



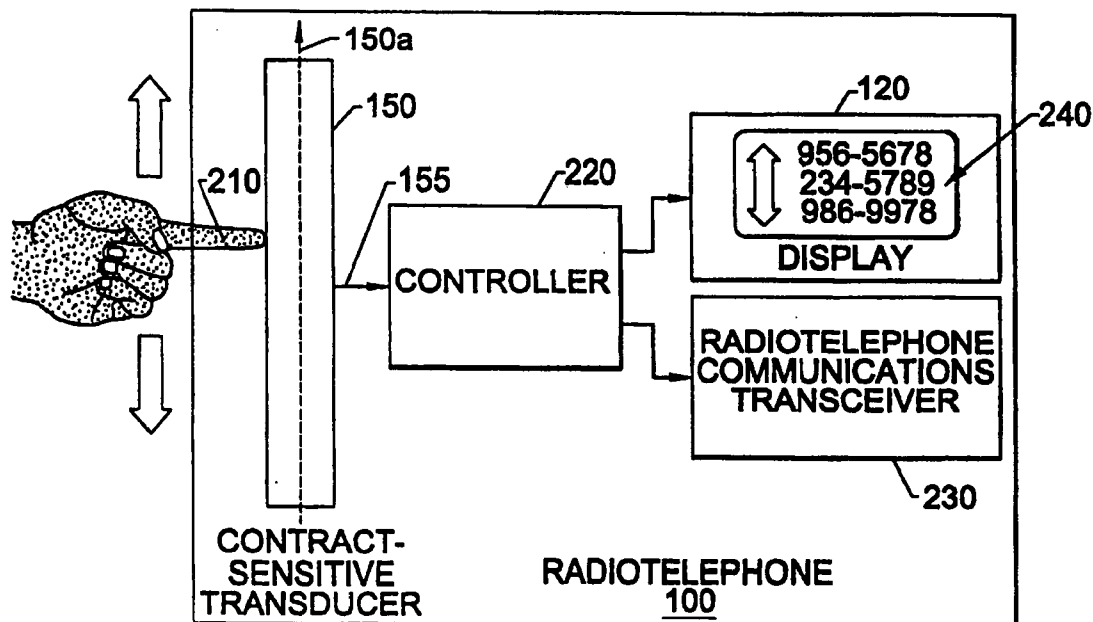
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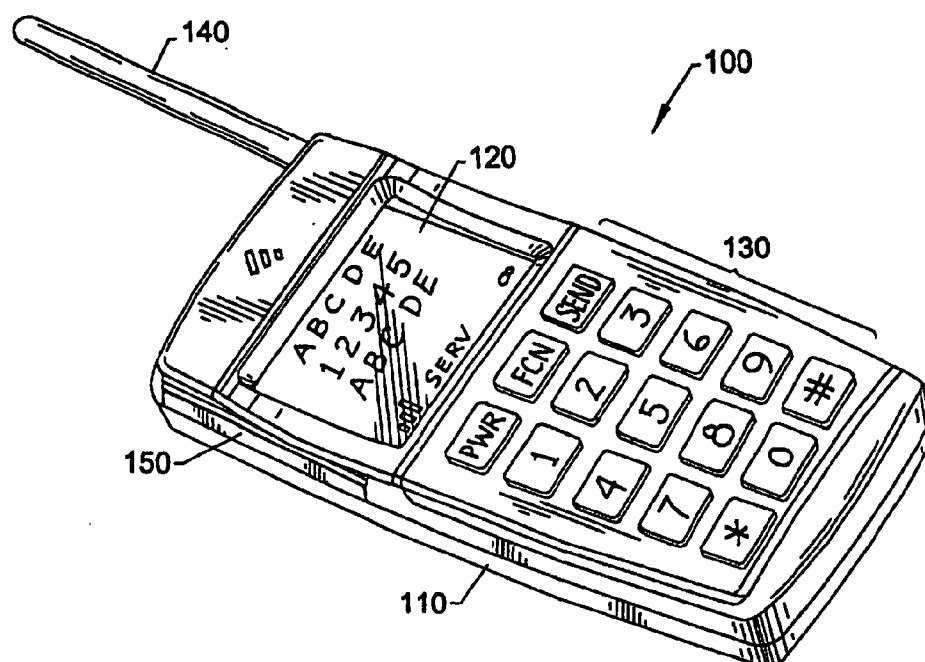
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**Hayes, Jr. et al.**(10) **Pub. No.: US 2014/0362018 A1**(43) **Pub. Date: Dec. 11, 2014**(54) **RADIOTELEPHONES HAVING  
CONTACT-SENSITIVE USER INTERFACES  
AND METHODS OF OPERATING SAME****Publication Classification**

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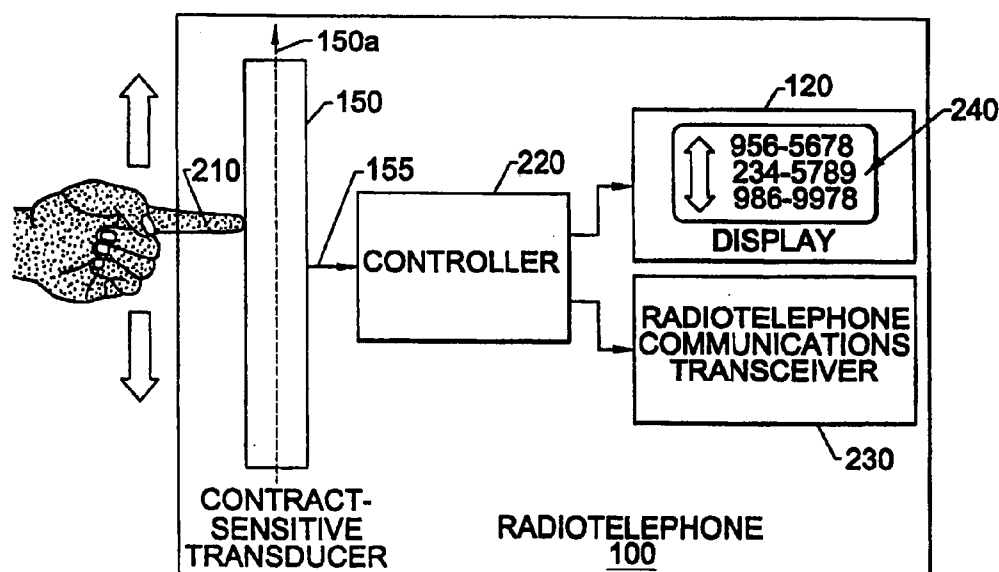
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Cary, NC (US)(73) Assignee: **ERICSSON INC.**, Plano, TX (US)(21) Appl. No.: **14/459,536**(22) Filed: **Aug. 14, 2014****Related U.S. Application Data**(63) Continuation of application No. 13/682,566, filed on  
Nov. 20, 2012, now Pat. No. 8,812,059, which is a  
continuation of application No. 11/078,916, filed on  
Mar. 11, 2005, now Pat. No. R,E43,931, which is an  
application for the reissue of Pat. No. 6,278,888, which  
is a continuation of application No. 09/001,173, filed  
on Dec. 30, 1997, now Pat. No. 6,131,047.(57) **ABSTRACT**

A device includes a housing having a front surface, a rear surface and first and second side surfaces; the rear surface configured engage a user's palm. The device includes a radiotelephone communications transceiver and a contact-sensitive display, supported by the housing. The contact sensitive display is configured to display an image at the front surface of the housing, and produce an output signal in response to moving contact of an object along a contact-sensitive surface of the contact-sensitive display. The device also includes a controller configured to control at least one of the display and the radiotelephone communications transceiver and to scroll displayed rows along an axis of the display based upon the output signal of the contact-sensitive transducer. The controller has a mode that is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to an input from a user.



