US007881902B1

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

(10) **Patent No.: US 7,881,902 B1**
(45) **Date of Patent: Feb. 1, 2011**

(54) **HUMAN ACTIVITY MONITORING DEVICE**

(75) Inventors: **Philippe Kahn**, Aptos, CA (US); **Arthur Kinsolving**, Santa Cruz, CA (US); **Mark Andrew Christensen**, Santa Cruz, CA (US); **Brian Y. Lee**, Aptos, CA (US); **David Vogel**, Santa Cruz, CA (US)

(73) Assignee: **DP Technologies, Inc.**, Scotts Valley, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/694,135**

(22) Filed: **Jan. 26, 2010**

Related U.S. Application Data

(63) Continuation of application No. 11/644,455, filed on Dec. 22, 2006, now Pat. No. 7,653,508.

(51) **Int. Cl.**
G01C 22/00 (2006.01)
G06F 19/00 (2006.01)

(52) **U.S. Cl.** **702/160**; 377/24.2; 702/97

(58) **Field of Classification Search** 33/700, 33/701; 73/1.01, 1.37, 1.38, 1.75, 1.76, 1.77, 73/1.78, 1.79, 1.81; 377/1, 13, 15, 17, 20, 377/24, 24.1, 24.2; 702/1, 85, 97, 127, 141, 702/150, 155, 158, 160, 187, 189
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,285,041	A	8/1981	Smith	
4,578,769	A	3/1986	Frederick	
5,446,725	A	8/1995	Ishiwatari	
5,446,775	A	8/1995	Wright et al.	
5,593,431	A	1/1997	Sheldon	
5,955,667	A	9/1999	Fyfe	
5,976,083	A	11/1999	Richardson et al.	
6,013,007	A	1/2000	Root et al.	
6,135,951	A	10/2000	Richardson et al.	
6,145,389	A	11/2000	Ebeling et al.	
6,369,794	B1	4/2002	Sakurai et al.	
6,493,652	B1	12/2002	Ohlenbusch et al.	
6,513,381	B2	2/2003	Fyfe et al.	
6,522,266	B1	2/2003	Soehren et al.	
6,532,419	B1	3/2003	Begin et al.	
6,539,336	B1	3/2003	Vock et al.	
6,611,789	B1 *	8/2003	Darley	702/160
6,700,499	B2	3/2004	Kubo et al.	
6,790,178	B1	9/2004	Mault et al.	
6,813,582	B2	11/2004	Levi et al.	

(Continued)

OTHER PUBLICATIONS

"Wearable Health Reports," Technology Review, Feb. 28, 2006, http://www.techreview.com/printer_friendly_article_aspx?id+16431, Mar. 22, 2007, 3 pages.

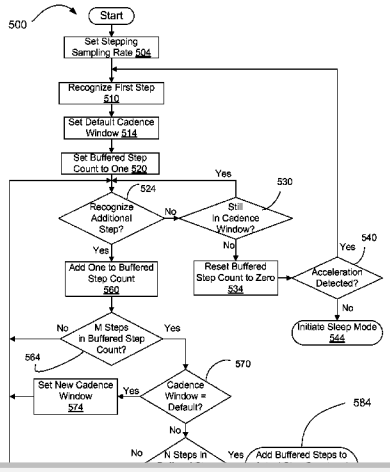
(Continued)

Primary Examiner—Edward R Cosimano
(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman, LLP; Judith A. Szepesi

(57) **ABSTRACT**

A method for monitoring human activity using an inertial sensor includes continuously determining an orientation of the inertial sensor, assigning a dominant axis, updating the dominant axis as the orientation of the inertial sensor changes, and counting periodic human motions by monitoring accelerations relative to the dominant axis.

