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(54) ENHANCED 3D INTERFACING FOR REMOTE DEVICES

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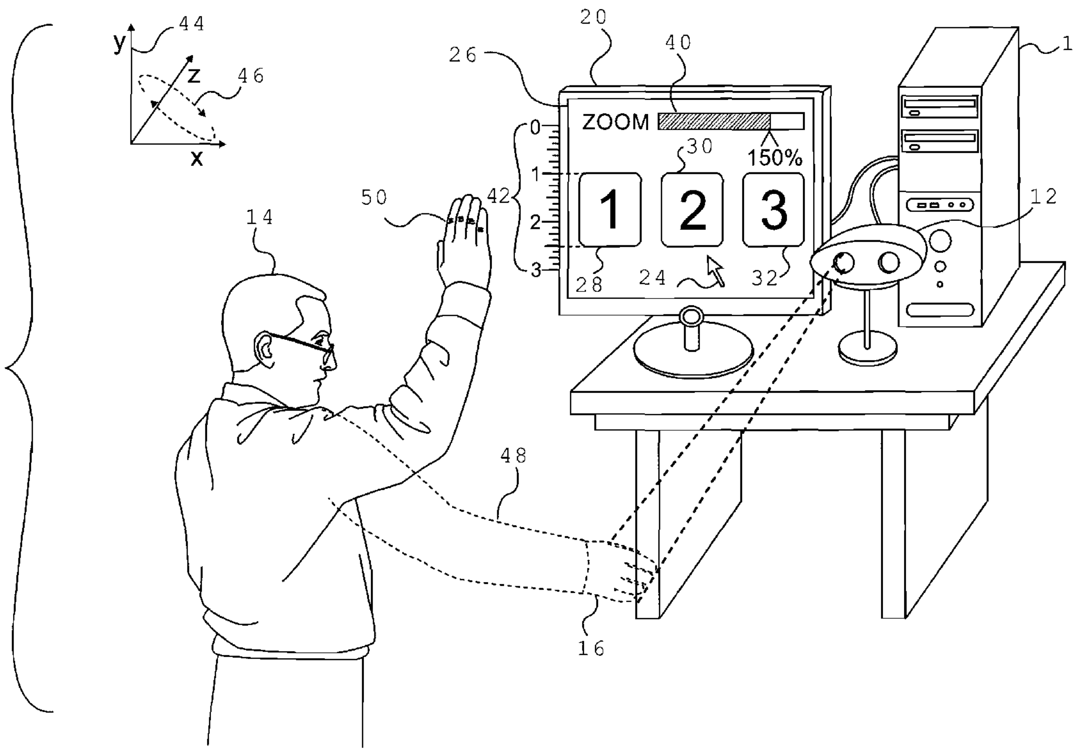
(57) **ABSTRACT**

Operating a computerized system includes presenting user interface elements on a display screen. A first gesture made in a three-dimensional space by a part of a body of a user is detected. In response to the first gesture, an area of the display screen selected by the user is identified, and a magnification level of one or more of the user elements appearing in the selected area on the display screen is increased. After increasing the magnification level, a second gesture made by the part of the body of the user is detected so as to select one of the user interface elements that appear in the selected area.



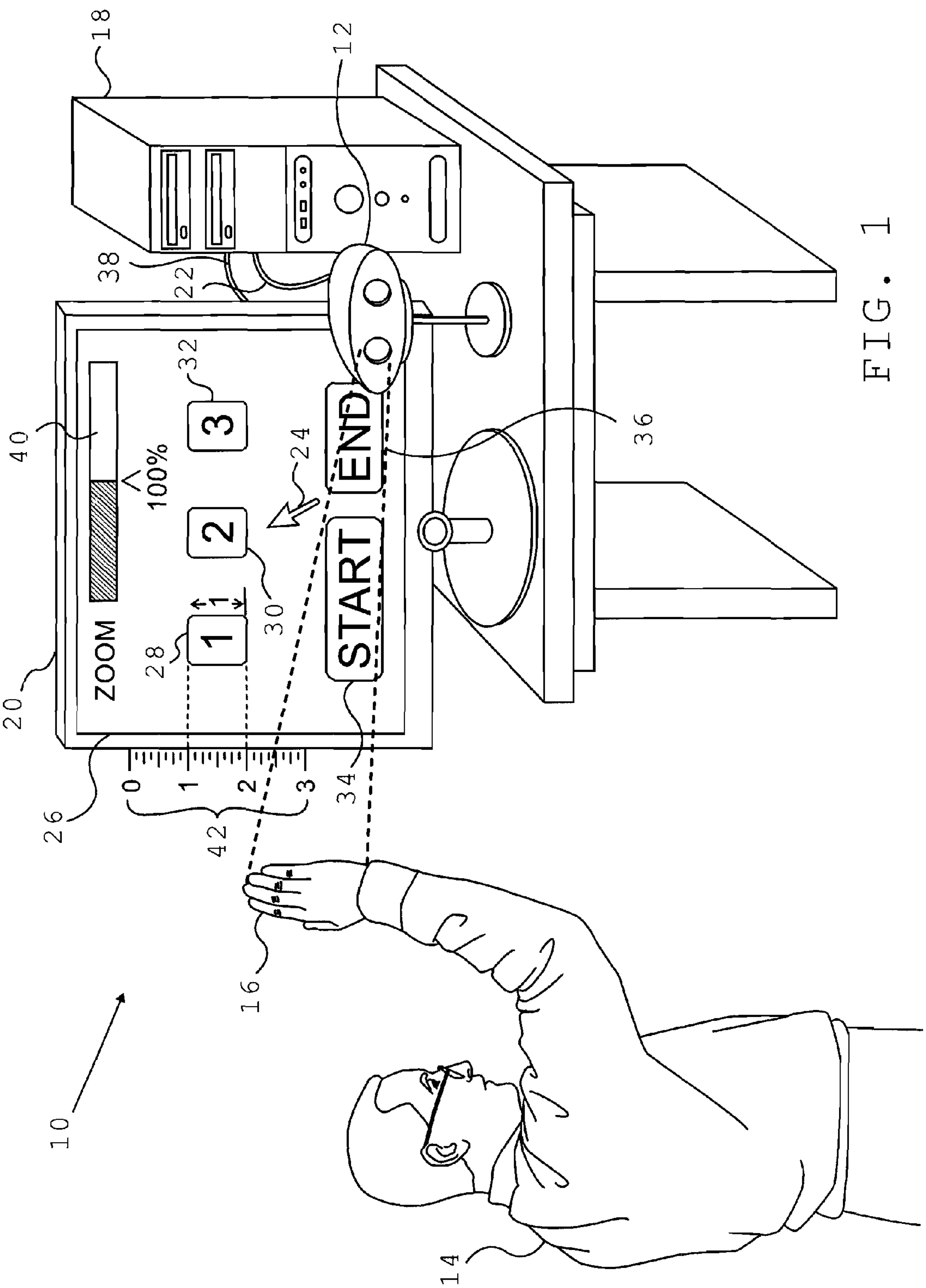

ZOOM
100%
1
2
3
START
END
0
1
2
3
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42