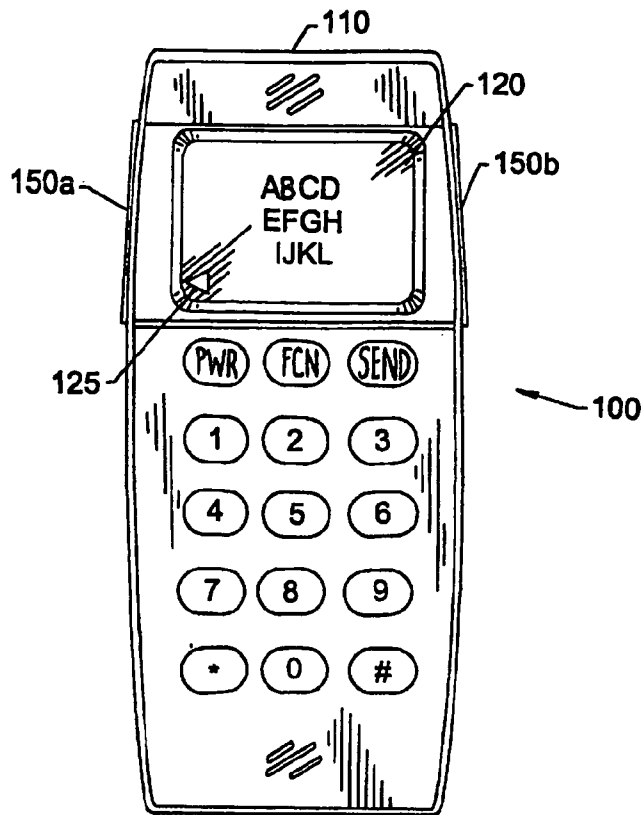


**FIG. 1.**

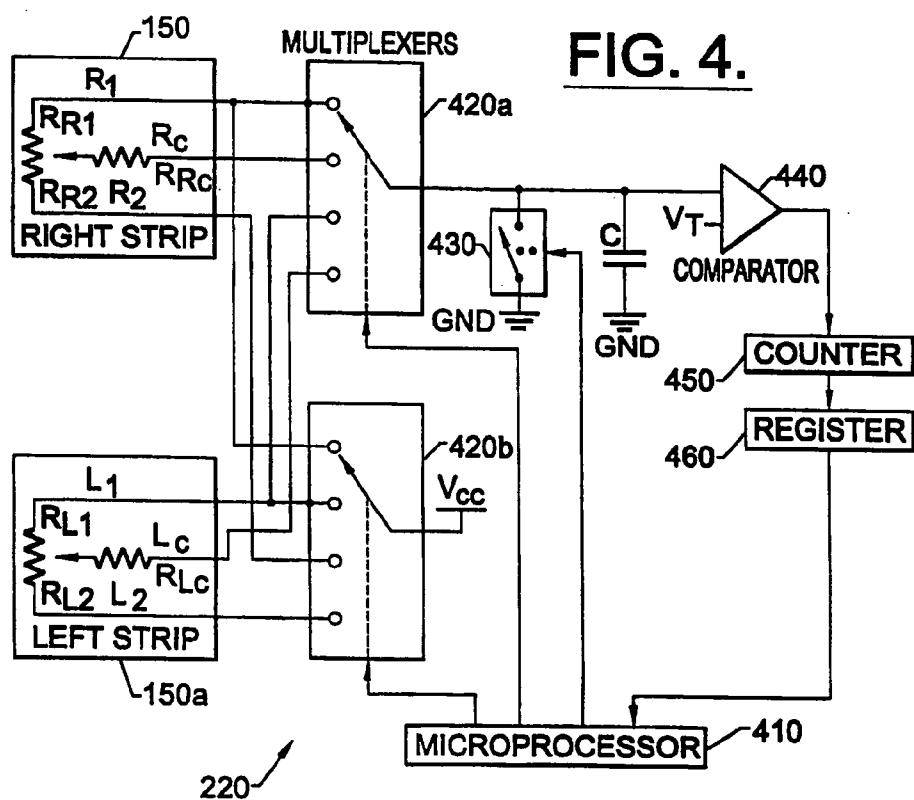


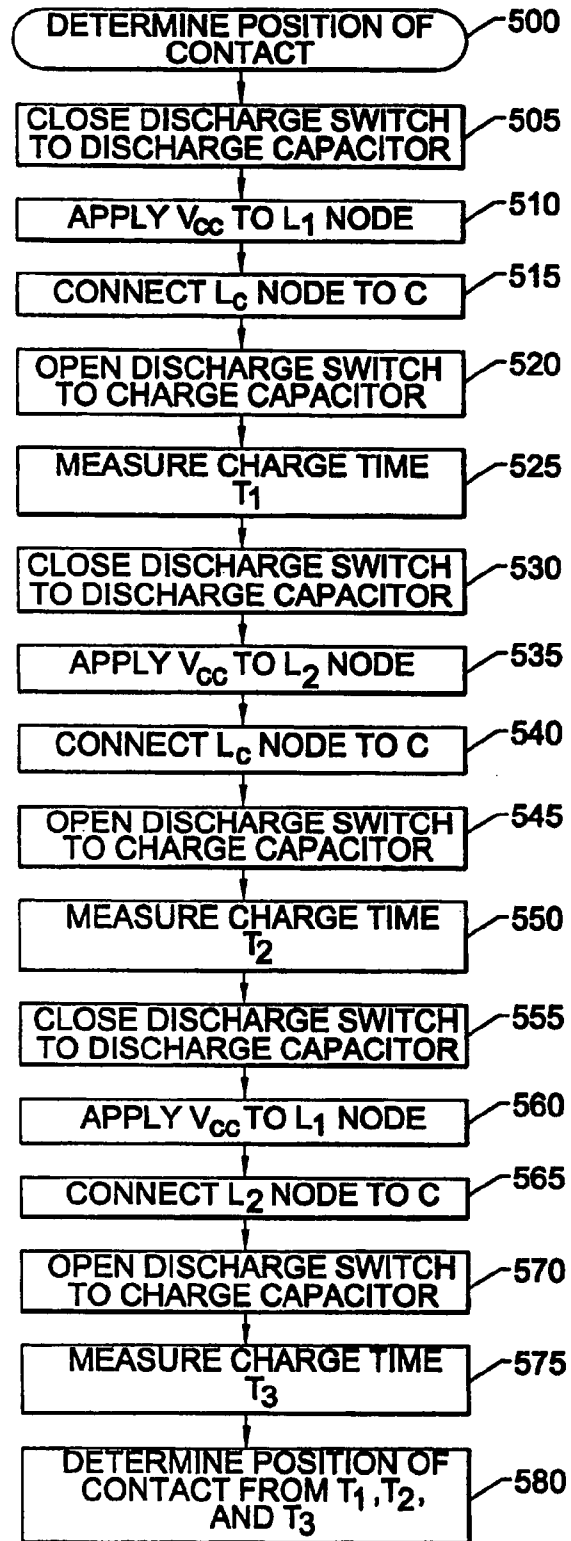
**FIG. 2.**

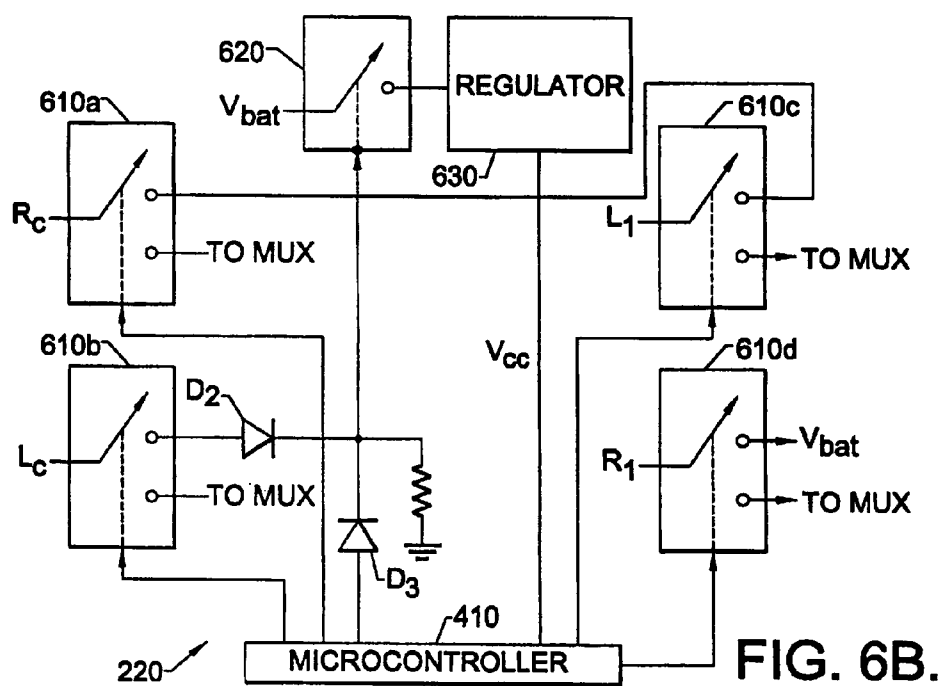
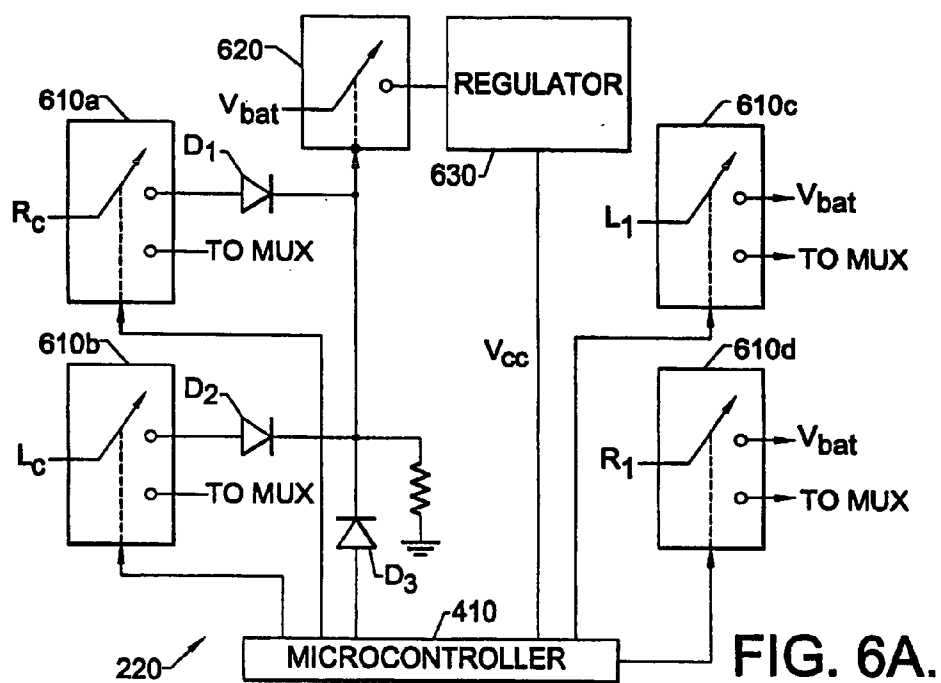
**FIG. 3.**