11 Claims, 9 Drawing Sheets



U.S. PATENT DOCUMENTS

6,823,036	B1	11/2004	Chen	
6,826,477	B2	11/2004	Ladetto et al.	
6,836,744	B1	12/2004	Asphahani et al.	
6,881,191	B2	4/2005	Oakley et al.	
6,885,971	B2	4/2005	Vock et al.	
6,898,550	B1	5/2005	Blackadar et al.	
6,928,382	B2	8/2005	Hong et al.	
6,941,239	B2	9/2005	Unuma et al.	
6,959,259	B2	10/2005	Vock et al.	
6,975,959	B2	12/2005	Dietrich et al.	
7,010,332	B1	3/2006	Irvin et al.	
7,072,789	B2	7/2006	Vock et al.	
7,092,846	B2	8/2006	Vock et al.	
7,148,797	B2	12/2006	Albert	
7,158,912	B2	1/2007	Vock et al.	
7,169,084	B2	1/2007	Tsuji	
7,171,331	B2	1/2007	Vock et al.	
7,200,517	B2	4/2007	Darley et al.	
7,212,943	B2	5/2007	Aoshima et al.	
7,220,220	B2	5/2007	Stubbs et al.	
7,297,088	B2	11/2007	Tsuji	
7,328,611	B2 *	2/2008	Klees et al.	73/290 V
7,334,472	B2	2/2008	Seo et al.	
7,353,112	B2	4/2008	Choi et al.	
7,387,611	B2	6/2008	Inoue et al.	
7,457,719	B1	11/2008	Kahn et al.	
7,526,402	B2	4/2009	Tenanhaus et al.	
7,647,196	B2 *	1/2010	Kahn et al.	702/149
7,653,508	B1 *	1/2010	Kahn et al.	702/160
7,753,861	B1 *	7/2010	Kahn et al.	600/595
2002/0089425	A1	7/2002	Kubo et al.	
2002/0109600	A1	8/2002	Mault et al.	
2002/0151810	A1	10/2002	Wong et al.	
2003/0018430	A1	1/2003	Ladetto et al.	
2003/0109258	A1	6/2003	Mantyjarvi et al.	
2003/0139692	A1	7/2003	Barrey et al.	
2004/0225467	A1	11/2004	Vock et al.	
2005/0033200	A1	2/2005	Soehren et al.	
2005/0222801	A1	10/2005	Wulff et al.	
2005/0232388	A1	10/2005	Tsuji	
2005/0232404	A1	10/2005	Gaskill	
2005/0238132	A1	10/2005	Tsuji	
2005/0240375	A1	10/2005	Sugai	
2005/0248718	A1	11/2005	Howell et al.	
2006/0020177	A1	1/2006	Seo et al.	
2006/0100546	A1	5/2006	Silk	
2006/0136173	A1	6/2006	Case et al.	
2006/0223547	A1	10/2006	Chin et al.	
2007/0061105	A1 *	3/2007	Darley et al.	702/182
2007/0063850	A1	3/2007	Devaul et al.	
2007/0067094	A1	3/2007	Park et al.	
2007/0082789	A1	4/2007	Nissila et al.	
2007/0125852	A1	6/2007	Rosenberg	
2007/0142715	A1	6/2007	Banet et al.	
2007/0208531	A1 *	9/2007	Darley et al.	702/142
2009/0043531	A1	2/2009	Kahn et al.	
2009/0234614	A1 *	9/2009	Kahn et al.	702/141
2009/0319221	A1 *	12/2009	Kahn et al.	702/141
2010/0056872	A1 *	3/2010	Kahn et al.	600/300
2010/0057398	A1 *	3/2010	Darley et al.	702/160

OTHER PUBLICATIONS

Dao, Ricardo, "Inclination Sensing with Thermal Accelerometers", MEMSIC, May 2002, 3 pages.

Lee, Seon-Woo, et al., "Recognition of Walking Behaviors for Pedestrian Navigation," ATR Media Integration & Communications Research Laboratories, Kyoto, Japan, 4 pages.

Margaria, Rodolfo, "Biomechanics and Energetics of Muscular Exercise", Chapter 3, pp. 105-125, Oxford: Clarendon Press 1976.

