



US007592999B2

(12) **United States Patent**
Rosenberg et al.

(10) **Patent No.:** **US 7,592,999 B2**
(45) **Date of Patent:** **Sep. 22, 2009**

(54) **HAPTIC FEEDBACK FOR TOUCHPADS AND OTHER TOUCH CONTROLS**

(75) Inventors: **Louis B. Rosenberg**, San Jose, CA (US); **James R. Riegel**, Santa Clara, CA (US)

(73) Assignee: **Immersion Corporation**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 82 days.

(21) Appl. No.: **11/405,811**

(22) Filed: **Apr. 17, 2006**

(65) **Prior Publication Data**

US 2006/0187215 A1 Aug. 24, 2006

Related U.S. Application Data

(63) Continuation of application No. 10/213,940, filed on Aug. 6, 2002, now Pat. No. 7,148,875, which is a continuation-in-part of application No. 09/487,737, filed on Jan. 19, 2000, now Pat. No. 6,429,846, which is a continuation-in-part of application No. 09/467,309, filed on Dec. 17, 1999, now Pat. No. 6,563,487, and a continuation-in-part of application No. 09/253,132, filed on Feb. 18, 1999, now Pat. No. 6,243,078, which is a continuation-in-part of application No. 09/156,802, filed on Sep. 17, 1998, now Pat. No. 6,184,868, and a continuation-in-part of application No. 09/103,281, filed on Jun. 23, 1998, now Pat. No. 6,088,019.

(51) **Int. Cl.**
G09G 5/00 (2006.01)

(52) **U.S. Cl.** **345/156**

(58) **Field of Classification Search** **345/156, 345/173, 184; 715/101-102, 702, 764; 463/38, 463/37; 178/18.01; 340/407.1, 825.25; 434/114**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,023,290 A 5/1977 Josephson

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0556999 B1 5/1998

(Continued)

OTHER PUBLICATIONS

Bliss, James C., "Optical-to-tactile Image Conversion for the Blind," IEEE Transactions on Man-Machine Systems, vol. MMS-11, No. 1, 1970, pp. 58-65.

(Continued)

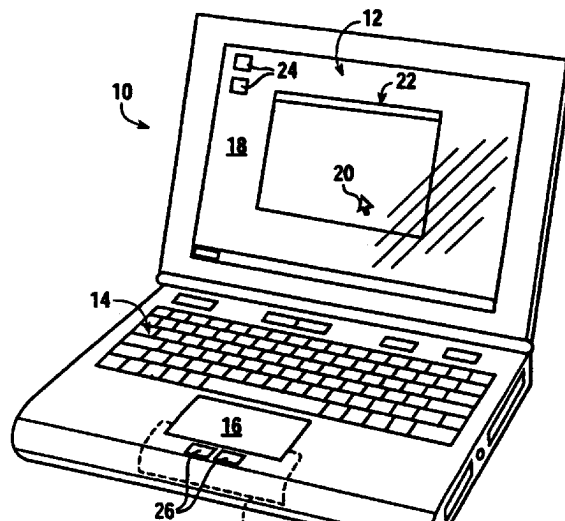
Primary Examiner—Abbas I Abdulselam

(74) *Attorney, Agent, or Firm*—Womble Carlyle Sandridge & Rice, PLLC

(57) **ABSTRACT**

A haptic feedback planar touch control used to provide input to a computer. A touch input device includes a planar touch surface that inputs a position signal to a processor of the computer based on a location of user contact on the touch surface. The computer can position a cursor in a displayed graphical environment based at least in part on the position signal, or perform a different function. At least one actuator is also coupled to the touch input device and outputs a force to provide a haptic sensation to the user contacting the touch surface. The touch input device can be a touchpad separate from the computer's display screen, or can be a touch screen. Output haptic sensations on the touch input device can include pulses, vibrations, and spatial textures. The touch input device can include multiple different regions to control different computer functions.