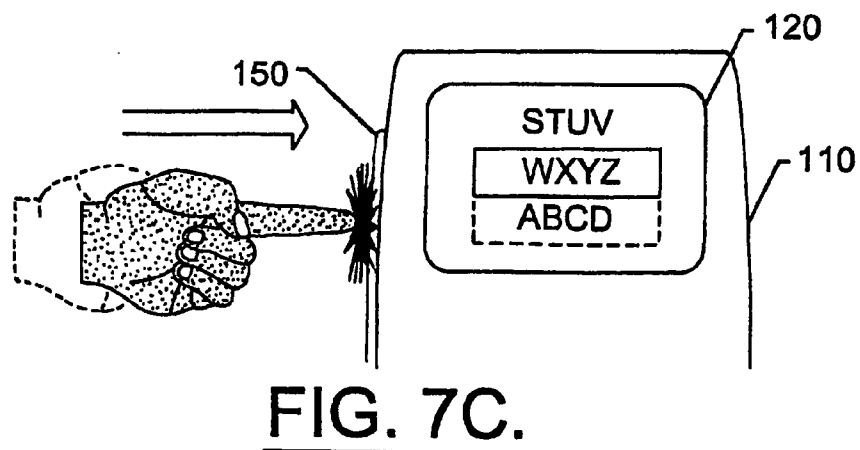
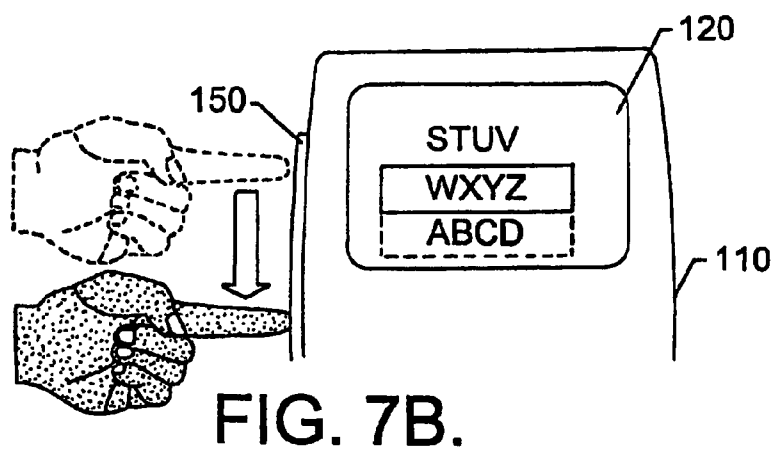
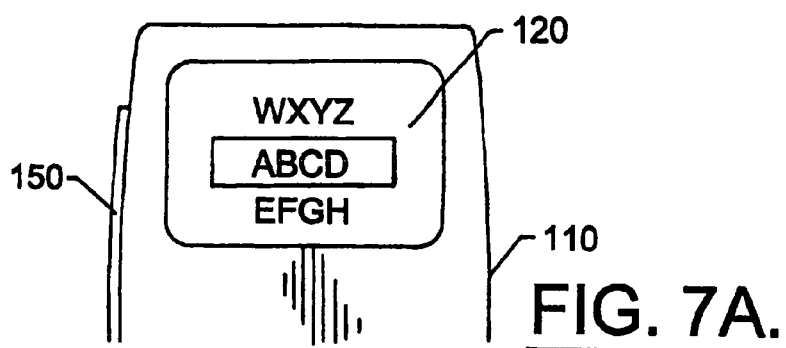


