment with other elements, and thus is not included in any row.

[0026] Referring again to FIG. **3**, block **330** may include determining a set of columns including potential input elements that are in a vertical alignment and in a same size range. For example, referring to FIGS. **1** and **4**C, the GUI analysis module **140** may identify columns **450**A-**450**C in the potential input elements that are in a horizontal alignment and have a similar size. In some implementations, the determination of vertical alignment may be based on specified thresholds. For example, the GUI analysis module **140** may determine the column **450**A by identifying three elements that are within a defined horizontal range. In some implementations, the defined horizontal range may be bounded by a distance or proportion to the right of a vertical fit line, and by a distance or proportion to the left of a vertical fit line (e.g., no more than 5 pixels to the right or left of a vertical line fit through the elements, no more than 10 percent to the right or left of a vertical line fit, and so forth). Further, the GUI analysis module **140** may determine the column **450**A if the identified elements are within a defined size range, variation, etc. Assume that, in the example of FIG. **4**C, the elements **440** and **460** are determined to not be in vertical alignment with other elements, and thus are not included in any column. Further, assume that the element **430** is determined to not have a similar size to other elements, and thus is not included in any column.

[0027] Referring again to FIG. **3**, block **340** may include determining a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns. For example, referring to FIGS. **1** and **4**D, the GUI analysis module **140** may determine intersections **470** of the rows **420** and the columns **450**. Further, the GUI analysis module **140** may use the determined intersections **470** to identify the set of input elements for use in automated testing. For example, FIG. **4**E illustrates a set of input elements **480** corresponding to the potential input elements that are located at the determined intersections **470** (shown in FIG. **4**D). In some implementations, as shown in FIG. **4**E, the set of input elements **480** may be assigned an index value (e.g., a numeric identifier) that is used to identify the input elements **480** during automated testing.

[0028] In some implementations, the GUI analysis module **140** may use the target patterns **160** as part of (or to assist in) identifying the set of input elements. For example, the target patterns **160** may store data indicating desired or expected patterns of input element locations within a GUI (e.g., a three-by-three grid, a four-by-three grid, etc.). In some examples, the GUI analysis module **140** may optionally compare the potential input elements located at the intersections **470** to a desired target pattern **160**, and may ignore a potential input element that fails to conform to the target pattern **160**. Stated differently, the potential input element that does not match the target pattern **160** is not included in the identified set of input elements for use testing.

[0029] In some implementations, the GUI analysis module **140** may perform optical character recognition (OCR) to determine any text characters associated with the identified set of input elements. For example, referring to FIGS. **1** and **4**E, the GUI analysis module **140** may determine text characters (e.g., “3”, “Enter”, etc.) associated with each of the set of input elements **480**. In some implementations, the determined text characters may be used to perform automated testing. For example, referring to FIGS. **1** and **2**A, the GUI analysis module **140** may identify the input elements **215** as the set of elements for testing, and may perform OCR to determine the numeric values for automated testing of the GUI **200** (e.g., to simulate user entry of PIN codes in the GUI **200**).

[0030] Referring again to FIG. **3**, block **350** may include performing automated testing of the GUI using the determined set of input elements. For example, referring to FIG. **1**, the testing module **150** may simulate user interactions with the identified set of input elements during automated testing of the GUI. After block **350**, the process **300** is completed.

[0031] Referring now to FIG. **5**, shown is a schematic diagram of an example computing device **500**. In some examples, the computing device **500** may correspond generally to the computing device **100** shown in FIGS. **1**-**2**. As shown, the computing device **500** may include hardware processor(s) **502** and machine-readable storage medium **505**. The machine-readable storage medium **505** may be a non-transitory medium, and may store instructions **510**-**550**. The instructions **510**-**550** can be executed by the hardware processor(s) **502**.

[0032] Instruction **510** may be executed to identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI). For example, referring to FIGS. **1**-**2**A, the GUI analysis module **140** may perform a blob detection analysis of the GUI **200**.

[0033] Instruction **520** may be executed to determine a set of rows including potential input elements that are in a horizontal alignment and in a same size range. For example, referring to FIGS. **1** and **4**B, the GUI analysis module **140** may identify rows **420**A-**420**C in the potential input elements that are in a horizontal alignment and have a similar size.

[0034] Instruction **530** may be executed to determine a set of columns including potential input elements that are in a vertical alignment and in a same size range. For example, referring to FIGS. **1** and **4**C, the GUI analysis module **140** may identify columns **450**A-**450**C in the potential input elements that are in a horizontal alignment and have a similar size.