17 Claims, 5 Drawing Sheets



U.S. PATENT DOCUMENTS

4,101,884 A 7/1978 Benton, Jr.
 4,108,164 A 8/1978 Hall, Sr.
 4,127,752 A 11/1978 Lowthorp
 4,242,823 A 1/1981 Bruno
 4,414,537 A 11/1983 Grimes
 4,414,984 A 11/1983 Zarudiansky
 4,550,221 A 10/1985 Mabusth
 4,557,275 A 12/1985 Dempsey, Jr.
 4,581,491 A 4/1986 Boothroyd
 4,584,625 A 4/1986 Kellogg
 4,692,756 A 9/1987 Clark
 4,715,235 A 12/1987 Fukui et al.
 4,757,453 A 7/1988 Nasiff
 4,758,165 A 7/1988 Tieman et al.
 4,772,205 A 9/1988 Chlumsky et al.
 4,791,416 A 12/1988 Adler
 4,821,030 A 4/1989 Batson et al.
 4,871,992 A 10/1989 Peterson
 4,885,565 A 12/1989 Embach
 4,926,879 A 5/1990 Sevrain et al.
 5,035,242 A 7/1991 Franklin et al.
 5,121,091 A 6/1992 Fujiyama
 5,143,505 A 9/1992 Burdea et al.
 5,159,159 A 10/1992 Asher
 5,165,897 A 11/1992 Johnson
 5,212,473 A 5/1993 Louis
 5,223,658 A 6/1993 Suzuki
 5,237,327 A 8/1993 Saitoh et al.
 5,262,777 A 11/1993 Low et al.
 5,316,017 A 5/1994 Edwards et al.
 5,355,148 A 10/1994 Anderson
 5,376,948 A 12/1994 Roberts
 5,389,849 A 2/1995 Asano et al.
 5,437,607 A 8/1995 Taylor
 5,451,924 A 9/1995 Massimino et al.
 5,521,336 A 5/1996 Buchanan et al.
 5,562,707 A 10/1996 Prochazka et al.
 5,580,251 A 12/1996 Gilkes et al.
 5,638,060 A 6/1997 Kataoka et al.
 5,670,755 A 9/1997 Kwon
 5,714,978 A 2/1998 Yamanaka et al.
 5,719,561 A 2/1998 Gonzales
 5,729,249 A 3/1998 Yasutake
 5,734,373 A 3/1998 Rosenberg et al.
 5,767,457 A 6/1998 Gerpheide et al.
 5,790,108 A 8/1998 Salcudean et al.
 5,828,197 A 10/1998 Martin et al.
 5,828,364 A 10/1998 Siddiqui
 5,835,080 A 11/1998 Beeteson et al.
 5,887,995 A 3/1999 Holehan
 5,889,236 A 3/1999 Gillespie et al.
 5,914,708 A 6/1999 LaGrange et al.
 5,917,906 A 6/1999 Thornton
 5,942,733 A 8/1999 Allen et al.
 5,943,044 A 8/1999 Martinelli et al.
 5,959,613 A 9/1999 Rosenberg et al.
 5,977,867 A 11/1999 Blouin
 5,982,304 A 11/1999 Selker et al.
 5,986,643 A 11/1999 Harvill et al.
 5,988,902 A 11/1999 Holehan
 5,999,168 A 12/1999 Rosenberg et al.
 6,004,134 A 12/1999 Marcus et al.
 6,008,800 A 12/1999 Pryor
 6,118,435 A 9/2000 Fujita et al.

6,429,846 B2* 8/2002 Rosenberg et al. 345/156
 6,680,729 B1 1/2004 Shahoian et al.
 2003/0122779 A1 7/2003 Martin et al.
 2004/0075676 A1 4/2004 Rosenberg et al.