Mizell, David, "Using Gravity to Estimate Accelerometer Orientation", Seventh IEEE International Symposium on Wearable Computers, 2003, 2 pages.

Ormoneit, D., et al., "Learning and Tracking Cyclic Human Motion," Encyclopedia of Library and Information Science, vol. 53, supplement 16, 2001, 7 pages.

PCT International Search Report and Written Opinion for International Application No. PCT/US2008/072537, mailed Oct. 22, 2008, 10 pages.

PCT International Search Report and Written Opinion for PCT/US2009/48523, mailed Aug. 27, 2009, 8 pages.

Weinberg, Harvey, "MEMS Motion Sensors Boost Handset Reliability" Jun. 2006, http://www.mwrf.com/Articles/Print.cfm?ArticleID=12740, Feb. 21, 2007, 4 pages.

* cited by examiner

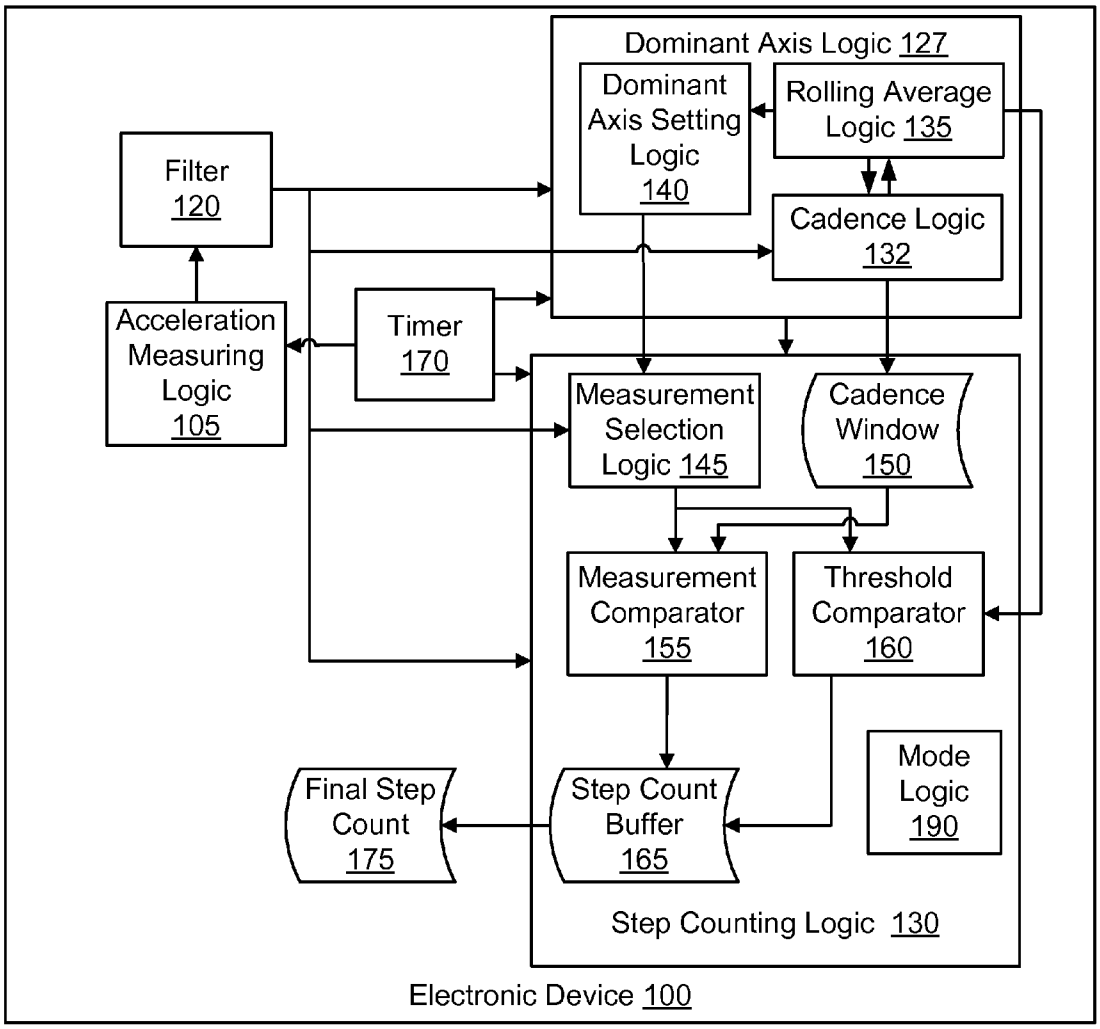


Figure 1

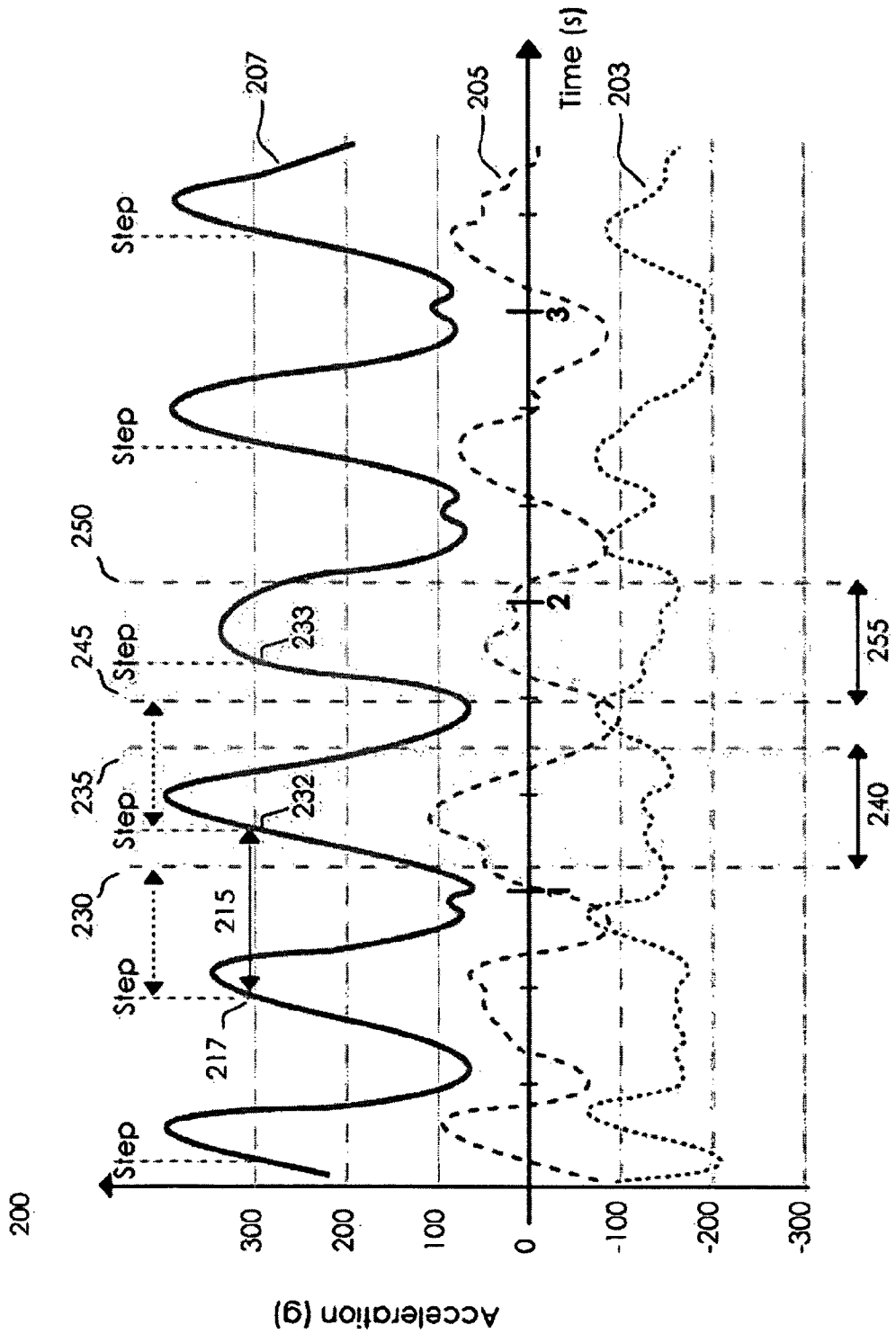


Figure 2

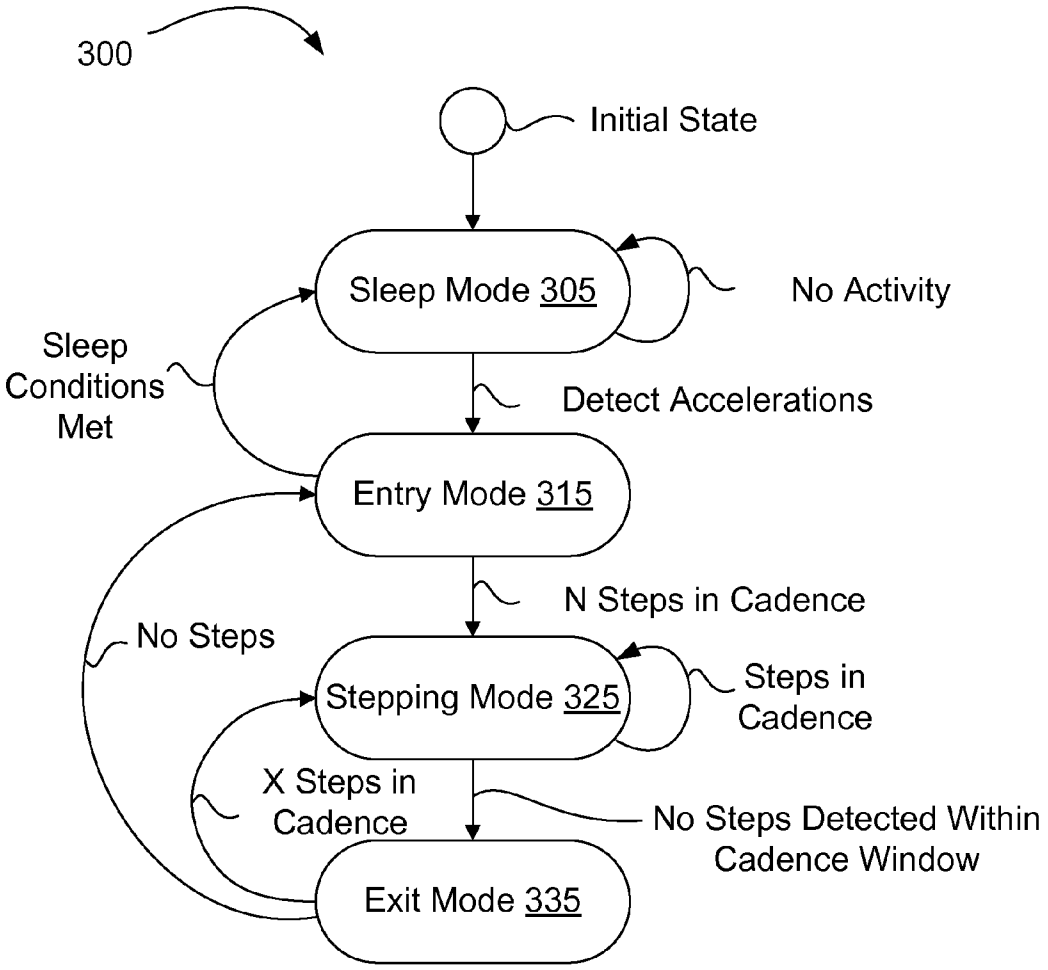


Figure 3

DOCKET ALARM

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.