

- [54] **ACCURATE, RAPID, RELIABLE POSITION SENSING USING MULTIPLE SENSING TECHNOLOGIES**
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- [73] **Assignee:** Virtual Technologies, Inc., Palo Alto, Calif.
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- [52] **U.S. Cl.** **364/550; 340/524; 340/619; 340/686; 364/559; 364/449.1; 473/128; 463/49**
- [58] **Field of Search** 128/639, 640, 128/642, 774, 779, 781, 782; 340/524, 547-549, 551, 573, 619, 686, 853.8; 364/453, 449, 459, 550, 559; 395/100, 152; 473/128; 463/49

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,868,565	2/1975	Kuipers	324/207.26
4,396,885	8/1983	Constant	324/208
4,414,537	11/1983	Grimes	340/365 R
4,444,205	4/1984	Jackson	128/782
4,542,291	9/1985	Zimmerman	250/231 R
4,986,280	1/1991	Marcus et al.	128/774
5,047,952	9/1991	Kramer et al.	364/513.5
5,166,463	11/1992	Weber	84/600
5,184,009	2/1993	Wright et al.	250/227.11
5,280,265	1/1994	Kramer et al.	338/210

FOREIGN PATENT DOCUMENTS

06408 7/1993 WIPO .

OTHER PUBLICATIONS

Foxlin et al., "An Inertial Head-Orientation Tracker . . ." Virtual Reality Software & Technology, eds. Gurminder et al., World Scientific, Singapore, Aug. 1994.
 Raab et al., "Magnetic position and orientation tracking system," IEEE Trans. on Aero. and Elect. Systems, vol. AES-15, No. 5, pp. 709-718, Sep., 1979.

Polhemus tech. note, "Latency-3SPACE® Magnetrak®, Tracker, Digitizer, and Isotrak®," P.O. Box 560, Colchester, VT, 05446.
 Polhemus 3SPACE® Fastrak® and Isotrak® II product data sheets, Oct. 1994 and Aug. 1993 respectively, P.O. Box 560, Colchester, VT, 05446.
 Ascension Technology Corp. data sheet #ATC 3-92, P.O. Box 527, Burlington, VT, 05402.
 Ascension Technology Corp. tech. note, "Comparison of specifications: Ascension Bird vs. Polhemus Isotrak," P.O. Box 527, Burlington, VT, 05402, pub. data unknown.
 Ascension Technology Corp. advertisement, "From head to toe, we cover all the motions," CyberEdge Journal, p. 9, Nov./Dec. 1994.

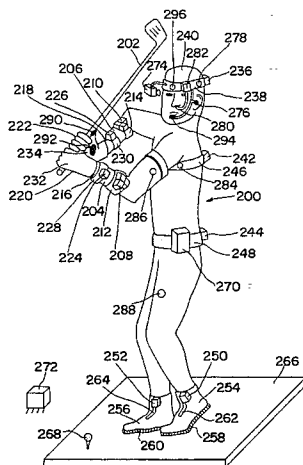
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Primary Examiner—Emanuel T. Voeltz
Assistant Examiner—Hien Vo

[57] **ABSTRACT**

In accordance with the subject invention, devices and methods are provided for the accurate reporting of movement of an entity. Sensors which are accurate, but provide a delayed signal ("delayed signal sensors"), which delay is unacceptable for many applications, may be used in conjunction with fast sensors ("fast signal sensors"), which are usually subject to drift and other inaccuracies in providing information about a position. Additional sensors which may provide even more accurate and/or less signal sensor delay for a period of time, but which sensor signal is subject to periods of interrupted or undesirable output thereby making it unreliable ("unreliable signal sensors") may also be used in combination with one or more of the delayed signal sensors and fast signal sensors. By using a combination of such sensors, accurate, reliable position information is rapidly obtained to allow high-resolution and/or real-time analysis and depictions of movement. Complex rapid movements associated with athletics, music, and other rapid activities can be monitored in real-time to provide accurate information during the movement. Such information may then be used to analyze the movement, for instruction for improvement, for repeating the activity in a virtual setting and the like.