FOREIGN PATENT DOCUMENTS

JP 6-18341 1/1994
 JP 11-299305 11/1999
 WO WO 92/00559 A1 1/1992
 WO WO 95/20788 A1 8/1995
 WO WO 97/18546 5/1997

OTHER PUBLICATIONS

Bolanowski, S.J. et al., "Four Channels Mediate the Mechanical Aspects of Touch," *J. Acoust. Soc. Am.* 84 vol. 84 (5), Nov. 1988, pp. 1680-1694.
 Durlach, Nathaniel I. et al., "Virtual Reality: Scientific and Technological Challenges," National Academy Press, Washington, D. C. 1995, pp. 160-205.
 Eberhardt, Silvio P. et al., "OMAR—A Haptic Display for Speech Perception by Deaf and Deaf-Blind Individuals," *IEEE* 1993, pp. 195-201.
 Eberhardt, Silvio P. et al., "Inducing Dynamic Haptic Perception by the Hand: System Description and Some Results," *Proceedings of ASME Dynamic Systems and Control*, vol. DSC-55-1, No. 1, 1994, pp. 345-351.
 Frisken-Gibson, Sarah F. et al., "A 64-Solenoid, Four-Level Fingertip Search Display for the Blind," *IEEE Transactions on Biomedical Engineering*, vol. BME-34, No. 12, Dec. 1987, pp. 963-965.
 Goldstein, Moise H. et al., "Tactile Aids for the Profoundly Deaf Child," *77 J. Acoust. Soc. Am* 77 (1), Jan. 1985, pp. 258-265.
 Jackson, K. M., "Linearity of Radio-Frequency Transducers," *Medical and Biological Engineering and Computer*, Jul. 1977, pp. 446-449.
 Johnson, David A., "Shape-Memory Alloy Tactical Feedback Actuator," *Tini Allow Company, Inc.*, Aug. 1990, 2 pages, pp. i-33.
 Kaczmarek, Kurt A. et al., "Electrotactile and Vibrotactile Displays for Sensory Substitution Systems", *IEEE Transactions on Biomedical Engineering*, vol. 38, No. 1, Jan. 1991, pp. 1-16.
 Kaczmarek, K. A. et al. "Tactile Displays," in: *Virtual Environments and Advanced Interface Design*, New York: Oxford University Press, 1995, pp. 349-414.
 Peine, W.J., "Tactile Shape Displays for Small Scale Shape Feedback," <http://www.hrl.harvard.edu/~peine/display.html>, 1998, pp. 1-2.
 Rabinowitz, W.M. et al., "Multidimensional Tactile Displays: Identification of Vibratory Intensity, Frequency, and Contact Area," *J. Acoust. Soc. Am.* 82 (4), Oct. 1987, pp. 1243-1252.
 Ramstein, Christophe, "Combining Haptic and Braille Technologies: Design Issues and Pilot Study," *Assets '96, 2nd Annual ACM Conference on Assistive Technologies*, ACM Siggraph, Apr. 1996, pp. 37-44.
 Wiker, Steven F., "Teletouch Display Development: Phase I Report," *Naval Ocean Systems Center, Technical Report 1230*, Jul. 1988, 66 pages.
 Wiker, Steven F. et al., "Development of Tactile Mice for Blind Access to Computers: Importance of Stimulation Locus, Object Size, and Vibrotactile Display Resolution," *Proceedings of the Human Factors Society 35th Annual Meeting*, 1991, pp. 708-712.
 International Preliminary Report on Patentability, Application No. PCT/US2005/036861, dated Apr. 11, 2007.
 International Search Report, Application No. PCT/US2005/036861, dated Feb. 23, 2006.