FIG. 1

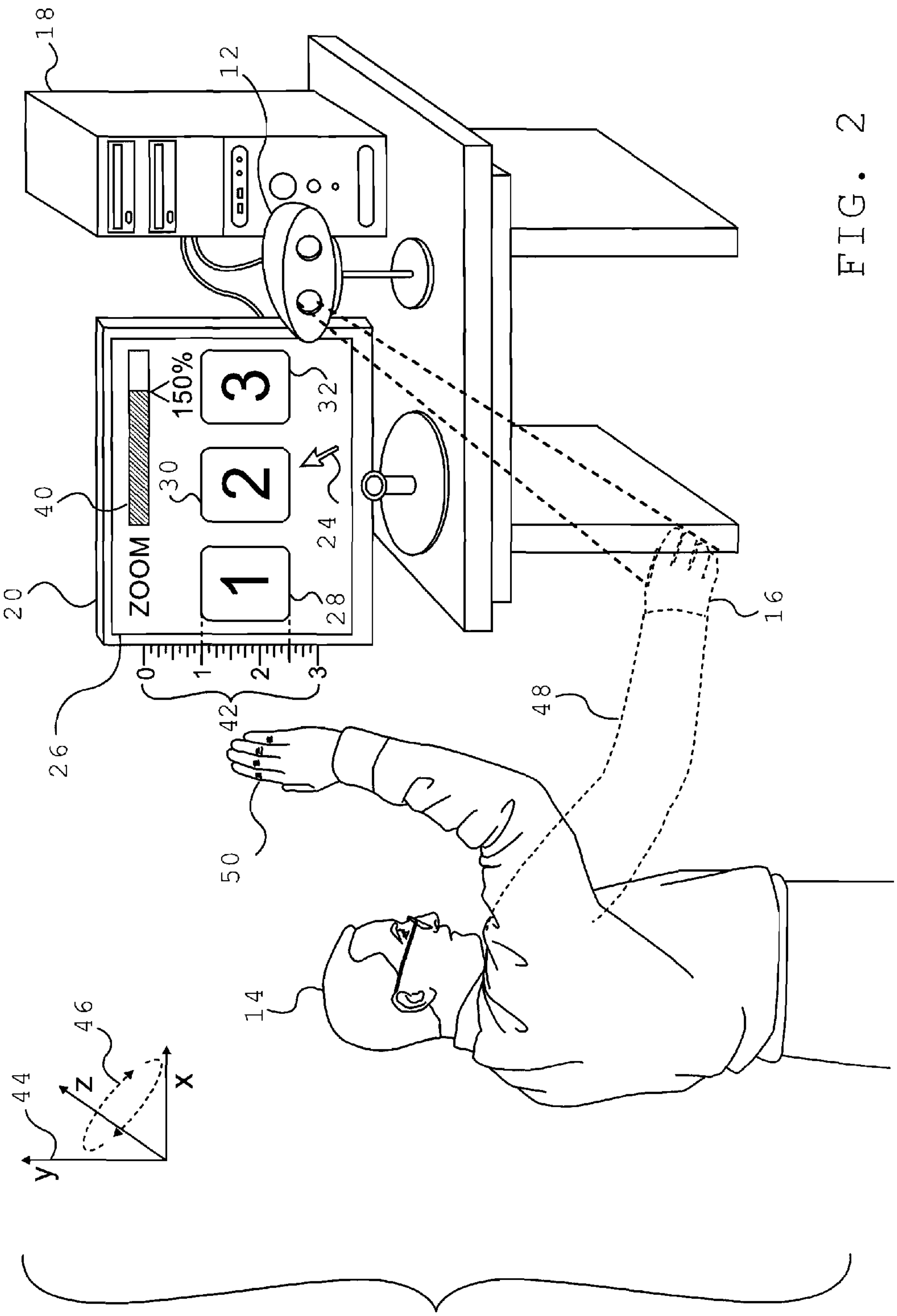


FIG. 2

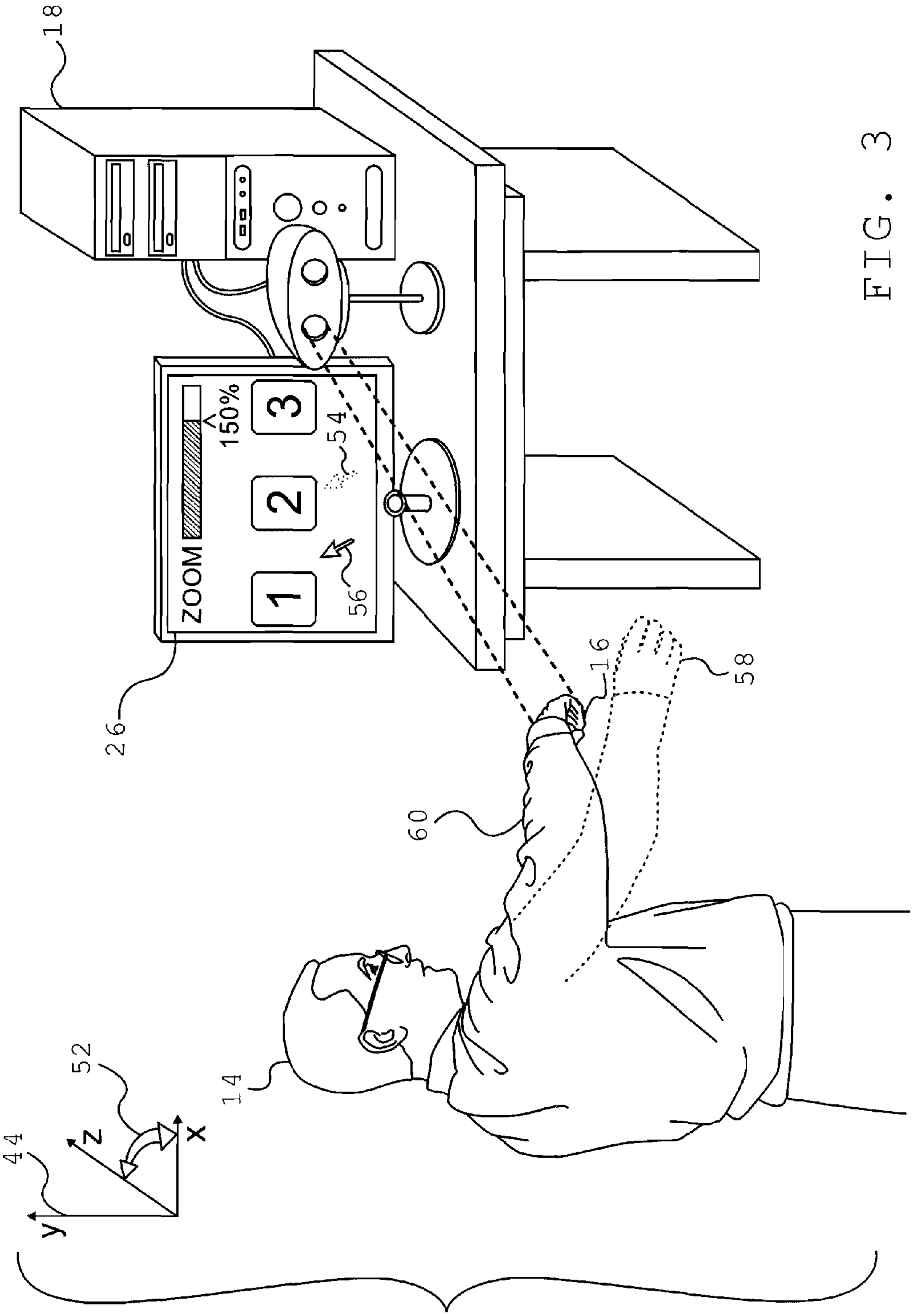


FIG. 3

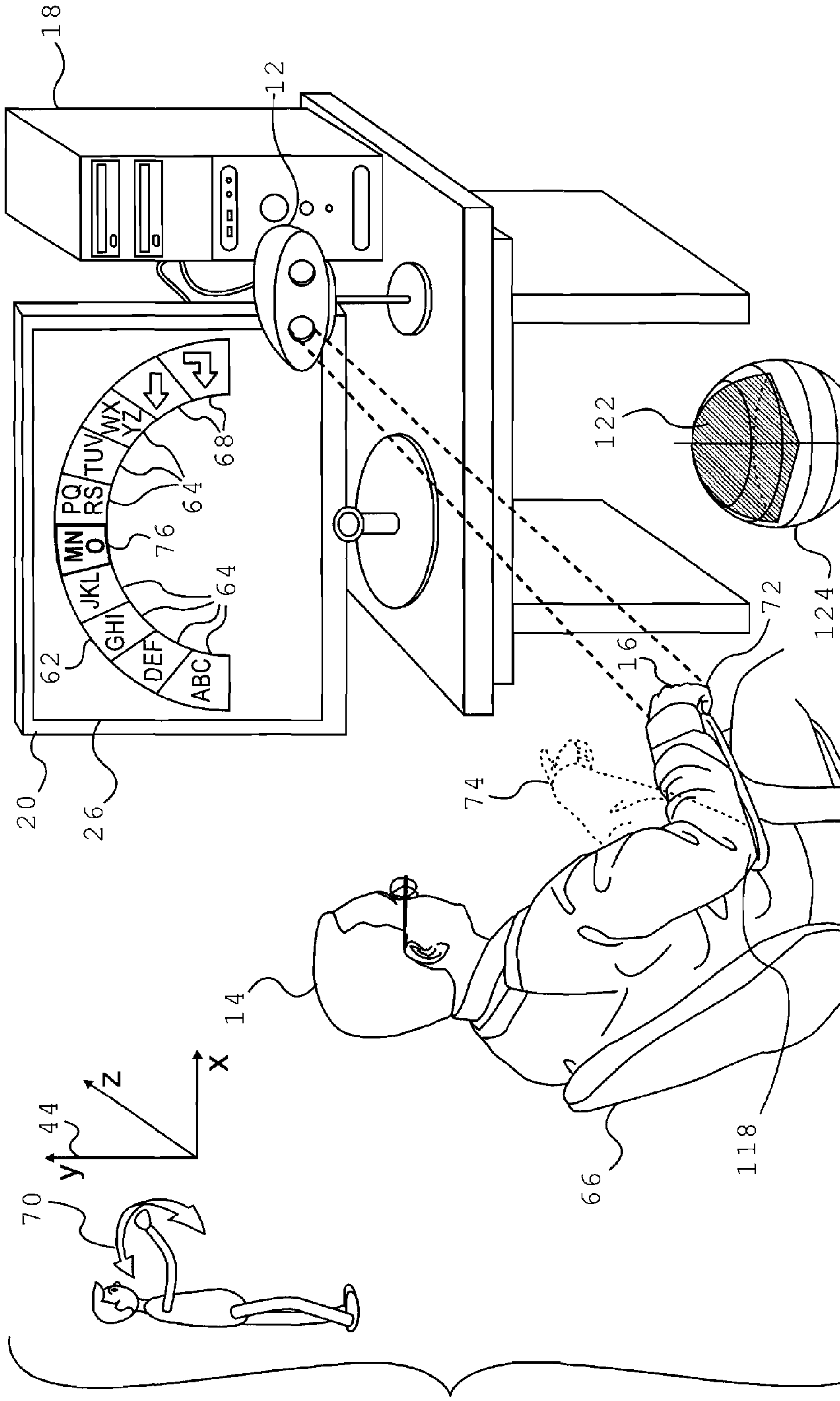

18
12
20
26
62
64
76
68
ABC
DEF
GHI
JKL