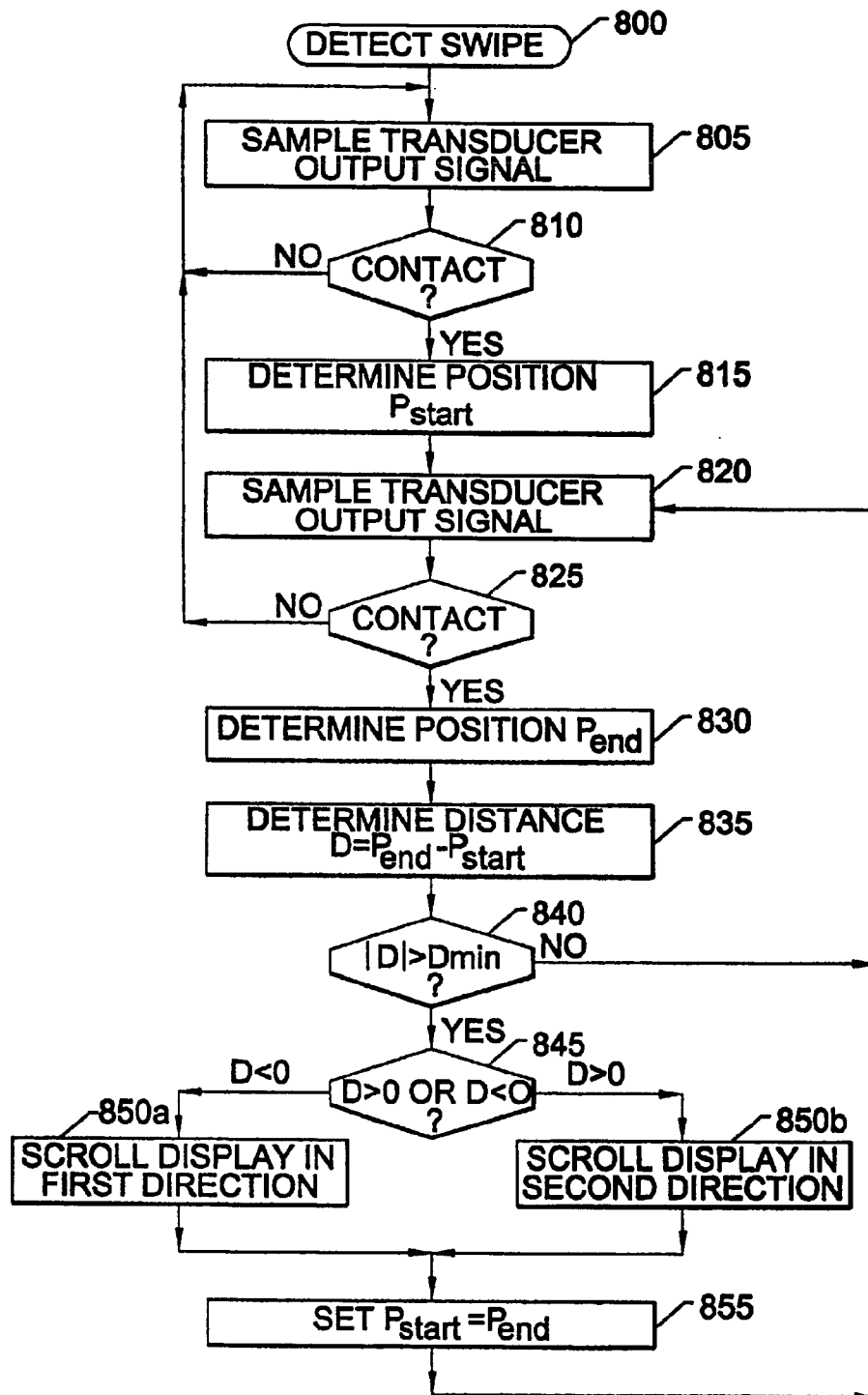
**FIG. 4.**



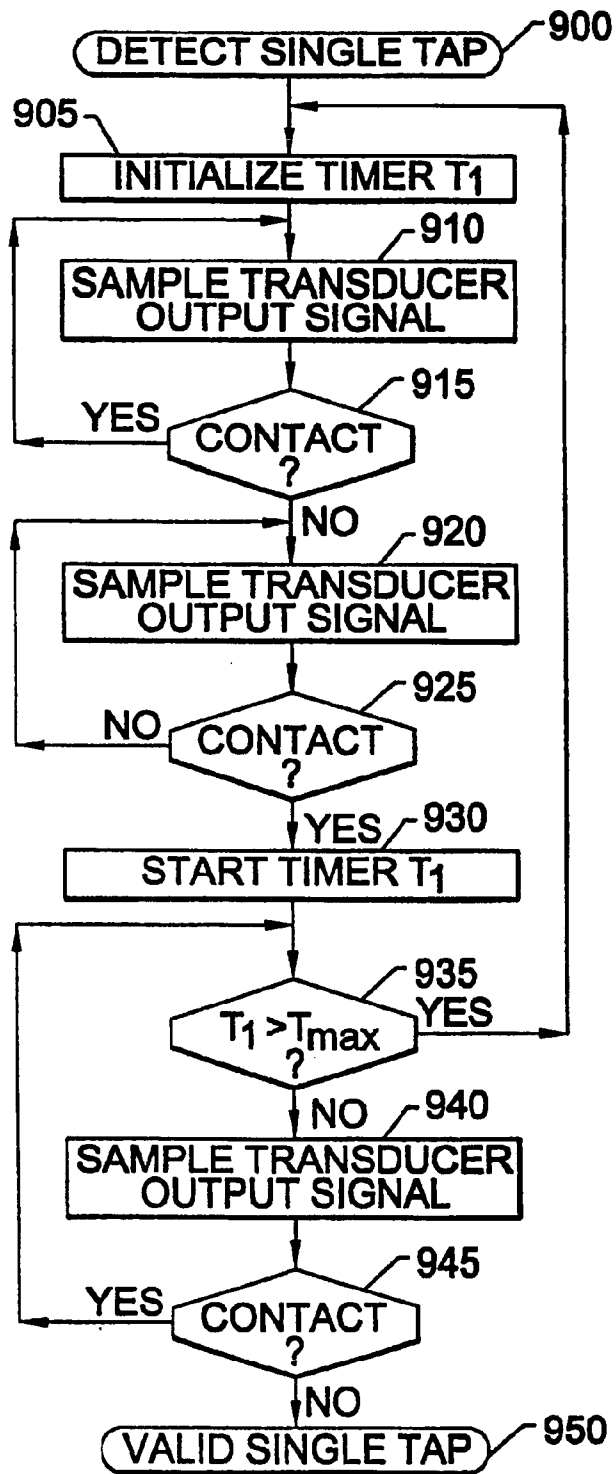
**FIG. 5.**







**FIG. 8.**

**FIG. 9.**



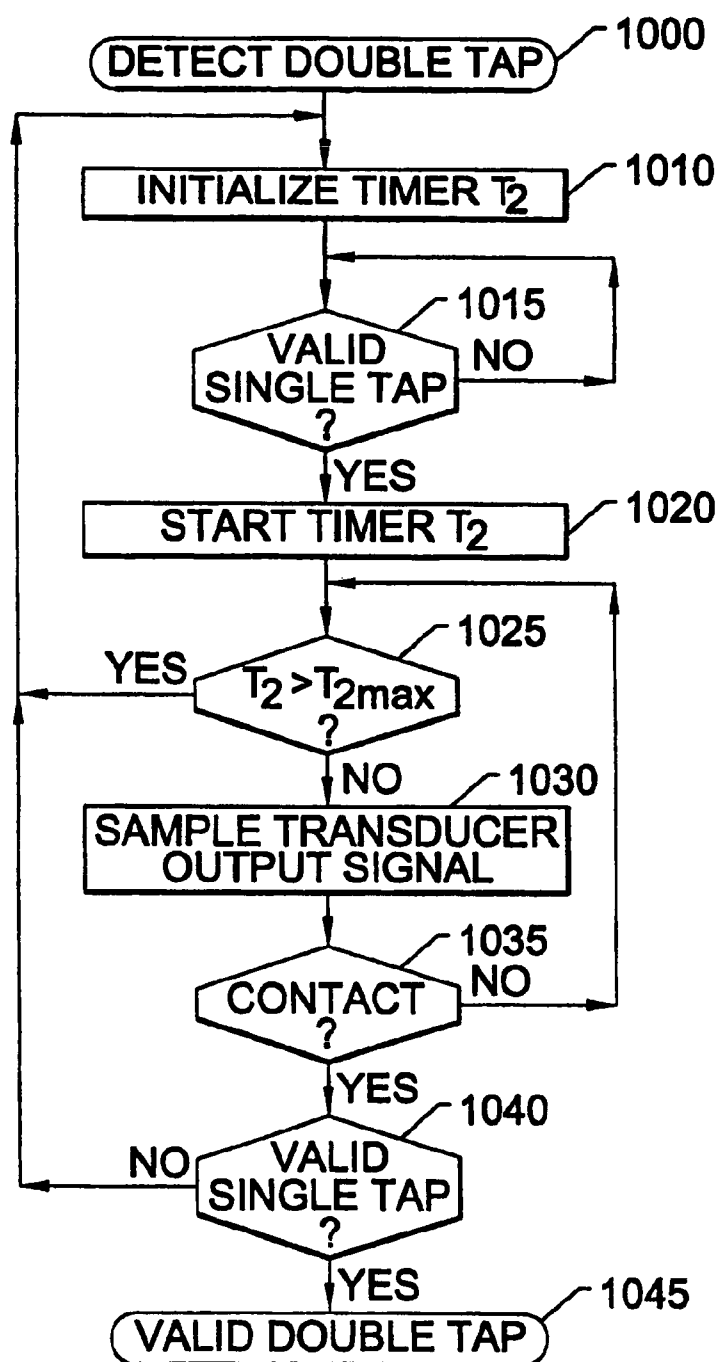


FIG. 10.

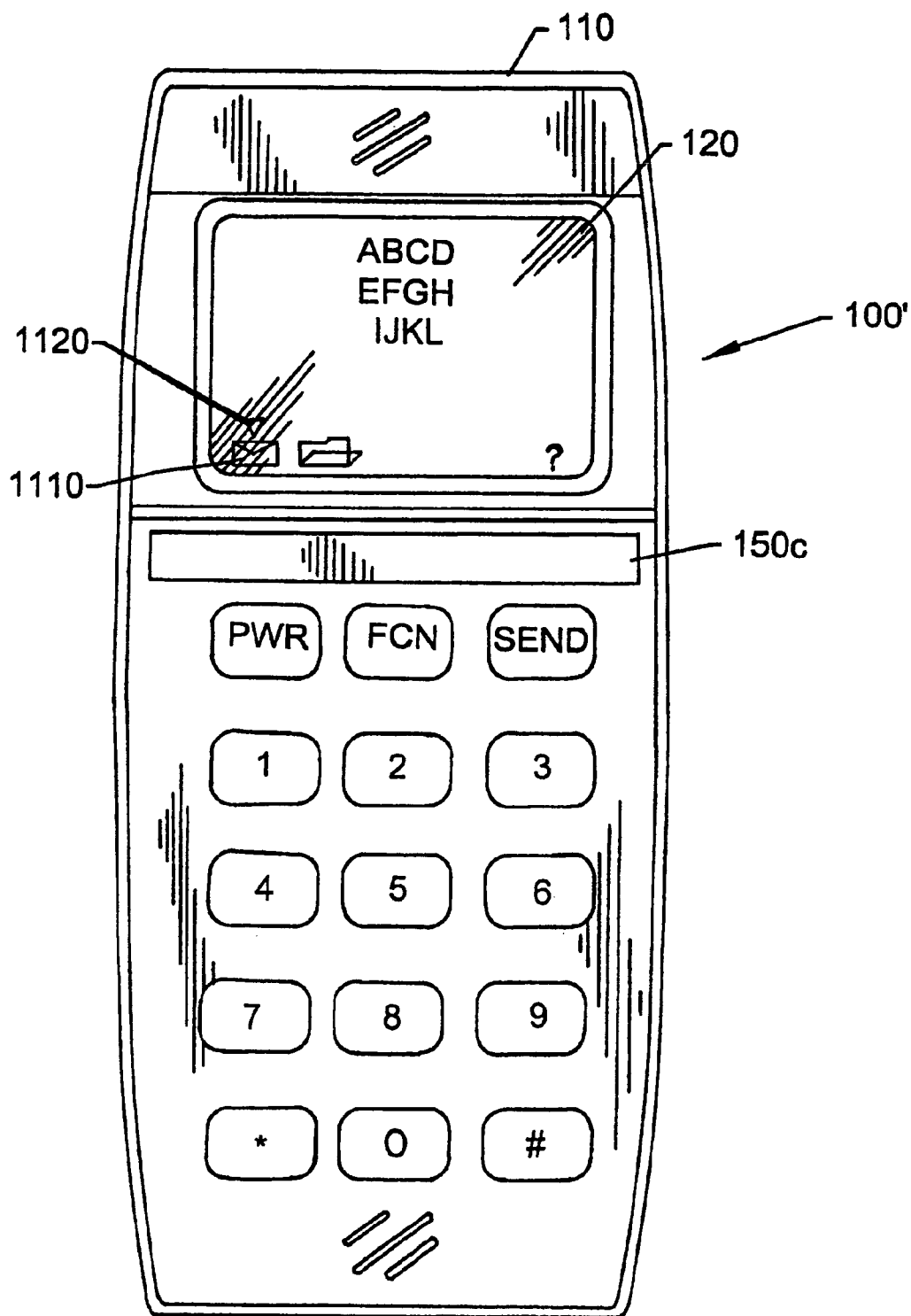


FIG. 11.

# **RADIOTELEPHONES HAVING CONTACT-SENSITIVE USER INTERFACES AND METHODS OF OPERATING SAME**

**[0001]** This application is a Continuation of patent application Ser. No. 13/682,566 entitled “RADIOTELEPHONES HAVING CONTACT-SENSITIVE USER INTERFACES AND METHODS OF OPERATING SAME,” filed on Nov. 20, 2012, currently allowed, which is a continuation of patent application Ser. No. 11/078,916, entitled “RADIOTELEPHONES HAVING CONTACT-SENSITIVE USER INTERFACES AND METHODS OF OPERATING SAME,” filed on Mar. 11, 2005, now Pat. No. RE43,931, which is a reissue of U.S. Pat. No. 6,278,888 which is a continuation of U.S. Pat. No. 6,131,047 the contents of which are incorporated herein by reference.

## **TECHNICAL FIELD**

**[0002]** The present invention relates to radiotelephones and methods of operation thereof, and more particularly, to apparatus and methods for providing user input to radiotelephones.

## **BACKGROUND**

**[0003]** Radiotelephone terminals typically include a radio transceiver integrated with a user interface mechanism within a handheld case. The user interface typically includes a plurality of keys similar to those provided on conventional wireline telephones, as well as additional function keys for controlling functions associated with radiotelephone operations. The keys provide a means for entering commands, telephone numbers or other data for processing by the radiotelephone. A display may be used to display information a user has entered at the keys, e.g., telephone numbers, menu selections, and the like, as well as to display messages or other information received from a radiotelephone system with which the radiotelephone is communicating. The display may also be used to display information stored in memory located in the radiotelephone.

**[0004]** Commonly, the display is configured to display one or more graphical objects, e.g. a list of commands in a command menu or a list of telephone numbers that are stored in the radiotelephone memory that the user may select for communication. The graphical objects may be selectively displayed, for example, by displaying a selected number of entries in a list of telephone numbers or command options. The list may be “scrolled” in response to a user input to allow a large list to be displayed on a small display.