* cited by examiner

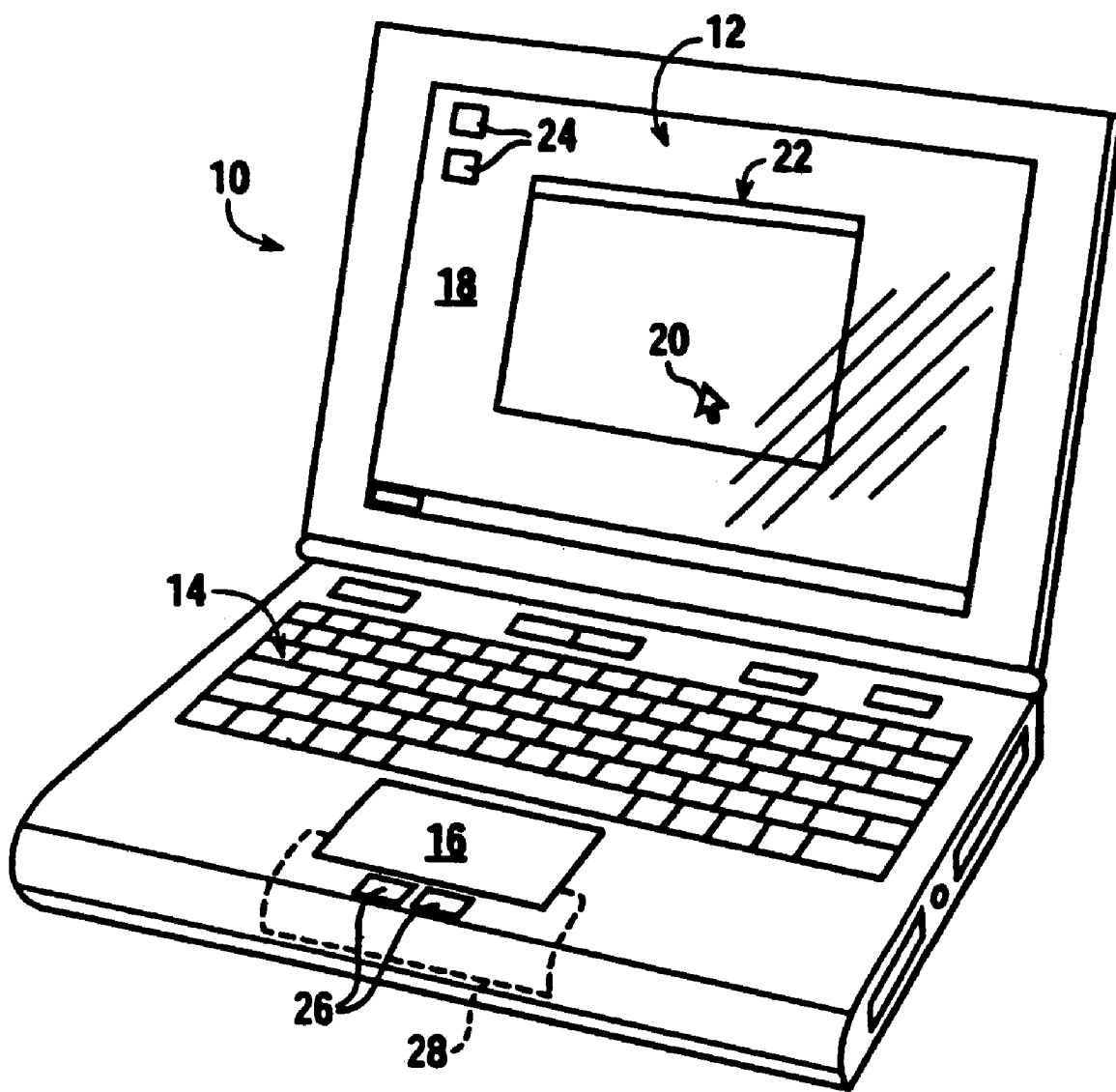


FIG. 1

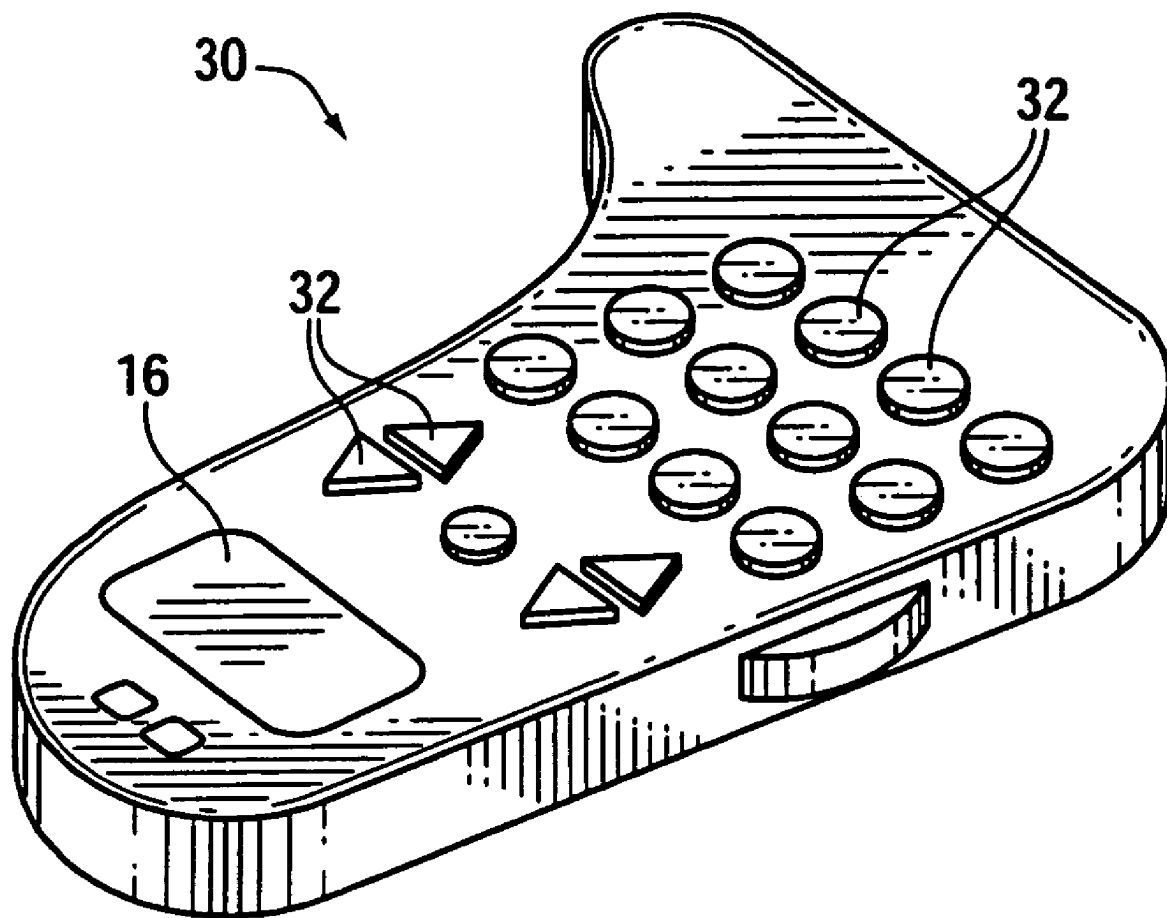


FIG. 2