MN
O
PQ
RS
TUV
WX
YZ
122
124
72
16
74
14
44
70
66
118
x
y
z

FIG. 4

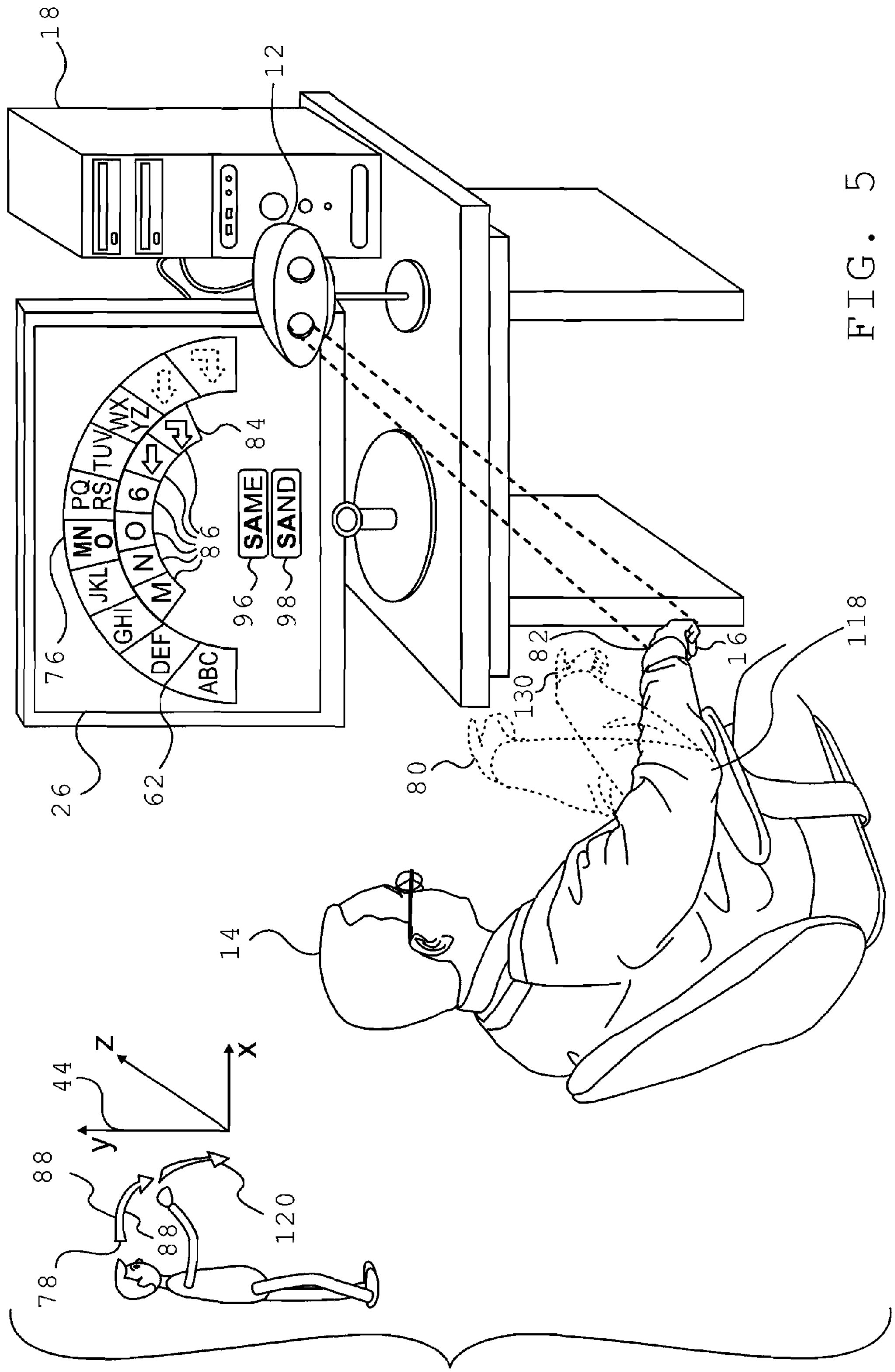
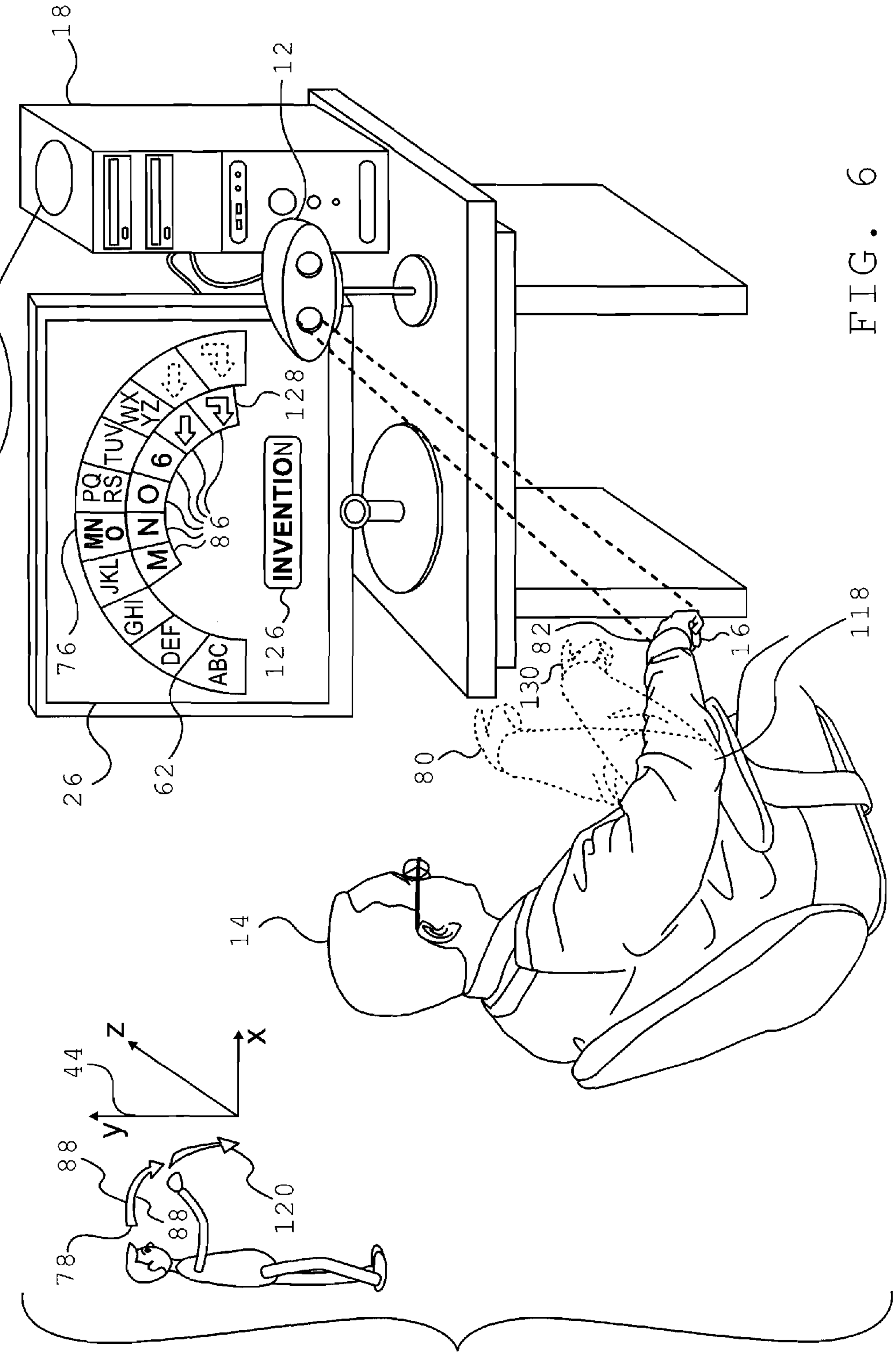
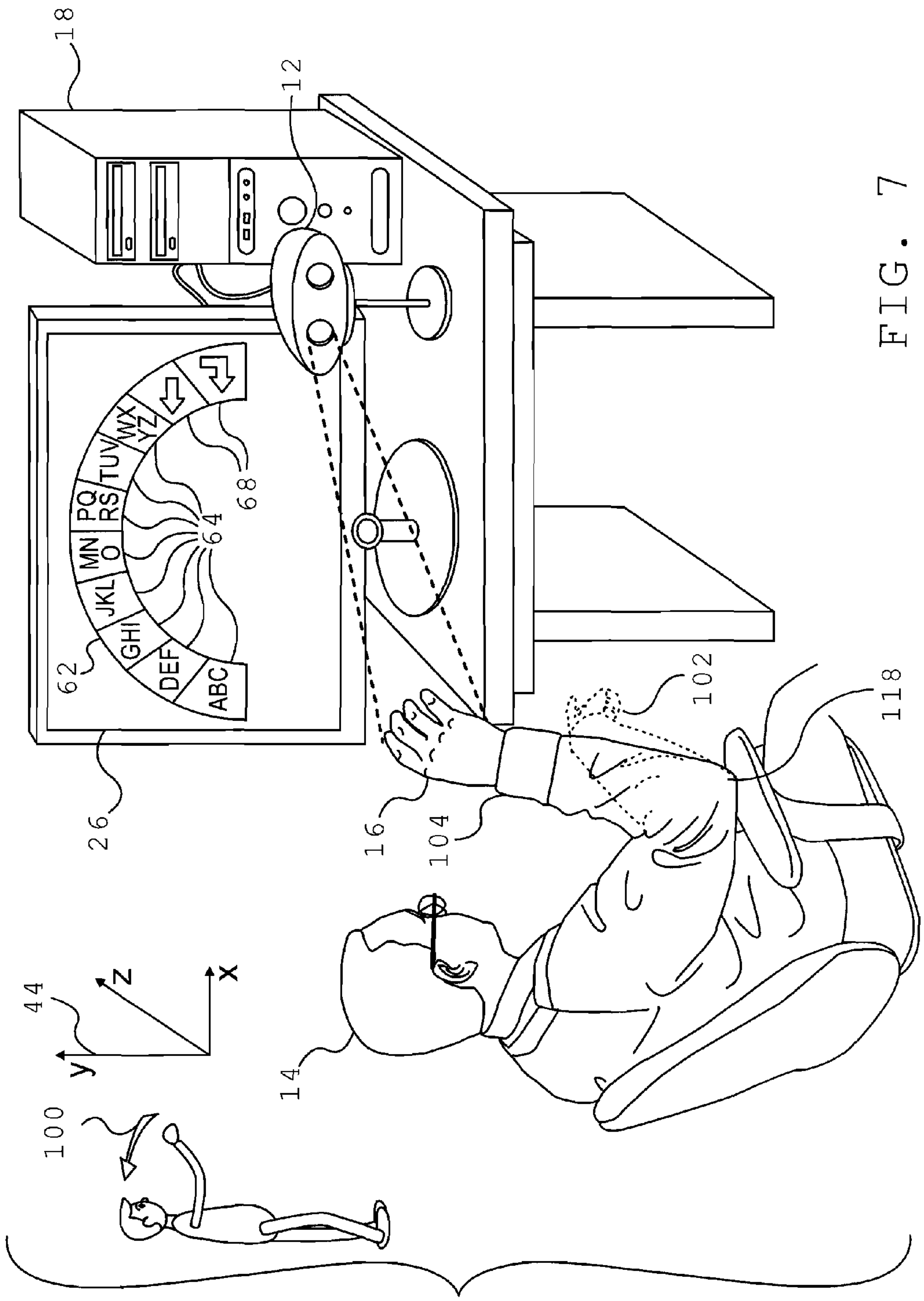