**[0005]** In some conventional radiotelephones, control of the scrolling of graphical objects on the display may be controlled by one or more keys, the operation of which may be similar to the “arrow” keys provided on computer keyboard. Other keys may be provided to invoke particular selections. In other conventional radiotelephone designs, a wheel-like input device may be mounted on the radiotelephone case that may be turned by a user to effect scrolling of graphical objects on the display. The wheel device may also be configured to select items on the display in response to user application of radial pressure to the wheel.

**[0006]** Each of these conventional techniques for control of a radiotelephone display has its limitations. Keys for scrolling and invoking display selections may be awkward to use, and may consume valuable space on the keypad of the radiotelephone. A wheeled input device may provide faster and more

intuitive scrolling control, but such a device may take up an inordinate amount of space and require moving parts which may be more prone to failure. Accordingly, there is a need for improved input devices for radiotelephones.

## **SUMMARY OF THE INVENTION**

**[0007]** In light of the foregoing, it is an object of the present invention to provide radiotelephones and methods of operation thereof which provide reliable, intuitive and efficient display control.

**[0008]** In one aspect, features of the present invention provide for a device, comprising a housing including a front surface, a rear surface and first and second side surfaces adjoining respective opposite edges of the front surface and extending from the respective opposite edges of the front surface to respective opposite edges of the rear surface. The rear surface is configured to be engaged by a user’s palm during use of the device. The device includes a radiotelephone communications transceiver and a contact-sensitive display, supported by the housing. The contact sensitive display is configured to display an image at the front surface of the housing, and produce an output signal in response to moving contact of an object along a contact-sensitive surface of the contact-sensitive display. The device also includes a controller, operatively coupled to the display and the radiotelephone communications transceiver. The controller is configured to control at least one of the display and the radiotelephone communications transceiver and to scroll displayed rows along an axis of the display based upon the output signal of the contact-sensitive transducer, the controller having a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller is unresponsive to contact with the contact-sensitive transducer, the second mode being entered in response to an input from a user.

**[0009]** In another aspect, the present invention may provide for a method comprising receiving a user input indicating one of a first mode and a second mode of operation. In response to receiving a user input indicating a first mode of operation, the method includes providing on a contact-sensitive surface a display including at least one of an alphanumeric character and an icon, detecting contact on the contact-sensitive surface at a location corresponding to the at least alphanumeric character or the at least one icon, generating an output signal in response to the detecting step, and taking an action in response to the output signal. In response to receiving a user input indicating a second mode of operation, the method includes detecting contact on the contact-sensitive surface, generating an output signal in response to the detecting step, and taking no action in response to the output signal.

**[0010]** In yet another aspect, the present invention may provide for a device comprising housing means and display means, supported by the housing means, for displaying an image at a front surface of the housing. The device further includes contact-sensitive means, supported by the housing means, for producing an output signal in response to moving contact of an object along the contact-sensitive means, and control means for, responsive to the output signal, for scrolling displayed rows along an axis of the display means based on the output signal of the contact-sensitive means. The device further includes means for receiving input from a user and for placing the control means in a first mode wherein the controller is responsive to contact with the contact-sensitive

means and a second mode wherein the control means is unresponsive to contact with the contact-sensitive means, in response to the user input.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0011] For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawing, in which:

[0012] FIG. 1 illustrates a radiotelephone according to an embodiment of the present invention;

[0013] FIG. 2 is a schematic diagram illustrating a radiotelephone according to an embodiment of the present invention;

[0014] FIG. 3 illustrates a radiotelephone with dual contact-sensitive strips according to another embodiment of the present invention;

[0015] FIG. 4 is a schematic diagram illustrating a circuit for controlling a display using a contact-sensitive transducer according to another embodiment of the present invention;

[0016] FIG. 5 is a flowchart illustration of operations for determining a position of contact of an object with a contact-sensitive transducer according to an aspect of the present invention;

[0017] FIGS. 6A through 6B are schematic diagrams illustrating a circuit for controlling power supply to a radiotelephone using a contact-sensitive transducer according to another embodiment of the present invention;

[0018] FIGS. 7A-7C illustrate operations for scrolling displayed items and selecting functions associated with a displayed item according to another aspect of the present invention;

[0019] FIG. 8 is a flowchart illustration of operations for detecting a swiping contact with a contact-sensitive transducer according to another aspect of the present invention;

[0020] FIGS. 9-10 are flowchart illustrations of operations for detecting contacts with a contact-sensitive transducer according to aspects of the present invention; and

[0021] FIG. 11 illustrates a radiotelephone with a horizontally mounted contact-sensitive strip according to another embodiment of the present invention.

#### DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0022] Before addressing the illustrated embodiments in detail, various aspects and advantageous features of embodiments of the invention will be discussed generally in the following paragraphs.

[0023] This and other objects, features and advantages are provided according to the present invention by radiotelephones and methods of operation thereof in which control of a radiotelephone's display and/or radiotelephone communications transceiver is effected using a contact-sensitive transducer such as a resistive or capacitive touch strip mounted on the radiotelephone. The contact-sensitive transducer produces an output signal that characterizes contact, e.g., contact of an object such as a user's finger, with a surface of the transducer. The output signal may be processed by a controller to control display of information on the display and to initiate actions associated with displayed items. For example, the contact-sensitive transducer may be used to control display of graphical objects such as rows or columns on the display, and initiation of functions associated with the graphical

objects. Preferably, the contact-sensitive transducer comprises an elongate strip and produces an output signal that characterizes contact with the strip along its elongate axis. In one embodiment, two of such elongate strips are mounted on respective sides of the radiotelephone. In another embodiment, an elongate strip is mounted on a front face of the radiotelephone.

[0024] Using a contact-sensitive transducer to control a radiotelephone offers several advantages. Because a contact-sensitive transducer may be configured to have a thin profile, the transducer may be mounted at a surface of the radiotelephone without taking up an inordinate amount of valuable space. Because characteristic types of contact with the transducer can be detected, such as swiping motions or taps, the transducer may be used to perform display movements such as scrolling or cursor movement, as well as for selection of items displayed on the display. In addition, because a contact-sensitive transducer may be fabricated without moving parts, reliability may be improved.

[0025] In particular, according to an aspect of the present invention, a radiotelephone includes a frame. The frame supports a radiotelephone communications transceiver and a display. A contact-sensitive transducer such as a resistive transducer, a capacitive transducer or a semiconductive transducer, is supported by the frame, e.g., mounted at a surface of a housing, and produces an output signal that characterizes contact along a contact-sensitive surface of the contact-sensitive transducer. A controller is responsive to the output signal and operatively associated with the display and the radiotelephone communications transceiver, and controls at least one of the display and the radiotelephone communications transceiver according to the output signal of the contact-sensitive transducer.

[0026] In an embodiment of the present invention, the controller is configured to selectively display an image, e.g., a graphical object such as a row of alphanumeric characters, on the display responsive to the output signal of the contact-sensitive transducer. The controller may include means for displaying of a plurality of graphical objects on the display, and means, responsive to the contact sensitive transducer, for identifying one of the displayed plurality of graphical objects based on the output signal of the contact-sensitive transducer.

[0027] According to another embodiment, the controller comprises means, responsive to the contact-sensitive transducer, for determining a position of contact along the axis of the contact-sensitive transducer. Means are also provided, responsive to the means for determining a position of contact, for selectively displaying a graphical object based on the determined position of contact to thereby identify the graphical object, e.g., by highlighting one of a plurality of displayed graphical objects or by displaying a cursor that indicates one of a plurality of displayed graphical objects.

[0028] In yet another embodiment of the present invention, the controller is configured to cause the display or the radiotelephone communications transceiver to perform a plurality of actions. An action of the plurality of actions may be associated with an identified graphical object, and the controller may further comprise means, responsive to the contact-sensitive transducer, for initiating the action associated with the identified graphical object. The means for initiating an action may include means, responsive to the contact-sensitive transducer, for detecting a momentary contact with the transducer. Means may be provided, responsive to the means for detecting a momentary contact, for initiating the action associated

with the identified graphical object. The means for initiating an action may include means for initiating the action in response to detection of a predetermined number of momentary contacts occurring within a predetermined time interval.

**[0029]** According to another embodiment of the present invention, the controller includes means, responsive to the contact-sensitive transducer, for scrolling displayed rows along an axis of the display based on the output signal of the contact-sensitive transducer. The means for scrolling may include means, responsive to the output signal of contact-sensitive transducer, for detecting moving contact with the contact-sensitive transducer along the axis of the contact-sensitive transducer, and means, responsive to the means for detecting moving contact, for scrolling displayed rows along the axis of the display based on the detected movement.

**[0030]** In yet another embodiment of the present invention, the controller has a first mode wherein the controller is responsive to contact with the contact-sensitive transducer and a second mode wherein the controller is unresponsive to contact with the contact-sensitive transducer. The radiotelephone further comprises means for placing the controller in one of the first mode or the second mode in response to an input from a user.

**[0031]** Another embodiment according to the present invention includes a power supply electrically connected to the contact-sensitive transducer. The controller comprises a first control circuit, responsive to the contact-sensitive transducer, which controls the radiotelephone communications transceiver and the display according to the output signal of the contact-sensitive transducer, and a second control circuit, responsive to the contact-sensitive transducer, which controls power transfer from the power supply to the first control circuit according to the output signal from the contact-sensitive transducer. The first control circuit may include a microcontroller, and the second control circuit may control power transfer from the power supply to the microcontroller according to the output signal of the contact-sensitive transducer.