31 Claims, 5 Drawing Sheets



OTHER PUBLICATIONS

Kistler Instrument Corp., "Advanced instrumentation for a world of applications," 75 John Glenn Dr., Amherst, NY, 14228-2171, Gen. Catalog K2.006, 3rd Ed, Jul. 1993.

Analog Devices, "Accelerometer data sheets and application notes," P.O. Box 9106, Norwood, MA 02062-9106, Apr. 1994.

Gyration, Inc., "Gyration open loop directional gyroengine, model GE9300C," 12930 Saratoga Ave., Bldg. C, Saratoga, CA 94070, data sheet C-1003, Sep. 1994.

BioVision, "State of the art motion capture," 2882 Sand Hill Road, Suite 116, Menlo Park, CA 94025, Product brochure, Aug. 1994.

Adaptive Optics Assoc., Inc., "Capture motion, release creativity," 54 Cambridge Park Dr., Cambridge, MA 02140-2308, Product brochure MT202-CM, Aug. 1994.

Tekscan, Inc., "Tekscan corporate capabilities," 451 D. Street, Boston, MA 02210.

Interlink Electronics, "FSR™ integration guide & evaluation parts catalog," 546 Flynn Road, Camarillo, CA, 93012.

Wavefront Technologies, "Synthetic characters wish to exist," 530 E. Montecito Street, Santa Barbara, CA 93103, X-IST product announcement, Aug. 1994.

B. A. Marcus, W. Lucas, EXOS, Inc., P. J. Churchill, A.D. Little, Inc. "Human hand sensing for robotics and teleoperations," Sensors Magazine, Nov. 1989.

J. A. Hall, "The human interface in three dimensional computer art space," Master's Thesis, Massachusetts Institute of Technology, Oct. 1985.