18
12
26
62
76
84
86
96
98
82
16
118
130
80
14
44
88
78
120
ABC
DEF
GHI
JKL
MN O
PQ RS
TUV
WX YZ
M
N
O
6
SAME
SAND
x
y
z

FIG. 5



18
12
132
LANGUAGE MODEL
ABC
DEF
GHI
JKL
MN O
PQ RS
TUV
WX YZ
M
N
O
6
INVENTION
128
86
76
126
62
26
118
16
82
130
80
14
44
z
x
y
88
88
78
120

FIG. 6



18
12
26
62
64
68
ABC
DEF
GHI
JKL
MN O
PQ RS
TUV
WX YZ
102
118
16
104
14
44
y
z
x
100

FIG. 7

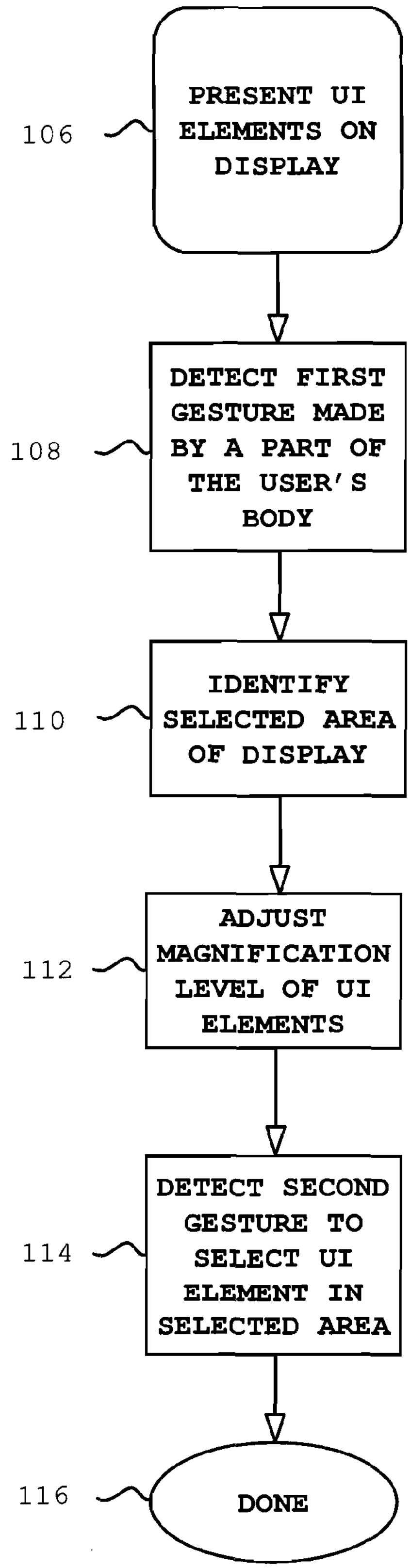

106
PRESENT UI ELEMENTS ON DISPLAY
108
DETECT FIRST GESTURE MADE BY A PART OF THE USER'S BODY
110
IDENTIFY SELECTED AREA OF DISPLAY
112
ADJUST MAGNIFICATION LEVEL OF UI ELEMENTS
114
DETECT SECOND GESTURE TO SELECT UI ELEMENT IN SELECTED AREA
116
DONE

FIG. 8

ENHANCED 3D INTERFACING FOR REMOTE DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Application claims the benefit of U.S. Provisional Application No. 61/159,808 filed Mar. 13, 2009, which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates generally to user interfaces for computerized systems and specifically to user interfaces with three-dimensional characteristics.

[0004] 2. Description of the Related Art

[0005] Many different types of user interface devices and methods are currently available. Common tactile interface devices include the computer keyboard, mouse and joystick. Touch screens detect the presence and location of a touch by a finger or other object within the display area. Infrared remote controls are widely used, and "wearable" hardware devices have been developed, as well, for purposes of remote control.

[0006] Computer interfaces based on three-dimensional sensing of parts of the user's body have also been proposed. For example, PCT International Publication WO 03/071410, whose disclosure is incorporated herein by reference, describes a gesture recognition system using depth-perceptive sensors. A three-dimensional sensor provides position information, which is used to identify gestures created by a body part of interest.

[0007] The gestures are recognized based on the shape of the body part and its position and orientation over an interval. The gesture is classified for determining an input into a related electronic device.

[0008] As another example, U.S. Pat. No. 7,348,963, whose disclosure is incorporated herein by reference, describes an interactive video display system, in which a display screen displays a visual image, and a camera captures three-dimensional information regarding an object in an interactive area located in front of the display screen. A computer system directs the display screen to change the visual image in response to the object.

SUMMARY

[0009] An embodiment of the invention provides a method for operating a computerized system, which is carried out by presenting user interface elements on a display screen of the computerized system and detecting a first gesture made in a three-dimensional space by a distal portion of an upper extremity of a user while a segment of the distal portion thereof rests on a surface. In response to the first gesture, an area of the display screen selected by the user is identified, and a corresponding user interface element is displayed. After displaying the corresponding user interface element, a second gesture made by the distal portion while the segment continues to rest on the surface is detected so as to select one of the user interface elements that appears in the selected area.

[0010] In another embodiment, the method further includes mapping an operation to the corresponding user interface element, wherein the second gesture causes the operation to be performed.