**[0032]** In another embodiment according to the present invention, the radiotelephone frame includes a housing and the contact-sensitive transducer comprises an elongate contact-sensitive strip mounted at a surface of the housing. The housing may have a front face and an adjoining first side, the display may be mounted at the front face, and the elongate contact-sensitive strip may be mounted at the first side adjoining the front face. A second contact-sensitive strip may be mounted at a second side of the radiotelephone housing, adjoining the front face and opposite the first side. According to another embodiment, a contact-sensitive transducer may be mounted at the front face of the housing.

**[0033]** According to method aspects of the present invention, user input is provided to a radiotelephone using a contact-sensitive transducer that produces an output signal that characterizes contact of an object on a contact-sensitive surface of the contact-sensitive transducer. At least one of a radiotelephone communications transceiver and a display of the radiotelephone may be controlled according to the output signal of the contact-sensitive transducer. An image may be selectively displayed on the radiotelephone display according to the output signal of the contact-sensitive transducer. Improved user interfaces for radiotelephones are thereby provided.

**[0034]** The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown.

Those skilled in the art will appreciate that the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, like numbers refer to like elements throughout. It will be understood that when a first object, e.g., a contact-sensitive transducer strip, is referred to as mounted “at” a surface of a second object, e.g., a housing or the like, the first object may be mounted directly on the surface of the second object, on a structural element or frame underlying the surface of the second object which allows a surface of the first object accessible through an opening in the surface of the second object, and the like.

**[0035]** FIG. 1 illustrates a radiotelephone 100 in which the apparatus and methods according to an embodiment of the present invention may be embodied. The radiotelephone includes a frame, here shown as including a housing 110. The housing 110 supports a display 120 and a plurality of keys 130. Those skilled in the art will appreciate that also included but not illustrated are a radiotelephone communications transceiver for communicating with a radiotelephone system, e.g., transmitter, receiver and associated control circuits for communicating with a cellular system via an antenna 140. The radiotelephone communications transceiver and the display 120 are controlled by a contact-sensitive transducer 150 mounted at a side surface of the radiotelephone housing 110, adjacent the display 120. It will be appreciated that the contact-sensitive transducer 150 may be attached to the housing 110 in a variety of different ways. For example, the transducer 150 may be attached to an outer surface of the housing 110, attached to a boss or similar structure attached to an outer surface of the housing 110, attached to a circuit board or similar structure mounted within the housing 110 and extending through an opening in a surface of the housing 110, or the like.

**[0036]** Referring now to FIG. 2, the contact-sensitive transducer 150 produces an output signal 155 that characterizes contact of an object, such as a user's finger 210, along an axis 150a of the transducer 150. A controller 220 is responsive to the output signal 155 and operatively associated with the display 120 and a radiotelephone communications transceiver 230. The controller 220 selectively display an image, such as one or more rows 240 of alphanumeric characters, on the display 120 based on the output signal 155 produced by the contact-sensitive transducer 150. The controller also controls the radiotelephone communications transceiver 230 according to the output signal 155. The contact-sensitive transducer 150 may comprise a variety of different contact-sensitive devices, including resistive, capacitive or semiconductive strips. For example, the contact-sensitive transducer 150 may be implemented using a semiconductive pad-type transducer of the type manufactured by Interlink Corp.

**[0037]** FIG. 3 illustrates an embodiment of the present invention, in which dual contact sensitive strips 150a, 150b are attached on opposite sides of a radiotelephone housing 110, adjacent the display 120. By providing strips on both sides of the radiotelephone housing 110, the radiotelephone 100 may be used in either a right-handed or left-handed fashion. Preferably, only one of the strips 150a, 150b is active at any given time, i.e., one of the strips is inactivated to prevent inadvertent generation of signals to the controller caused by gripping of the radiotelephone. The active strip

may be indicated by, for example, displaying an icon 125 near the edge of the display 120 closest the active strip 150a.

[0038] FIG. 4 illustrates an exemplary embodiment of the controller 220 that includes a circuit connected to nodes  $R_1$ ,  $R_2$ ,  $R_c$ ,  $L_1$ ,  $L_2$ ,  $L_c$ , of the transducers 150a, 150b. Voltages between the nodes  $R_1$  and  $R_c$  and nodes  $L_1$  and  $L_c$  are sampled under the control of a microcontroller 410 which controls multiplexers 420a, 420b and a discharge switch 430, selectively applying the voltages at the nodes  $R_1$ ,  $R_2$ ,  $R_c$ ,  $L_1$ ,  $L_2$ ,  $L_c$ , to capacitor C. A comparator 440, in conjunction with a counter 450, determines the time required to charge the capacitor C to a threshold voltage  $V_T$  after a node of one of the transducers 150a, 150b is connected to the capacitor C. A trio of charge times is sampled for a given transducer, providing a measure of a position of contact of an object with the transducer, as will be described in detail below. The counts produced by the counter 450, representing contact position samples, are latched into a register 460, and in turn conveyed to the microcontroller 410 for further processing.

[0039] Those skilled in the art will appreciate that a wide variety of apparatus other than the illustrated embodiment of FIG. 4 may be used with the present invention. For example, a different type of contact-sensitive transducer may be employed which utilizes a different kind of controller circuitry to process output signals produced by the contact-sensitive transducer. In general, it will be appreciated that a controller 220 for processing output signals produced by a contact-sensitive transducer and for controlling a display 120 and a radiotelephone communications transceiver 230 according to the output signal, as described with respect to FIG. 2, may be implemented using special purpose hardware, software or firmware running on general-purpose or special-purpose computing apparatus, or combinations thereof.

[0040] The flowchart illustration of FIG. 5 illustrates methods and apparatus for determining a position of contact with a contact-sensitive transducer according to an aspect of the present invention. It will be understood that blocks of the flowchart illustration, and combinations of blocks in the flowchart illustration, can be implemented by computer program instructions which may be loaded onto a computer or other programmable data processing apparatus to produce a machine such that the instructions which execute on the computer or other programmable data processing apparatus create means for implementing the functions specified in the flowchart block or blocks. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks. Accordingly, blocks of the flowchart illustration support combinations of means for performing the specified functions and combinations of steps for performing the specified functions. It will also be understood that each block of the flowchart illustrations, and combinations of blocks in the flowchart illustration, can be implemented by special purpose hardware which performs the specified functions or steps, or combinations of special purpose hardware such as the microcontroller 410 of FIG. 4, microprocessors, digital signal processing (DSP) chips, application-specific integrated circuits (ASICs) or the like, which execute computer instructions.

[0041] FIG. 5 illustrates exemplary detailed operations (Block 500 et seq.) for determining a position of contact of an object with the left contact strip 150a of FIG. 3. The discharge switch 430 is closed to discharge the capacitor C (Block 505). The power supply voltage  $V_{cc}$  is then applied to the  $L_1$  node (Block 510), and the  $L_c$  node is connected to the capacitor C (Block 515). The discharge switch 430 is then opened to charge the capacitor C (Block 520), and a first capacitor charge time  $T_1$ , is measured (Block 525). The capacitor C is then discharged by closing the switch 430 again (Block 530). The power supply voltage  $V_{cc}$  is next applied to the  $L_2$  node (Block 535), and the  $L_c$  node is connected to the capacitor C (Block 540). The discharge switch 430 is then opened (Block 545), and a second capacitor charge time  $T_2$  is measured (Block 550). The capacitor C is discharged once again by closing the discharge switch 430 (Block 555). The power supply voltage  $V_{cc}$  is then applied to the  $L_1$  node (Block 560), and the  $L_2$  node is connected to the capacitor C (Block 565). The discharge switch 430 is opened (Block 570), and a third capacitor charge time  $T_3$  is measured (Block 575). The first, second and third capacitor charge times  $T_1$ ,  $T_2$ ,  $T_3$  are then used to determine a position of contact with the transducer 520b (Block 580).

[0042] In particular, three equations are applicable to the measurements described with respect to FIG. 5:  $T_1 = k(R_{L1} + R_{Lc})$ ;  $T_2 = k(R_{L2} + R_{Lc})$ ; and  $T_3 = k(R_{L1} + R_{L2})$ , where  $k = -C \ln(1 - V_1/V_{cc})$ .

[0043] These equations may be solved for  $R_{L1}$ ,  $R_{L2}$ , and  $R_{Lc}$ , and the position of contact P can be determined as: ##EQU1##

[0044] Those skilled in the art will appreciate that similar operations may be performed to determine a position of contact with the right contact strip 150a. It will also be understood that by application of appropriate control signals to the multiplexers 420a, 420b, either one of the transducers 150a, 150b may be disconnected from the capacitor C, effectively preventing input from the disconnected transducer.

[0045] FIG. 6A illustrates another embodiment of the present invention, specifically a circuit which may be used in conjunction with the control circuit illustrated in FIG. 4 to control power transfer from a power supply, e.g., a battery supplying a battery voltage  $V_{bat}$ , to the microcontroller 410 and/or other circuits in a radiotelephone based on input signals from a contact-sensitive transducer. Additional switches 610a-610d may be provided in the signal paths connecting the nodes  $R_c$ ,  $L_c$ ,  $R_1$ ,  $L_1$ . These switches may be used to connect the associated nodes to the control input for the switch 620 via diodes  $D_1$ ,  $D_2$  (in the case of nodes  $R_c$ ,  $L_c$ ) and to the battery voltage  $V_{bat}$  (in the case of nodes  $R_1$ ,  $L_1$ ) in an "off" state, as shown. In the off state, a power switch 620 disconnects the battery voltage  $V_{bat}$  from a regulator 630 that provides a regulated power supply voltage  $V_{cc}$  to the microcontroller 410.