[0035] Instruction **540** may be executed to determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns. For example, referring to FIGS. **1**, **4**D, and **4**E, the GUI analysis module **140** may identify the set of input elements **480** based on the intersections **470** of the rows **420** and the columns **450**.

[0036] Instruction **550** may be executed to perform an automated testing of the GUI using the determined set of input elements. For example, referring to FIG. **1**, the testing module **150** may simulate user interactions with the identified set of input elements during automated testing of the GUI.

[0037] Referring now to FIG. **6**, shown is machine-readable medium **600** storing instructions **610**-**650**, in accordance with some implementations. The instructions **610**-**650** can be executed by any number of processors (e.g., the processor(s) **110** shown in FIG. **2**). The machine-readable medium **600** may be a non-transitory storage medium, such as an optical, semiconductor, or magnetic storage medium.

[0038] Instruction **610** may be executed to identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI). Instruction **620** may be executed to determine a set of rows including potential input elements that are in a horizontal alignment and in a same size range. Instruction **630** may be executed to determine a set of columns including potential input elements that are in a vertical alignment and in a same size range. Instruction **640** may be executed to determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns. Instruction **650** may be executed to perform an automated testing of the GUI using the determined set of input elements.

[0039] Note that, while FIGS. **1**-**6** show various examples, other implementations are contemplated. For example, referring to FIG. **1**, it is contemplated that the computing device **100** may include additional components, fewer components, or different components. Further, while FIGS. **2**A-**2**B and **4**A-**4**E illustrate various example GUIs and elements, implementations are not limited in this regard. Further, some implementations may exclude the use of OCR and/or the target patterns **150**. Other combinations and/or variations are also possible.

[0040] In accordance with some implementations, examples are provided for automated identification of input elements in a GUI. In some examples, the identification technique may include performing a blob detection analysis on an image of the GUI. The blob detection analysis may identify potential input elements that can be used to form rows and columns. The intersections of the rows and columns may be used to automatically identify a set of input elements for automated testing of the GUI. Accordingly, some implementations may provide improved automated testing of GUIs.

[0041] Data and instructions are stored in respective storage devices, which are implemented as one or multiple computer-readable or machine-readable storage media. The storage media include different forms of non-transitory memory including semiconductor memory devices such as dynamic or static random access memories (DRAMs or SRAMs), erasable and programmable read-only memories (EPROMs), electrically erasable and programmable read-only memories (EEPROMs) and flash memories; magnetic disks such as fixed, floppy and removable disks; other magnetic media including tape; optical media such as compact disks (CDs) or digital video disks (DVDs); or other types of storage devices.

[0042] Note that the instructions discussed above can be provided on one computer-readable or machine-readable storage medium, or alternatively, can be provided on multiple computer-readable or machine-readable storage media distributed in a large system having possibly plural nodes. Such computer-readable or machine-readable storage medium or media is (are) considered to be part of an article (or article of manufacture). An article or article of manufacture can refer to any manufactured single component or multiple components. The storage medium or media can be located either in the machine running the machine-readable instructions, or located at a remote site from which machine-readable instructions can be downloaded over a network for execution.

[0043] In the foregoing description, numerous details are set forth to provide an understanding of the subject disclosed herein. However, implementations may be practiced without some of these details. Other implementations may include modifications and variations from the details discussed above. It is intended that the appended claims cover such modifications and variations.

What is claimed is:

1. A computing device comprising:

a hardware processor; and

a machine-readable storage medium storing instructions, the instructions executable by the processor to:

identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI);

determine a set of rows including potential input elements that are in a horizontal alignment and in a same size range;

determine a set of columns including potential input elements that are in a vertical alignment and in a same size range;

determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns; and

perform automated testing of the GUI using the determined set of input elements.

2. The computing device of claim **1**, wherein the instructions are executable by the processor to:

identify a first group of potential input elements that are within a defined vertical range;

determine that each of the identified first group of potential input elements is within a defined size range; and

in response to a determination that each of the identified first group of potential input elements is within the defined size range, determine a row including the identified first group of potential input elements.

3. The computing device of claim **2**, wherein the instructions are executable by the processor to:

identify a second group of potential input elements that are within a defined horizontal range;

determine that each of the identified second group of potential input elements is within the defined size range; and

in response to a determination that each of the identified second group of potential input elements is within the defined size range, determine a column including the identified second group of potential input elements.

4. The computing device of claim **3**, wherein:

the defined vertical range is bounded by a distance above a horizontal fit line and a distance below the horizontal fit line; and

the defined horizontal range is bounded by a distance to the right of a vertical fit line and a distance to the left of the vertical fit line.