[0011] In yet another embodiment, the method further includes mapping a three-dimensional location of the distal portion of the upper extremity to two parameters of a two-dimensional parametric surface, which is a section of a sphere that corresponds to possible locations of the distal portion of the upper extremity while the segment of the distal portion rests on a surface, and mapping the two parameters to corresponding parameters in a planar two-dimensional coordinate system of the display screen where the user interface elements are located

[0012] According to an aspect of the method, the first gesture describes a first arc-like movement forming at least a portion of a horizontal circular arc mapped to the section of the sphere as a pointing command, and the second gesture includes a second arc-like movement mapped to the section of the sphere as a selection command.

[0013] According to an additional aspect of the method, the pointing command includes pointing to a letter on the display screen and the selection command includes inputting the letter to the system.

[0014] According to one aspect of the method, a threshold is defined, and includes displaying a subset of letters when a magnitude of the arc-like movement is less than the threshold and inputting the letter when the magnitude of the arc-like movement is greater than the threshold.

[0015] According to an aspect of the method, the subset of letters is shifted on the display screen using a language model to determine a probability of a preferred letter, and wherein inputting the letter is performed in a single continuous motion with high probability.

[0016] According to one aspect of the method, the segment of the distal portion may include an elbow, a wrist, or a forearm.

[0017] An embodiment of the invention provides a method for operating a computerized system, which is carried out by presenting user interface elements on a display screen of the computerized system and detecting a first gesture made in a three-dimensional space by a part of a body of a user. An area of the display screen selected by the user is identified responsively to the first gesture, and a magnification level of one or more of the user elements appearing in the selected area on the display screen is increased. After increasing the magnification level, a second gesture made by the part of the body of the user is detected so as to select one of the user elements that appear in the selected area.

[0018] According to an aspect of the method, a third gesture made by the part of the body is detected, and the magnification level is decreased in response to the third gesture.

[0019] According to an additional aspect of the method, the first and the third gesture include circular motions of a hand of the user in opposite, respective directions.

[0020] According to one aspect of the method, detecting the second gesture includes actuating a shortcut on the display in response to the second gesture.

[0021] According to yet another aspect of the method, selecting the magnified alphanumeric symbol includes adding the selected magnified alphanumeric symbol to a word spelled on the display screen, wherein the method includes detecting a third gesture made by the part of the body, opposite to the second gesture, and removing one or more symbols from the word in response to the third gesture.

[0022] According to one aspect of the method, the first gesture includes a three-dimensional movement by the part of the body of the user.

[0023] According to still another aspect of the method, presenting user interface elements includes displaying a plurality of symbols arranged in at least one arc.

[0024] According to a further aspect of the method, displaying the plurality of symbols includes presenting a set of symbols in a first arc, and increasing the magnification level includes presenting a magnified subset of the set of symbols in a second arc adjacent to the first arc.

[0025] According to an aspect of the method, detecting the first gesture includes detecting an arcuate movement of a hand of the user, and associating the arcuate movement with the plurality of symbols in the at least one arc.

[0026] According to an additional aspect of the method, presenting user interface elements includes presenting a sequence of textual characters, and increasing the magnification level includes displaying further characters for addition to the sequence using a language model to select the further characters.

[0027] According to another aspect of the method, detecting the first gesture includes scrolling forward or backward along the sequence responsively to first movements of a hand of the user in first and second directions along the sequence, and detecting the second gesture includes selecting the further characters for addition to the sequence in response to second movements of the hand in at least a third direction perpendicular to the first and second directions.

[0028] An embodiment of the invention provides a computer software product for operating a computer system, including a sensing device, which is configured to detect at least a part of a body of a user, a display screen, which is configured to present user interface elements, and a processor, which is coupled to the sensing device so as to detect a first gesture made in a three-dimensional space by the part of the body. The processor is additionally configured to identify an area of the display screen selected by the user in response to the first gesture, and to increase a magnification level of one or more of the user interface elements appearing in the selected area on the display screen, and after increasing the magnification level, to detect a second gesture made by the part of the body so as to select one of the user interface elements that appears in the selected area.

[0029] An embodiment of the invention provides a computer software product for operating a computerized system, including a computer storage medium in which computer program instructions are stored, which instructions, when executed by a computer, cause the computer to present user interface elements on a display screen of the computerized system, to detect a first gesture made in a three-dimensional space by a part of a body of a user, to identify an area of the display screen selected by the user in response to the first gesture, and to increase a magnification level of one or more of the user interface elements appearing in the selected area on the display screen. After increasing the magnification level, the instructions cause the computer to detect a second gesture made by the part of the body of the user so as to select one of the user interface elements that appears in the selected area.

[0030] There is also provided, in accordance with an embodiment of the present invention, a method for operating a computerized system, including the steps of presenting user interface elements on a display screen of the computerized system and detecting a gesture made in a three-dimensional space by a part of a body of a user. While the user performs the gesture, one or more of the user interface elements on the display screen are continuously modified responsively to a direction of the gesture.

[0031] In some embodiments, continuously modifying the one or more of the user interface elements includes increasing or decreasing a magnification level of at least one of the user interface elements, typically by zooming in on a user interface element toward which the gesture is directed.

[0032] In other embodiments, presenting the user interface elements includes presenting a sequence of textual characters, which is continuously modifying by adding characters to the sequence while scrolling over the sequence responsively to the gesture. Adding the characters typically includes presenting choices of further characters to add to the sequence, using a language model to determine the choices, and selecting at least one of the choices responsively to the gesture. Presenting the choices may include determining, based on the language model, a respective likelihood of correctness of each of the choices, and displaying the choices so that an effort required by the user to select a given choice is a decreasing function of the likelihood. Additionally or alternatively, continuously modifying the one or more of the user interface elements may include scrolling forward or backward along the sequence responsively to first movements of a hand of the user in first and second directions along the sequence, and selecting further characters for addition to the sequence responsively to second movements of the hand in at least a third direction perpendicular to the first and second directions.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0033] For a better understanding of the present invention, reference is made to the detailed description of the invention, by way of example, which is to be read in conjunction with the following drawings, wherein like elements are given like reference numerals, and wherein:

[0034] FIG. **1** is a schematic, pictorial illustration of a system for remote gesture-mediated information input, in accordance with an embodiment of the present invention;

[0035] FIG. **2** is a view of portions of a system operating under remote control of a user in accordance with an embodiment of the present invention;

[0036] FIG. **3** is a view of portions of a system operating under remote control of a user in accordance with an embodiment of the present invention;

[0037] FIG. **4** is a schematic, pictorial illustration of a system for remote information input, in accordance with an embodiment of the present invention;

[0038] FIG. **5** is a view of portions of a system operating under remote control of a user in accordance with an embodiment of the present invention;

[0039] FIG. **6** is a view of portions of a system operating under remote control of a user in accordance with an embodiment of the present invention;

[0040] FIG. **7** is a view of portions of a system operating under remote control of a user in accordance with an embodiment of the present invention; and

[0041] FIG. **8** is a flow chart of a method for remotely interfacing with a computer system, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

[0042] In the following description, numerous specific details are set forth in order to provide a thorough understand-

distance between hand **16** and sensing device **12** vary as the specialized gesture is performed.

[0056] The inclination of the plane of the circle may be significant, according to specifications programmed in remote device **18**. Thus, a circle described vertically in the yz plane may be interpreted by remote device **18** differently from a circle in the xy plane or a horizontally executed circular gesture, e.g., as a pointing command. Substantially circular gestures described in various oblique planes may be given even more specialized interpretations. The clockwise circular gesture is recognized by sensing device **12**, and remote device **18** interprets the gesture as a zoom command. The clockwise circular gesture thus commands remote device **18** to smoothly increase the zoom (or magnification) level of remote information input interface **26** on display screen **20** using pointer **24** as a reference point for the zooming. That is to say, remote device **18** identifies an area of display screen **20** around pointer **24** as having been selected by user **14** for the zoom command. By performing the gesture, hand **16** may move from an initial position **48** to a final position **50**. Scale indicator **42** shows symbols **28**, **30**, **32** having a final height of 1.5 units on remote information input interface **26**.

[0057] In a similar fashion, counter-clockwise circular gestures may be interpreted by remote device **18** as a command to decrease the zoom level. In the example of FIG. **2**, zoom level indicator **40** shows that, in comparison with FIG. **1**, the clockwise circular gesture has increased the zoom level from the initial value of 100% immediately prior to the gesture to a final value of 150%. A corresponding increase in the size of symbols **28**, **30**, **32** is shown on display screen **20** as a result of the zoom command. That is to say, one or more of the user interface elements appearing in the selected area on display screen **20** are magnified.

[0058] Reference is now made to FIG. **3**, which is a view of portions of system **10** (FIG. **1**) operating under control of user **14** in accordance with an embodiment of the present invention. In the example of FIG. **3**, user **14** performs a leftward, substantially horizontal gesture using hand **16** as indicated by an arrow **52** on reference coordinate system **44**. The leftward gesture commands remote device **18** to move pointer **24** to the left on remote information input interface **26**. In the example of FIG. **3**, the leftward movement of pointer **24** (FIG. **2**) executes from a first position (indicated by a cursor **54** (shown in broken outline) to a second position, indicated by a cursor **56** (shown in solid outline) as a result of the command. By performing the gesture, hand **16** may move from an initial position **58** to a final position **60**.