[0046] When either of the right or the left strips 150a, 150b is pressed such that a voltage is produced sufficient to overcome the drop across the associated diode  $D_1$ ,  $D_2$  and the input activation voltage of the power switch 620, the power switch 620 closes and applies the battery voltage  $V_{bat}$  to the regulator 630. Power is thus provided to the microcontroller 410. The microcontroller may then latch the power switch 620 into a sustained "on" state by driving a third diode  $D_3$  and by applying control signals to the switches 610a-610d to connect the nodes  $R_c$ ,  $L_c$ ,  $R_1$ ,  $L_1$  the appropriate multiplexers as illustrated in FIG. 4. The microcontroller 410 may return

the power switch **620** to the “off” state by inverting the logic on the line driving the third diode  $D_3$ . Because a specific voltage is needed to activate the power switch **620**, accidental activation of the radiotelephone can be prevented. According to another embodiment illustrated in FIG. 6B, the circuit of FIG. 6A may be modified such pressure on both of the strips **150a**, **150b** is required to power up the regulator **630**. When the right strip **150b** is pressed, the battery voltage  $V_{bat}$  is applied from  $R_1$  and  $R_c$  to  $L_1$ . If the left strip **150a** is simultaneously pressed, the voltage is also applied to the control input of the power switch **620** through  $D_2$ . Otherwise, the operation of the circuit of FIG. 6B is similar to that described with respect to the circuit of FIG. 6A.

**[0047]** The conceptual illustrations of FIGS. 7A-7B and the flowchart illustrations of FIGS. 8-10 illustrate methods and apparatus for determining contact with a contact-sensitive transducer to identify graphical objects on a display and for initiating functions associated with the identified objects. It will be understood that blocks of the flowchart illustrations, and combinations of blocks in the flowchart illustrations, can be implemented by computer program instructions which may be loaded onto a computer or other programmable data processing apparatus to produce a machine such that the instructions which execute on the computer or other programmable data processing apparatus create means for implementing the functions specified in the flowchart block or blocks. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks. Accordingly, blocks of the flowchart illustrations support combinations of means for performing the specified functions and combinations of steps for performing the specified functions. It will also be understood that each block of the flowchart illustrations, and combinations of blocks in the flowchart illustration, can be implemented by special purpose hardware which performs the specified functions or steps, or combinations of special purpose hardware such as microcontrollers, microprocessors, digital signal processing (DSP) chips, application-specific integrated circuits (ASICs) or the like, which execute computer instructions.

**[0048]** FIGS. 7A-7C illustrate operations for controlling display of an image on a radiotelephone display according to another aspect of the present invention, in particular, operations for “scrolling” graphical objects, here shown as rows, on a radiotelephone display **120**, and for initiating a function associated with a graphical object identified on the display **120**. At least one graphical object is displayed on a radiotelephone display **120**. As illustrated in FIG. 7B, a user makes a swiping or displacement motion in contact with a contact-sensitive strip **150** mounted on a side of the radiotelephone **100**, causing the display rows to “scroll” along the direction of the user’s movement. Those skilled in the art will appreciate that “scrolling” in a generic sense refers to selective display of a row on the display **120**, and may be encompass a number of different graphical operations. For example, as depicted in FIGS. 7A-7C, a plurality of rows may be displayed on the display **120**, and a selected one of displayed rows may be highlighted or otherwise identified in response to the user input. Different rows may be sequentially dis-

played on the display **120**, giving the appearance of a scrolling movement. In addition, actions such as scrolling by sequentially highlighting rows or other graphical objects or moving a cursor to sequentially indicate rows or other graphical objects responsive to a swiping motion on the transducer **150** may also be employed.

**[0049]** As illustrated in FIG. 7C, a function associated with an item identified by, for example, highlighting or cursor positioning, is initiated with the user performs a predetermined number of momentary contacts or taps on the contact-sensitive transducer **150**, as illustrated in FIG. 7C. These momentary contacts or taps may occur anywhere along the contact-sensitive transducer **150**. Those skilled in the art will appreciate that a number of variations on the above-described operations may be performed within the scope of the present invention. For example, instead of providing multi-graphical object display, the display **120** may be configured to display only one row at a time, sequentially displaying rows stored in memory to give the appearance of scrolling.

**[0050]** FIG. 8 illustrates exemplary operations for detecting a swiping contact with a contact-sensitive transducer (Blocks **800** et seq.). The transducer output signal is sampled (Block **805**). If the sample indicates contact of an object with the transducer, a starting position  $P_{start}$  of contact is next determined (Blocks **810-815**). The transducer output signal is again sampled (Block **820**), and if contact is still detected, an ending position  $P_{end}$  is determined (Blocks **825-830**). A distance  $D$  is then determined from the starting and ending positions  $P_{start}$ ,  $P_{end}$  (Block **835**). If the magnitude of the distance  $D$  is less than a minimum distance  $D_{min}$ , the movement is disregarded and another sample obtained (Blocks **840-820**). If the distance  $D$  is sufficiently large, however, the controller determines the direction of the movement by looking at the sign of the distance  $D$  (Block **845**). If the distance  $D$  is negative, the display is scrolled in a first direction (Block **850a**); if the distance  $D$  is positive, however, the display is scrolled in a second direction (Block **850b**). The ending position is then used as a new starting position (Block **855**).

**[0051]** FIG. 9 illustrates exemplary operations (Blocks **900** et seq.) for detecting a momentary contact or tap on a contact-sensitive transducer according to another aspect of the present invention. Generally speaking, a momentary contact or tap is detected by satisfaction of a series of three conditions: (1) absence of contact with the contact-sensitive transducer; (2) contact with the contact-sensitive transducer; and (3) termination of contact with the contact-sensitive transducer within a predetermined time period. In the exemplary operations shown, a timer  $T_1$  (for example, a software timer implemented in the microcontroller **410** of FIG. 4) is initialized (Block **905**). The output signal from a contact-sensitive transducer is sampled (Block **910**). If the sampled output signal indicates that an object is in contact with the transducer, the output signal is repeatedly sampled until contact is not detected (Blocks **910-915**). Once no contact is detected, the first condition for a tap is satisfied. A second round of sampling is then initiated, with the output being sampled until contact is again detected (Blocks **920-925**). Once contact is again detected, the second condition for a tap is satisfied. The timer  $T_1$  is then started (Block **930**). As long as contact continues and the time measured by the timer  $T_1$  is less than a predetermined maximum time interval  $T_{max}$ , the output of the transducer is repeatedly sampled (Blocks **935-945**). If contact ceases before the timer  $T_1$  exceeds the maximum time  $T_{max}$ , the third condition for a tap has been satisfied, and a valid

single tap has been detected (Block 550). However, if the timer  $T_1$  exceeds the maximum time  $T_{max}$  before contact ceases, the timer  $T_1$  is reinitialized (Block 905) and the detection process begins anew.

[0052] FIG. 10 illustrates operations (Block 1000 et seq.) for detecting a double tap on the contact-sensitive transducer. A second timer  $T_2$  is initialized (Block 110). Once a valid single tap is detected, the second timer  $T_2$  is started (Blocks 1015-1020). As long as the time measured by the second time  $T_2$  remains less than a second maximum time interval  $T_{2max}$ , and no contact with the transducer is detected, the transducer is repeatedly sampled (Blocks 1025-1035). If the timer has yet to expire when contact is detected, it is next determined whether the contact constitutes a valid single tap (Block 1040). If a valid single tap is detected, a valid double tap has occurred (Block 1045). If not, the second timer  $T_2$  is reinitialized (Block 1005), starting the detection process anew.

[0053] FIG. 11 illustrates another embodiment according to the present invention, a radiotelephone 100' which includes a horizontally-arranged contact-sensitive transducer 150c, here shown mounted on a front face of the radiotelephone housing 110, near the display 120. In a manner similar to that described with respect to the side-mounted transducers of FIG. 3, the transducer 150c may be used to selectively display column-organized graphical objects on the display 120 based on contact of an object, e.g., a finger or stylus, with the contact-sensitive transducer 150c. For example, as illustrated in FIG. 11, icons 1110 may be displayed in columns on the display 120, and may be selectively identified according to contact with the contact sensitive transducer 150c, using apparatus and operations similar to those described with respect to FIGS. 4-10. An icon may be identified by several techniques, such as by highlighting or by displaying a cursor 1120 adjacent the identified icon. A function associated with the identified icon may be selected using apparatus and operations manner similar to those described with respect to FIGS. 7A-7C. Those skilled in the art will also appreciate that other embodiments may include side-mounted contact-sensitive strips such as those illustrated in FIG. 3 in combination with a horizontally-mounted contact-sensitive strip as illustrated in FIG. 11 to provide both row and column-oriented controls for the display 120.

[0054] In the drawings and specification, there have been disclosed typical embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.

What is claimed is:

1. A communication device, comprising:

a housing comprising a front surface, a rear surface, a first side surface, and a second side surface, wherein the first side surface and the second side surface adjoin respective opposite edges of the front surface and extend from the respective opposite edges of the front surface to respective opposite edges of the rear surface, and wherein the housing is configured such that the rear surface confronts a user's palm when the device is held in the user's hand during use;

a display, supported by the housing, the display configured to display an image at the front surface of the housing;

a contact-sensitive transducer, supported by the housing, the contact-sensitive transducer is configured to pro-

duce an output signal that characterizes contact of an object along a contact-sensitive surface of the contact-sensitive transducer; and

a controller, operatively associated with the display and configured to respond to the output signal by scrolling displayed rows along an axis of the display based on the output signal of the contact-sensitive transducer, wherein the controller is configured to scroll the displayed rows based on the output signal by:

detecting, based on the output signal of the contact-sensitive transducer, a swipe motion made by the user in a first direction along an axis of the contact-sensitive surface; and

scrolling the displayed rows in the first direction in response to detecting the swipe motion.