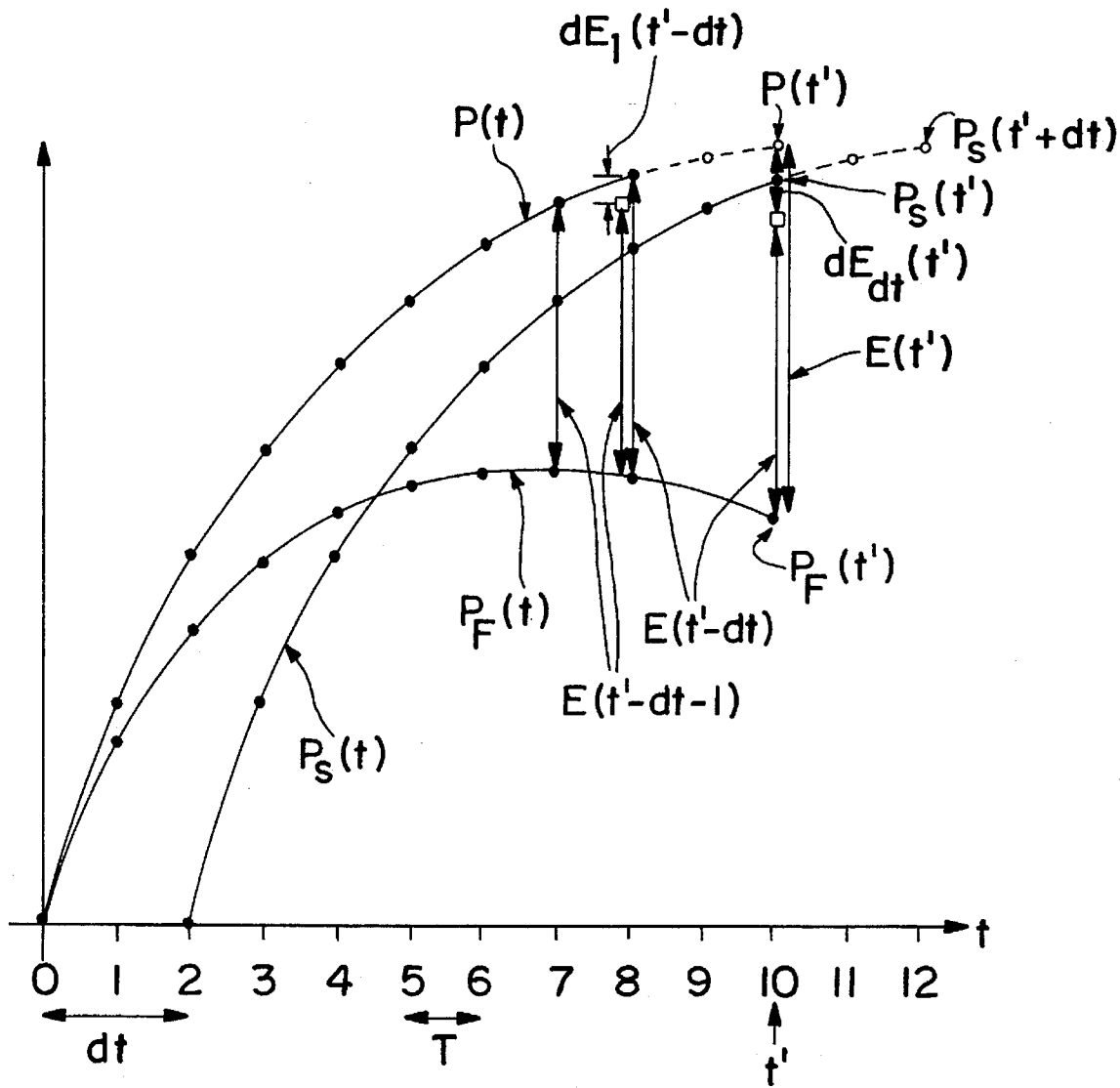


FIG. 1

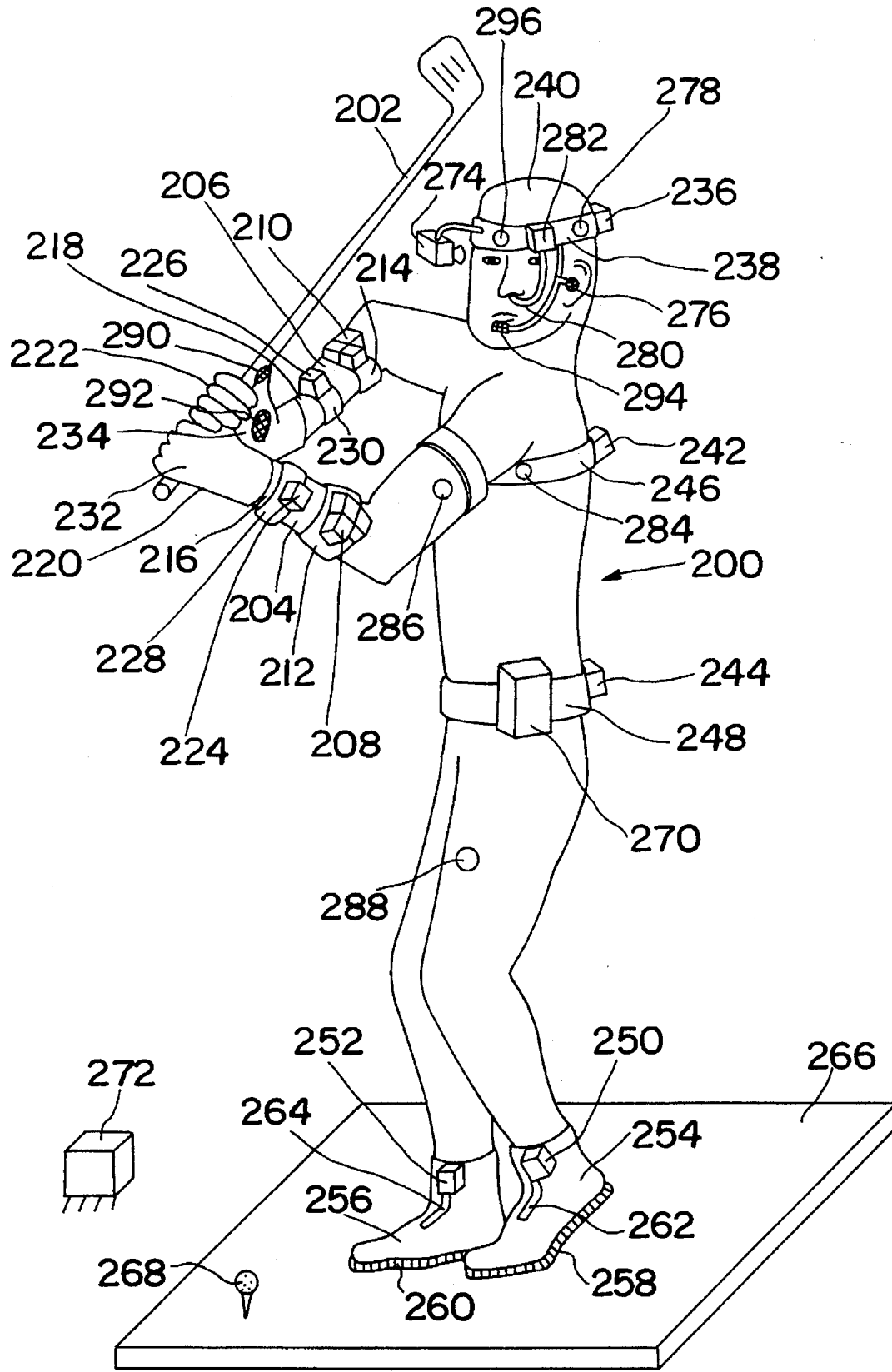