[0059] A rightward gesture may be interpreted as a command to move pointer **24** to the right from the perspective of user **14**, while gestures performed upward and downward may similarly be interpreted by remote device **18** as commands to move pointer **24** upward and downward, respectively.

[0060] Suitable calibration of sensing device **12** and remote device **18** assures a desired sensitivity, i.e., a correspondence between a spatiotemporal displacement of the control entity and the effect on elements shown on remote information input interface **26**. It is recommended to compensate for the viewing distance and viewing angle of user **14** using known methods. The compensation techniques described in U.S. Patent Application Publication No. 2009/0009593, entitled "Three-dimensional Projection Display" may be applied for this purpose.

Remote Information Input.

[0061] Reference is now made to FIG. **4**, which is a schematic, pictorial illustration of system **10** (FIG. **1**) for remote information input, in accordance with an embodiment of the present invention. A first symbol arc **62** is shown within remote information input interface **26** on display screen **20**, in an embodiment that implements a T9® text input layout. T9 text input represents "text on 9 keys," a method for streamlining input of text on numeric keypads, typically for mobile devices, available at the T9 web site (t9.com). Many suitable variations will occur to those skilled in the art for streamlining information input by providing an improved symbol layout on remote information input interface **26**. First symbol arc **62** comprises an arcuate, nearly semi-circular display of groups of alphanumeric symbol buttons **64** to simulate relaxed movement of hand **16** while user **14** sits comfortably on a chair **66**. First symbol arc **62** may comprise additional symbol buttons **68** to support input of special symbols, e.g., space, backspace, or carriage return.

[0062] As user **14** moves a control entity, such as hand **16** usually, but not necessarily while seated, and typically in a horizontal arc-like movement as indicated by an approximately semicircular arc **70** adjacent to reference coordinate system **44**. Sensing device **12** detects the movement and remote device **18** interprets the movement by highlighting each of additional symbol buttons **68** and alphanumeric symbol buttons **64** sequentially as hand **16** moves through semicircular arc **70** from a first position **72** to a second position **74**. Provision of an arcuate display enables hand **16** to move while an elbow **118** of the same upper extremity as hand **16** rests on chair **66**. A portion of a sphere **122** is shaded within a spherical coordinate system **124** using an axis based upon elbow **118** to indicate an approximate range of motion of hand **16** when elbow **118** rests on a surface. In the arrangement of FIG. **4**, a three-dimensional space is mapped to spherical coordinate system **124**, and is also mapped to a two-dimensional coordinate system. The latter can be conveniently appreciated as a plane in reference coordinate system **44**.

[0063] It is recommended that the movement of semi-circular arc **70** be parallel to the xy plane in reference coordinate system **44**. However, the movement may also be made so that the angle between a plane of the motion of semi-circular arc **70** and the xy plane is above 0 degrees, typically up to 45 degrees. In the example of FIG. **4**, an emphasized symbol button **76** is shown on display screen **20** to indicate that performance of a second gesture, described hereinbelow as a selection gesture, will result in selection of the symbols displayed therein. That is to say, remote device **18** identifies emphasized symbol button **76** as the area of display screen **20** that is currently selected by user **14**. Corresponding selection gestures performed by hand **16** at other points along semicircular arc **70** would select corresponding symbols of first symbol arc **62**. The first gesture and the second gesture may be recognized by remote device **18** according to time-varying coordinates on the two-dimensional coordinate system and the spherical coordinate system, respectively.

[0064] Reference is now additionally made to FIG. **5**, which is a view of portions of system **10** (FIG. **1**) operating under remote control of user **14** in accordance with an embodiment of the present invention. The selection gesture is typically performed in two stages, as described hereinabove. User **14** may perform a first stage of the selection gesture by moving hand **16** downward in a vertical arc **78** generally directed toward display screen **20**. Remote device **18** uses the threshold, described hereinabove, to determine completion of each selection stage. The selection gesture may pivot about the elbow or shoulder, whichever is applicable. Of course, when pivoting about the shoulder the advantages of resting a portion of the arm on a surface are lost. By performing the selection gesture, hand **16** may move from an initial position **80** to an intermediate position **130** while performing the first stage, and then to a final position **82** while performing a second stage. Sensing device **12** detects the movement, and remote device **18** interprets the selection gesture as a command to display a second symbol arc **84** directly below first symbol arc **62**, comprising individually delineated symbol buttons **86**, which are grouped together in highlighted symbol button **76**. In the present example, user **14** next moves hand **16** in another arc-like movement, which is detected by sensing device **12**. Remote device **18** interprets the movement by highlighting each of individually delineated symbol buttons **86** as described hereinabove. User **14** may then perform the second stage of the selection gesture by moving hand **16** further downward to remotely input one of individually delineated symbol buttons **86**. The second stage of the selection gesture is indicated by a further downwardly directed vertical arc **120**. Hand **16** may move from intermediate position **130** to final position **82** while performing the second stage. FIG. **4** and FIG. **5** may be viewed as a sequence of actions, whereby in FIG. **4** user **14** selects an area of display screen **20**, e.g., one of additional symbol buttons **68**, and in FIG. **5** selects one of the user interface elements, e.g., highlighted symbol button **76**, in order to display second symbol arc **84** and to input one of individually delineated symbol buttons **86**.

[0065] Use of arcuate displays like first symbol arc **62** for remotely inputting information may provide particularly enhanced ergonomic value. The motions involved in their use for remote information input are not fatiguing, e.g., in comparison with a standard "QWERTY" keyboard layout. Virtual keyboard layouts such as the QWERTY keyboard layout may not as conveniently permit remote information input with a resting or fixed elbow position.

[0066] As noted above, the selection gesture is made by moving hand **16** downwards. That is, it involves a forward displacement of the hand in the z-axis with respect to sensing device **12**. There are two variants of the motion. In one case user **14** may move hand **16** towards the center (origin) of spherical coordinate system **124** (FIG. **4**), such that the motion involves both a component in the xy plane and a component in yz plane. In the other case, user **14** may move hand **16** directly downwards, such that only a component in the yz plane exists. In both cases, remote device **18** is able to distinguish the selection gesture from other linear or curved movements in the xy plane alone, by calculating the displacement of the hand along the z-axis. When the magnitude of the motion component in the z-axis is greater than another predefined threshold, remote device **18** interprets the movement as a selection gesture and ignores the motion component in the xy plane. In both cases, remote device **18** may provide enhanced ergonomic value when recognizing these selection gestures, as they allow user **14** to use a natural selection motion, as indicated by the location of hand **16** on the xy axis.

[0067] If user **14** causes pointer **24** (FIG. **1**) to hover over second symbol arc **84**, remote device **18** may cause a corresponding user interface element, e.g., shortcuts **96**, **98** to be shown on remote information input interface **26**, offering suggestions for completing a word. In the example of FIG. **5**, letters "S" and "A" have been previously input, and the autocomplete feature of remote device **18** provides shortcuts **96** and **98** for selection. Previously input information may be emphasized on shortcuts **96** and **98**.

[0068] Reference is now made to FIG. **6**, which is a view of portions of system **10** (FIG. **1**) operating under remote control of user **14** in accordance with an embodiment of the present invention. A domain-specific language model **132** may be used to determine the probability of a symbol or next letter being preferred by user **14**. In the example of FIG. **6**, language model **132** is shown as a computer program module operated by device **18**. In the example of FIG. **6**, user **14** has previously input the letters "INVENTIO". User **14** next moves hand **16** over emphasized symbol button **76**. Device **18** uses the domain-specific language model and determines that the probability of a letter "N" is significantly higher than another letter shown in emphasized symbol button **76**, as shown in a shortcut **126**. In some embodiments device **18** uses the domain-specific language model to shift an adjusted second symbol arc **128** to place the letter with a highest probability beneath emphasized symbol button **76**. Both stages of the selection gesture may be performed by user **14** in a continuous motion to select a preferred letter, thus minimizing required movement by hand **16**. In the context of the present application and claims, the term "language model" herein refers to any suitable statistical model for assigning a probability to a sequence of letters or words by means of a probability distribution.

[0069] Reference is now made to FIG. **7**, which is a view of portions of system **10** (FIG. **1**) operating under remote control of user **14** in accordance with an embodiment of the present invention. User **14** may choose to perform a deselection gesture after inputting information remotely, or to deselect second symbol arc **84**. The deselection gesture may comprise raising hand **16** as indicated by an upwardly directed vertical arc **100** which is a reversal of vertical arc **78** (FIG. **5**). Sensing device **12** detects the deselection gesture, and remote device **18** interprets the movement as a command to cancel the selection of second symbol arc **84** (FIG. **5**) which has responsively been removed from remote information input interface **26** in FIG. **7**. Thereafter, any movement by hand **16** after the deselection gesture has been performed is interpreted by remote device **18** as a command to resume highlighting alphanumeric symbol buttons **64** on first symbol arc **62** for selection. In performing the deselection gesture, hand **16** moves from an initial position **102** to a final position **104**.