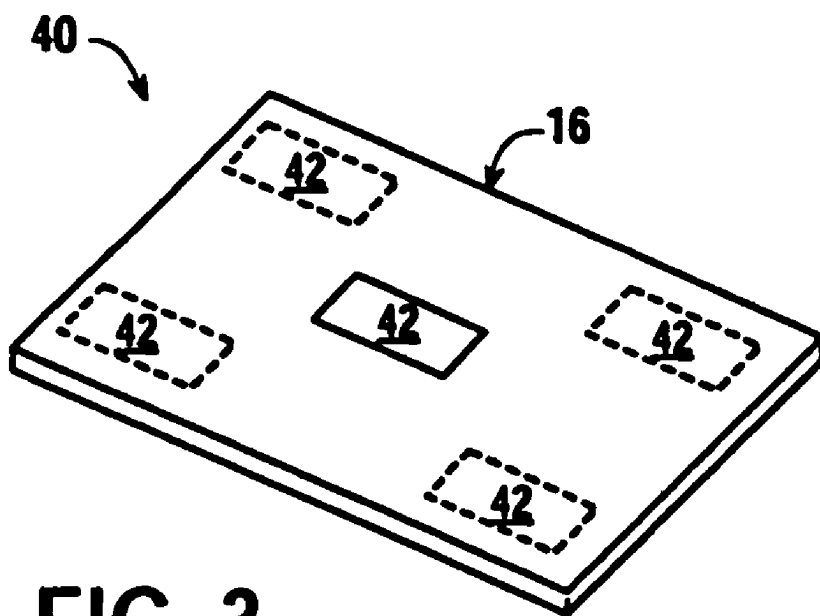


FIG. 3

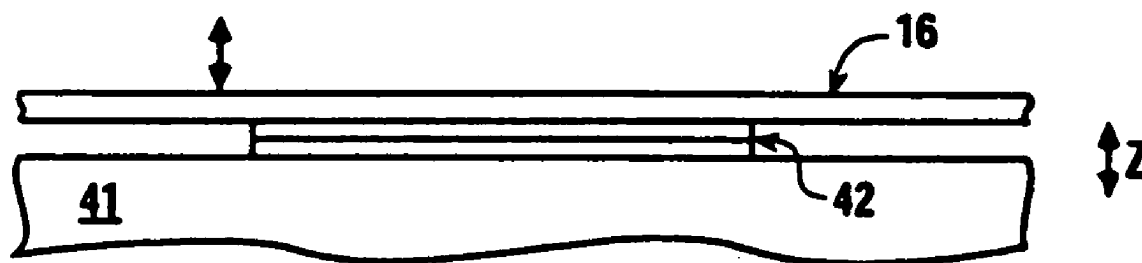


FIG. 4

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.