5. The computing device of claim **1**, wherein each of the determined set of input elements is associated with a text value that is randomized for each presentation of the GUI.

6. The computing device of claim **1**, wherein the instructions are executable by the processor to:

compare the multiple potential input elements located at the intersections to a stored target pattern;

determine that a first potential input element of the multiple potential input elements does not match the stored target pattern; and

in response to a determination that the first potential input element does not match the stored target pattern, exclude the first potential input element from the determined set of input elements.

7. The computing device of claim 1, wherein the instructions are executable by the processor to:

perform optical character recognition (OCR) to determine text characters associated with the determined set of input elements; and

simulate a user entry in the GUI using the determined text characters.

8. A non-transitory machine-readable storage medium storing instructions that upon execution cause a processor to:

identify, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI);

determine a set of rows including potential input elements that are in a horizontal alignment and in a same size range;

determine a set of columns including potential input elements that are in a vertical alignment and in a same size range;

determine a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns; and

perform automated testing of the GUI using the determined set of input elements.

9. The non-transitory machine-readable storage medium of claim 8, wherein the instructions further cause the processor to:

identify a first group of potential input elements that are within a defined vertical range;

determine that each of the identified first group of potential input elements is within a defined size range; and

in response to a determination that each of the identified first group of potential input elements is within the defined size range, determine a row including the identified first group of potential input elements.

10. The non-transitory machine-readable storage medium of claim 9, wherein the instructions further cause the processor to:

identify a second group of potential input elements that are within a defined horizontal range;

determine that each of the identified second group of potential input elements is within the defined size range; and

in response to a determination that each of the identified second group of potential input elements is within the defined size range, determine a column including the identified second group of potential input elements.

11. The non-transitory machine-readable storage medium of claim 10, wherein:

the defined vertical range is bounded by a distance above a horizontal fit line and a distance below the horizontal fit line; and

the defined horizontal range is bounded by a distance to the right of a vertical fit line and a distance to the left of the vertical fit line.

12. The non-transitory machine-readable storage medium of claim 8, wherein each of the determined set of input elements is associated with a text value that is randomized for each presentation of the GUI.

13. The non-transitory machine-readable storage medium of claim 8, wherein the instructions cause the processor to:

compare the multiple potential input elements located at the intersections to a stored target pattern;

determine that a first potential input element of the multiple potential input elements does not match the stored target pattern; and

in response to a determination that the first potential input element does not match the stored target pattern, exclude the first potential input element from the determined set of input elements.

14. The non-transitory machine-readable storage medium of claim 8, wherein the instructions cause the processor to:

perform optical character recognition (OCR) to determine text characters associated with the determined set of input elements; and

simulate a user entry in the GUI using the determined text character.

15. A computer implemented method, comprising:

identifying, based on a blob detection analysis, a plurality of potential input elements in a graphical user interface (GUI);

determining a set of rows including potential input elements that are in a horizontal alignment and in a same size range;

determining a set of columns including potential input elements that are in a vertical alignment and in a same size range;

determining a set of input elements comprising multiple potential input elements that are located at intersections of the identified set of rows and the identified set of columns; and

performing automated testing of the GUI using the determined set of input elements.

16. The computer implemented method of claim 15, further comprising:

identifying a first group of potential input elements that are within a defined vertical range;

determining that each of the identified first group of potential input elements is within a defined size range; and

in response to a determination that each of the identified first group of potential input elements is within the defined size range, determining a row including the identified first group of potential input elements.

17. The computer implemented method of claim 16, further comprising:

identifying a second group of potential input elements that are within a defined horizontal range;

determining that each of the identified second group of potential input elements is within the defined size range; and

in response to a determination that each of the identified second group of potential input elements is within the defined size range, determining a column including the identified second group of potential input elements.

18. The computer implemented method of claim 17, wherein:

the defined vertical range is bounded by a distance above a horizontal fit line and a distance below the horizontal fit line; and the defined horizontal range is bounded by a distance to the right of a vertical fit line and a distance to the left of the vertical fit line.

19. The computer implemented method of claim **15**, further comprising:

comparing the multiple potential input elements located at the intersections to a stored target pattern;

determining that a first potential input element of the multiple potential input elements does not match the stored target pattern; and

in response to a determination that the first potential input element does not match the stored target pattern, excluding the first potential input element from the determined set of input elements.

20. The computer implemented method of claim **15**, further comprising:

performing the blob detection analysis based on a based on differential analysis of the GUI.

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