[0070] In alternative embodiments, after user **14** performs the above-described selection gesture, remote device **18** automatically removes second symbol arc **84** without requiring the deselection gesture to be performed. Thus, remote information input requires less movement by user **14** than in the previous embodiment. Device **18** typically requires user **14** to return hand **16** to final position **104** before recognizing a new selection.

[0071] Embodiments of the present invention that utilize the T9 text input layout as symbol arcs on remote information input interface **26** may provide an advantage whereby input is provided remotely without the need to move the control entity in three dimensions. As described hereinabove, moving hand **16** in an arcuate motion along semi-circular arc **70** (FIG. **4**) is interpreted by remote device **18** as movement within two dimensions, e.g., leftward, rightward, upward and downward. By limiting semi-circular arc **70** to motions substantially parallel to the xz plane, 3-dimensional interpretation issues are avoided. A complex movement in three dimensions, e.g., to perform the point-and-click gesture, is not required, thus simplifying interpretation of the gesture and thereby facilitating remote information input.

Remote Interfacing Via Specialized Gestures.

[0072] Reference is now made to FIG. **8**, which is a flow chart of a method for remotely interfacing with a computer system, in accordance with an embodiment of the present invention. Shown by way of example, user **14** (FIG. **1**) may need to search a large volume of media without using a physical keyboard or other interface connected to a remote device. User **14** would thus need to perform efficient, streamlined search commands to interact remotely with a computer application running on the remote device. The process steps are described below in a particular linear sequence for clarity of presentation. However, it will be evident that some of them can be performed in parallel, asynchronously, or in different orders. The process can be performed, for example, by system **10**.

[0073] User interface elements comprising a remote information input interface to a computer application are presented to a user on a display screen in a display presentation step **106**. The computer application may be a media search and presentation system. It is assumed that the computer application has been loaded, and that a three-dimensional sensing device is in operation. The sensing device can be any three-dimensional sensor or camera, provided that it generates data for interpretation by the remote device.

[0074] The user performs a first gesture in a three-dimensional space using a control entity, e.g., a part of the user's body. A sensing device, such as sensing device **12** (FIG. **1**), detects the gesture made by the control entity, e.g., hand **16**, in a gesture detecting step **108**. The computer iteratively analyzes three-dimensional data provided by the sensing device, for example by constructing a three-dimensional map as described in commonly assigned co-pending U.S. application Ser. No. 12/683,452, which is herein incorporated by reference. In response to the detected gesture, an area of the display screen is identified by the computer in a selected area identification step **110**.

[0075] The first gesture is recognized by the computer as a command to increase the magnification level of user interface elements within the selected area on the display screen in a magnification level adjusting step **112**. Any gesture recognition algorithm may be employed to carry out magnification level adjusting step **112**, so long as the system can relate the user gesture to a recognized command and a location of interest on the remote information input interface.

[0076] A second gesture is recognized by the computer as a command to select one of the user interface elements within the selected area in a selection gesture detecting step **114**. The second gesture can be for any purpose, for example to perform another zoom command, to input a symbol, or to alter the remote information input interface in accordance with the gesture identified. For example, the clockwise circular gesture command described with respect to FIG. **2** might correspond to an instruction to increase the zoom level of the remote information input interface on the display screen, while a counter-clockwise circular gesture, in which the direction of the motion is reversed, could result in an instruction to decrease the zoom level. Many such combinations will occur to a developer of computer applications or other signal processing systems. An updated display screen results, and is shown in subsequent iterations of the method. In practice the process iterates so long as the remote device is active or some error occurs.

[0077] The method then terminates at a final step **116**.

Alternative Embodiments

[0078] In some embodiments, the circular gestures comprise requiring at least one complete circle to be performed by the control entity before the zoom level is changed. In alternative embodiments, multiple control entities are used to perform the specialized gesture. For example, the zoom command may be input using a second hand (not shown) to complement hand **16** (FIG. **1**). Once remote device **18** recognizes the second hand by analyzing input from sensing device **12**, movement of the second hand farther away from hand **16** may be interpreted as the zoom command to increase the zoom level, and vice versa. Using multiple control entities may provide an advantage wherein pointer **24** is not moved prior to the change in zoom level. Thus, the changes in magnification may be performed around pointer **24**.

[0079] In variants of the embodiments of FIG. **6** and FIG. **7**, language model **132** is used to assign a probability to each letter on remote information input interface **26**. Device **18** may order the letters accordingly, displaying the letters in a continuous ungrouped series of individual letters, rather than in groups, e.g., the group of three letters displayed in emphasized symbol button **76**. Device **18** may invite access to letters on the display having relatively high probabilities, e.g., by presenting them in closer proximity to the center of remote information input interface **26**. Alternatively, letters having relatively high and low probabilities may be grouped together and placed into secondary symbol arcs (not shown).

[0080] In yet another variant, the spatial distribution of letters in a symbol arc may reflect their respective probabilities. Thus, letters having relatively high and low probabilities of selection may be spaced apart and crowded together, respectively, in varying degrees.

[0081] Other commercial methods for remote information input may be used in conjunction with the specialized gestures and command interpretation by remote devices using three-dimensional sensing described hereinabove. For example, concepts described by the MessagEase™ text input system, available for sale at the MessagEase web site (exideas.com), may be enhanced accordingly.

[0082] In an alternative embodiment (not shown specifically in the figures), text input created by the user is shown as a linear stream of characters running across the screen, from left to right, for example. The user may perform a special gesture, recognized by the remote device, to mark a neutral reference position. Movement of the user's hand in a direction along the sequence, such as to the right of the reference position will then cause the display to advance to the right along the text stream whereas movement to the left will scroll backward through the text stream. The scroll speed presented by the remote device on the display may initially be slow when the user gestures sideways to the right or left and may gradually accelerate the longer the user's hand is in the advance or reverse position. As the text stream advances, the above-mentioned language model may be used to display alternative choices of additional characters and even words to append to the stream. These choices may be displayed above and/or below the existing line of characters, with the likeliest choices typically vertically closest to the line and possibly magnified. The user selects the desired choice by upward and downward motions of the hand, perpendicular to the direction of the text sequence. Thus, following the initial special gesture, the user can add text quickly and efficiently using simple right/left and up/down motions.

[0083] The user's right/left and up/down hand motions may be made in a generally planar space or, if the elbow is resting on a surface as in some of the embodiments described above, may be over a generally spherical surface. In either case, the right/left and up/down motions are not limited to a two-dimensional plane, but may be mapped to a two-dimensional coordinate system by the remote device. Within this latter coordinate system, one dimension of hand movement controls the speed of scrolling forward and back (wherein backward movement may delete characters previously appended to the stream), while the other dimension controls the selection of new characters.

[0084] This sort of embodiment may be used to present and add text input in a sort of continuous "flight mode": As the user scrolls to the right (forward) to add text to the stream being created, various potential continuations of the existing text are presented to the right of the existing text, above and/or below the text line. The potential continuations may be ordered or otherwise presented in such a way that the effort necessary to select a given continuation is a decreasing function of the likelihood that the given continuation is the correct one, based on the language model (higher likelihood yields lower effort). For example, likelier continuations may be presented with larger size and/or in closer proximity to the current cursor position.

[0085] It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and sub-combinations of the various features described hereinabove, as well as variations and modifications thereof that are not in the prior art, which would occur to persons skilled in the art upon reading the foregoing description.

1. A method for operating a computerized system, comprising the steps of:
presenting user interface elements on a display screen of the computerized system;
detecting a first gesture made in a three-dimensional space by a distal portion of an upper extremity of a user while a segment of the distal portion thereof rests on a surface;
responsively to the first gesture, identifying an area of the display screen selected by the user and displaying a corresponding user interface element; and
after displaying the corresponding user interface element, detecting a second gesture made by the distal portion while the segment continues to rest on the surface so as to select one of the user interface elements that appears in the selected area.

2. The method according to claim 1, further comprising mapping an operation to the corresponding user interface element, wherein the second gesture causes the operation to be performed.

3. The method according to claim 1, further comprising:
mapping a three-dimensional location of the distal portion of the upper extremity to two parameters of a two-dimensional parametric surface, which is a section of a sphere that corresponds to possible locations of the distal portion of the upper extremity while the segment of the distal portion rests on a surface; and
mapping the two parameters to corresponding parameters in a planar two-dimensional coordinate system of the display screen where the user interface elements are located.

4. The method according to claim 3, wherein the first gesture describes a first arc-like movement forming at least a portion of a horizontal circular arc mapped to the section of the sphere as a pointing command and wherein the second gesture comprises a second arc-like movement mapped to the section of the sphere as a selection command.

5. The method according to claim 4, wherein the pointing command comprises pointing to a letter on the display screen and wherein the selection command comprises inputting the letter to the system.