2. The device of claim 1, wherein the controller is configured to detect the swipe motion by:

determining, based on the output signal produced by the contact-sensitive transducer at a first time, that the object is in contact with the contact-sensitive surface; and

determining based on the output signal produced by the contact-sensitive transducer at a second time, that the object is still in contact with the contact-sensitive surface and a position of contact has changed.

3. The device of claim 1, wherein the controller is further configured to detect the swipe motion, at least in part, by:

at a first sampling time, detecting contact between the object and the contact-sensitive surface at a first position on the contact-sensitive surface; and

at a second sampling time, detecting contact between the object and the contact-sensitive surface at a second position on the contact-sensitive surface.

4. The device of claim 3, wherein the controller is further configured to detect the swipe motion, at least in part, by:

calculating a distance (D) between the first position on the contact-sensitive surface and the second position on the contact-sensitive surface; and

determining the first direction for scrolling the displayed rows based on a sign of the distance (D).

5. The device of claim 3, wherein the controller is further configured to detect the swipe motion, at least in part, by:

calculating a distance (D) between the first position on the contact-sensitive surface and the second position on the contact-sensitive surface;

determining whether a magnitude of the distance (D) is greater than a minimum distance ( $D_{min}$ ); and

determining whether the user has performed the swipe motion based on whether the magnitude is greater than the minimum distance ( $D_{min}$ ).

6. The device of claim 3, wherein the controller is further configured to detect the swipe motion, at least in part, by:

calculating a distance (D) between the first position on the contact-sensitive surface and the second position on the contact-sensitive surface;

determining whether a magnitude of the distance (D) is greater than a minimum distance ( $D_{min}$ ); and

in response to determining that the magnitude is less than the minimum distance ( $D_{min}$ ) disregarding a change in contact position indicated by the output signal.

7. The device of claim 1, wherein the controller is further configured to:

detect a momentary contact on the contact-sensitive surface; and



in response to detecting the momentary contact on the contact-sensitive surface, initiate a function associated with an item displayed in one of the displayed rows.

8. The device of claim 7, wherein the controller is further configured to detect the momentary contact, at least in part, by:

- detecting absence of contact between the object and the contact-sensitive surface at a first time;
- detecting contact between the object and the contact-sensitive surface at a second time; and
- detecting termination of the contact before a maximum amount of time is exceeded.

9. The device of claim 1, wherein the controller is further configured to:

- detect that a predetermined number of momentary contacts with the contact-sensitive surface have occurred, wherein the predetermined number is greater than one; and

in response to detecting the predetermined number of momentary contacts have occurred, initiate a function associated with an item displayed in one of the displayed rows.

10. The device of claim 9, wherein the controller is further configured to detect that the predetermined number of momentary contacts have occurred, at least in part, by:

- detecting absence of contact between the object and the contact-sensitive surface;
- after detecting absence of contact, detecting a first instance of contact between the object and the contact-sensitive surface;
- detecting termination of the first instance of contact before an amount of time associated with the first instance of contact exceeds a first maximum amount of time; and
- within a second maximum amount of time after detecting termination of the first instance of contact:
  - detecting a second instance of contact between the object and the contact-sensitive surface; and
  - detecting termination of the second instance of contact before an amount of time associated with the second instance of contact exceeds the first maximum amount of time.

11. The device of claim 1, wherein the contact-sensitive transducer comprises a capacitive touch strip that includes a capacitor,

12. The device of claim 11, wherein the contact-sensitive transducer is further configured to produce the output signal based on one or more charge times associated with the capacitor.

13. The device of claim 1, wherein the controller is further configured to be responsive to contact with the contact-sensitive surface when in a first mode and to be unresponsive to contact with the contact-sensitive surface when in a second mode, and wherein the controller is further configured to enter at least one of the first mode and the second mode in response to input from the user.

14. A communication device, comprising:

- a housing comprising a front surface, a rear surface, a first side surface, and a second side surface, wherein the first side surface and the second side surface adjoin respective opposite edges of the front surface and extend from the respective opposite edges of the front surface to respective opposite edges of the rear surface, and wherein the housing is configured such that the rear

surface confronts a user's palm when the device is held in the user's hand during use;

a display, supported by the housing, the display configured to display an image at the front surface of the housing;

a contact-sensitive transducer, supported by the housing, the contact-sensitive transducer is configured to produce an output signal that characterizes contact of an object along a contact-sensitive surface of the contact-sensitive transducer; and

a controller, operatively associated with the display and configured to respond to the output signal by scrolling displayed rows along an axis of the display based on the output signal of the contact-sensitive transducer, wherein the controller is configured to scroll the displayed rows based on the output signal by:

- determining, based on the output signal produced by the contact-sensitive transducer at a first time, that the object is in contact with the contact-sensitive surface; and

determining, based on the output signal produced by the contact-sensitive transducer at a second time, that the object is still in contact with the contact-sensitive surface and a position of contact has changed.

15. The communication device of claim 14, wherein the controller is further configured to scroll the displayed rows only when the output signal indicates that a difference in the position of contact exceeds a minimum amount.

16. The communication device of claim 15, wherein the controller is further configured to disregard the output signal for purposes of scrolling when the output signal indicates that the difference in the position of contact does not exceed the minimum amount.

17. A communication device, comprising:

- a housing comprising a front surface, a rear surface, a first side surface, and a second side surface, wherein the first side surface and the second side surface adjoin respective opposite edges of the front surface and extend from the respective opposite edges of the front surface to respective opposite edges of the rear surface, and wherein the housing is configured such that the rear surface confronts a user's palm when the device is held in the user's hand during use;

a display, supported by the housing, the display configured to display an image at the front surface of the housing;

a contact-sensitive transducer, supported by the housing, the contact-sensitive transducer is configured to produce an output signal that characterizes contact of an object along a contact-sensitive surface of the contact-sensitive transducer; and

a controller, operatively associated with the display and configured to respond to the output signal by scrolling displayed rows along an axis of the display based on the output signal of the contact-sensitive transducer, wherein the controller is configured to scroll the displayed rows based on the output signal, at least in part, by:

- at a first sampling time, detecting contact by the object at a starting position on the contact-sensitive surface;
- at a second sampling time, detecting contact by the object at an ending position on the contact-sensitive surface;
- calculating a distance on the contact-sensitive surface between the starting position and the ending position; and
- scrolling the displayed rows based on the distance.

18. In an apparatus including a housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite edges of the front surface and extending from the respective opposite edges of the front surface to respective opposite edges of the rear surface, a display that displays an image at the front surface, and a controller that controls the display, a method of providing user input comprising:

holding the housing in a user's hand such that the rear surface confronts the user's palm and the display projects away from the user's palm; and

providing the user input to the controller using a contact-sensitive transducer having a contact-sensitive surface disposed at at least one of the first and second side surfaces of the housing, the contact-sensitive transducer being operable to produce an output signal that characterizes contact with the contact-sensitive surface of the contact-sensitive transducer; and

causing the controller to scroll displayed rows of the display by performing a swipe motion on the contact-sensitive surface, wherein the controller scrolls the displayed rows by:

detecting, based on the output signal of the contact-sensitive transducer, that the swipe motion has been performed in a first direction along an axis of the contact-sensitive surface; and

scrolling the displayed rows in the first direction in response to detecting the swipe motion.

19. In an apparatus including a housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite edges of the front surface and extending from the respective opposite edges of the front surface to respective opposite edges of the rear surface, a display that displays an image at the front surface, and a controller that controls the display, a method of providing user input comprising:

holding the housing in a user's hand such that the rear surface confronts the user's palm and the display projects away from the user's palm; and

providing the user input to the controller using a contact-sensitive transducer having a contact-sensitive surface disposed at at least one of the first and second side surfaces of the housing, the contact-sensitive transducer being operable to produce an output signal that characterizes contact with the contact-sensitive surface of the contact-sensitive transducer; and

causing contact with the contact-sensitive surface that instructs the controller to scroll displayed rows of the display, wherein the controller scrolls the displayed rows by:

determining, based on the output signal produced by the contact-sensitive transducer at a first time, that an object is in contact with the contact-sensitive surface; and

determining, based on the output signal produced by the contact-sensitive transducer at a second time, that the object is still in contact with the contact-sensitive surface and a position of contact has changed.

20. In an apparatus including a housing having a front surface, a rear surface and first and second side surfaces adjoining respective opposite edges of the front surface and extending from the respective opposite edges of the front surface to respective opposite edges of the rear surface, a display that displays an image at the front surface, and a controller that controls the display, a method of providing user input comprising:

holding the housing in a user's hand such that the rear surface confronts the user's palm and the display projects away from the user's palm; and

providing the user input to the controller using a contact-sensitive transducer having a contact-sensitive surface disposed at at least one of the first and second side surfaces of the housing, the contact-sensitive transducer being operable to produce an output signal that characterizes contact with the contact-sensitive surface of the contact-sensitive transducer; and

causing contact with the contact-sensitive surface that instructs the controller to scroll displayed rows of the display, wherein the controller scrolls the displayed rows by:

at a first sampling time, detecting contact by an object at a starting position on the contact-sensitive surface;

at a second sampling time, detecting contact by the object at an ending position on the contact-sensitive surface;

calculating a distance on the contact-sensitive surface between the starting position and the ending position; and

scrolling the displayed rows based on the distance.

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