6. The method according to claim 5, wherein a threshold is defined, and comprising displaying a subset of letters when a magnitude of the arc-like movement is less than the threshold and inputting the letter when the magnitude of the arc-like movement is greater than the threshold.

7. The method according to claim 6, wherein the subset of letters is shifted on the display screen using a language model to determine a probability of a preferred letter, and wherein inputting the letter is performed in a continuous motion.

8. The method according to claim 1, wherein the segment of the distal portion comprises an elbow.

9. The method according to claim 1, wherein the segment of the distal portion comprises a wrist.

10. The method according to claim 1, wherein the segment of the distal portion comprises a forearm.

11. A method for operating a computerized system, comprising the steps of:
presenting user interface elements on a display screen of the computerized system;
detecting a first gesture made in a three-dimensional space by a part of a body of a user;
responsively to the first gesture, identifying an area of the display screen selected by the user and increasing a magnification level of one or more of the user interface elements appearing in the selected area on the display screen; and
after increasing the magnification level, detecting a second gesture made by the part of the body of the user so as to select one of the user interface elements that appears in the selected area.

12. The method according to claim 11, and comprising detecting a third gesture made by the part of the body, and decreasing the magnification level responsively to the third gesture.

13. The method according to claim 12, wherein the first gesture and the third gesture comprise circular motions of a hand of the user in opposite, respective directions.

14. The method according to claim 11, wherein detecting the second gesture comprises actuating a shortcut on the display screen in response to the second gesture.

15. The method according to claim 11, wherein detecting the second gesture comprises selecting a magnified alphanumeric symbol indicated by the second gesture on the display screen.

16. The method according to claim 15, wherein selecting the magnified alphanumeric symbol comprises adding the selected magnified alphanumeric symbol to a word spelled on the display screen, and wherein the method comprises detecting a third gesture made by the part of the body, opposite to

the second gesture, and removing one or more symbols from the word responsively to the third gesture.

17. The method according to claim **11**, wherein the first gesture comprises a three-dimensional movement by the part of the body of the user.

18. The method according to claim **17**, wherein presenting user interface elements comprises displaying a plurality of symbols arranged in at least one arc.

19. The method according to claim **18**, wherein displaying the plurality of symbols comprises presenting a set of symbols in a first arc, and wherein increasing the magnification level comprises presenting a magnified subset of the set of symbols in a second arc adjacent to the first arc.

20. The method according to claim **18**, wherein detecting the first gesture comprises detecting an arcuate movement of a hand of the user, and associating the arcuate movement with the plurality of symbols in the at least one arc.

21. The method according to claim **11**, wherein presenting user interface elements comprises presenting a sequence of textual characters, and wherein increasing the magnification level comprises displaying further characters for addition to the sequence using a language model to select the further characters.

22. The method according to claim **21**, wherein detecting the first gesture comprises scrolling forward or backward along the sequence responsively to first movements of a hand of the user in first and second directions along the sequence, and wherein detecting the second gesture comprises selecting the further characters for addition to the sequence responsively to second movements of the hand in at least a third direction perpendicular to the first and second directions.

23. Apparatus for operating a computerized system, the apparatus comprising:

a sensing device, which is configured to detect at least a part of a body of a user;

a display screen, which is configured to present user interface elements; and

a processor, which is coupled to the sensing device so as to detect a first gesture made in a three-dimensional space by the part of the body, and which is configured to identify, responsively to the first gesture, an area of the display screen selected by the user and to increase a magnification level of one or more of the user interface elements appearing in the selected area on the display screen, and after increasing the magnification level, to detect a second gesture made by the part of the body so as to select one of the user interface elements that appears in the selected area.

24. The apparatus according to claim **23**, wherein the sensing device is further configured to detect a control entity grasped by the part of the body and wherein at least the first gesture is performed using the control entity.

25. The apparatus according to claim **23**, and comprising detecting a third gesture made by the part of the body, and decreasing the magnification level responsively to the third gesture.

26. The apparatus according to claim **25**, wherein the first gesture and the third gesture comprise circular motions of a hand of the user in opposite, respective directions.

27. The apparatus according to claim **23**, wherein the processor is configured to detect the second gesture by actuating a shortcut on the display screen in response to the second gesture.

28. The apparatus according to claim **23**, wherein the processor is configured to detect the second gesture by selecting a magnified alphanumeric symbol indicated by the second gesture on the display screen.

29. The apparatus according to claim **28**, wherein selecting the magnified alphanumeric symbol comprises adding the selected symbol to a word spelled on the display screen, and wherein the method comprises configuring the processor to detect a third gesture made by the part of the body, opposite to the second gesture, and to remove one or more symbols from the word responsively to the third gesture.

30. The apparatus according to claim **23**, wherein the first gesture comprises a three-dimensional movement by the part of the body of the user.

31. The apparatus according to claim **30**, wherein the processor is configured to present the user interface elements by displaying a plurality of symbols arranged in at least one arc.

32. The apparatus according to claim **31**, wherein displaying the plurality of symbols comprises presenting a set of symbols in a first arc, and wherein the processor is configured to increase the magnification level by presenting a magnified subset of the set of symbols in a second arc adjacent to the first arc.

33. The apparatus according to claim **31**, wherein the processor is configured to detect the first gesture by detecting an arcuate movement of a hand of the user, and associating the arcuate movement with the plurality of symbols in the at least one arc.

34. A computer software product for operating a computerized system, comprising a computer storage medium in which computer program instructions are stored, which instructions, when executed by a computer, cause the computer to present user interface elements on a display screen of the computerized system, to detect a first gesture made in a three-dimensional space by a part of a body of a user, and responsively to the first gesture, to identify an area of the display screen selected by the user and to increase a magnification level of one or more of the user interface elements appearing in the selected area on the display screen, and after increasing the magnification level, to detect a second gesture made by the part of the body of the user so as to select one of the user interface elements that appears in the selected area.

35. The product according to claim **34**, wherein the instructions cause the computer to detect a third gesture made by the part of the body, and to decrease the magnification level responsively to the third gesture.

36. The product according to claim **35**, wherein the first gesture and the third gesture comprise circular motions of a hand of the user in opposite, respective directions.

37. The product according to claim **34**, wherein the instructions cause the computer to detect the second gesture by actuating a shortcut on the display screen in response to the second gesture.

38. The product according to claim **34**, wherein the instructions cause the computer to detect the second gesture by selecting a magnified alphanumeric symbol indicated by the second gesture on the display screen.

39. The product according to claim **38**, wherein selecting the magnified alphanumeric symbol comprises adding the selected symbol to a word spelled on the display screen, and wherein the instructions cause the computer to detect a third gesture made by the part of the body, opposite to the second gesture, and to remove one or more symbols from the word responsively to the third gesture.

40. The product according to claim **34**, wherein the first gesture comprises a three-dimensional movement by the part of the body of the user.

41. The product according to claim **40**, wherein the instructions cause the computer to present the user interface elements by displaying a plurality of symbols arranged in at least one arc.

42. The product according to claim **41**, wherein the instructions cause the computer to display the plurality of symbols by presenting a set of symbols in a first arc, and wherein the instructions cause the computer to increase the magnification level by presenting a magnified subset of the set of symbols in a second arc adjacent to the first arc.

43. The product according to claim **41**, wherein the instructions cause the computer to detect the first gesture by detecting an arcuate movement of a hand of the user, and associating the arcuate movement with the plurality of symbols in the at least one arc.

44. A method for operating a computerized system, comprising the steps of:

presenting user interface elements on a display screen of the computerized system;

detecting a gesture made in a three-dimensional space by a part of a body of a user; and

while the user performs the gesture, continuously modifying, responsively to a direction of the gesture, one or more of the user interface elements on the display screen.

45. The method according to claim **44**, wherein continuously modifying the one or more of the user interface elements comprises increasing or decreasing a magnification level of at least one of the user interface elements.

46. The method according to claim **45**, wherein increasing the magnification level comprises zooming in on a user interface element toward which the gesture is directed.

47. The method according to claim **44**, wherein presenting the user interface elements comprises presenting a sequence of textual characters, and wherein continuously modifying the one or more of the user interface elements comprises adding characters to the sequence while scrolling over the sequence responsively to the gesture.

48. The method according to claim **47**, wherein adding the characters comprises presenting choices of further characters to add to the sequence, using a language model to determine the choices, and selecting at least one of the choices responsively to the gesture.

49. The method according to claim **48**, wherein presenting the choices comprises determining, based on the language model, a respective likelihood of correctness of each of the choices, and displaying the choices so that an effort required by the user to select a given choice is a decreasing function of the likelihood.

50. The method according to claim **47**, wherein continuously modifying the one or more of the user interface elements comprises scrolling forward or backward along the sequence responsively to first movements of a hand of the user in first and second directions along the sequence, and selecting further characters for addition to the sequence responsively to second movements of the hand in at least a third direction perpendicular to the first and second directions.

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