FIG. 2

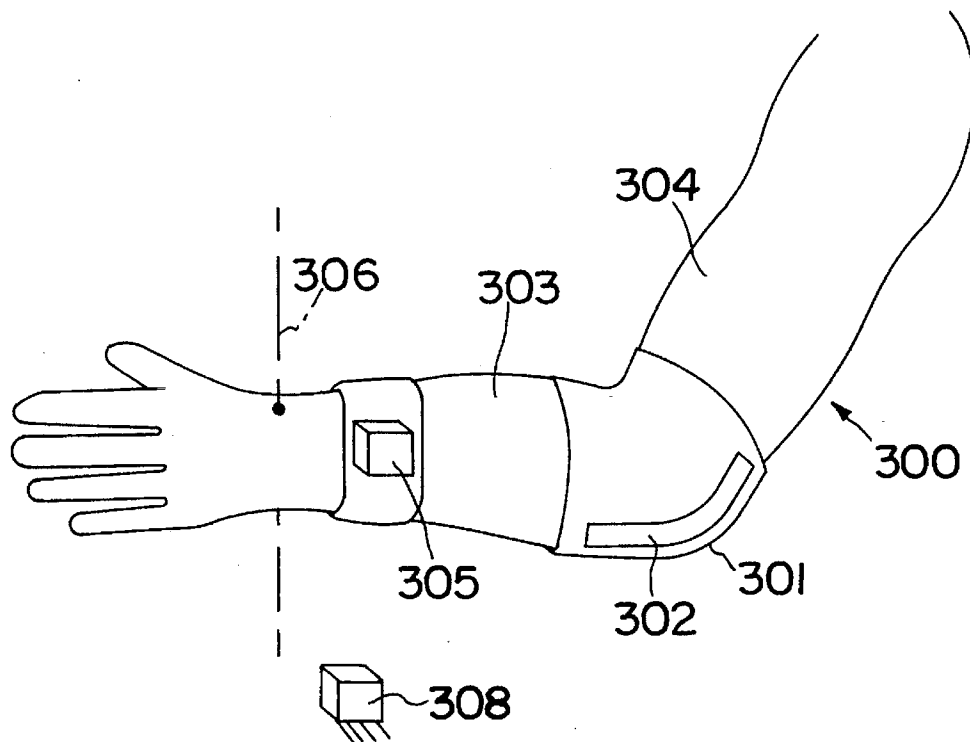


FIG. 3

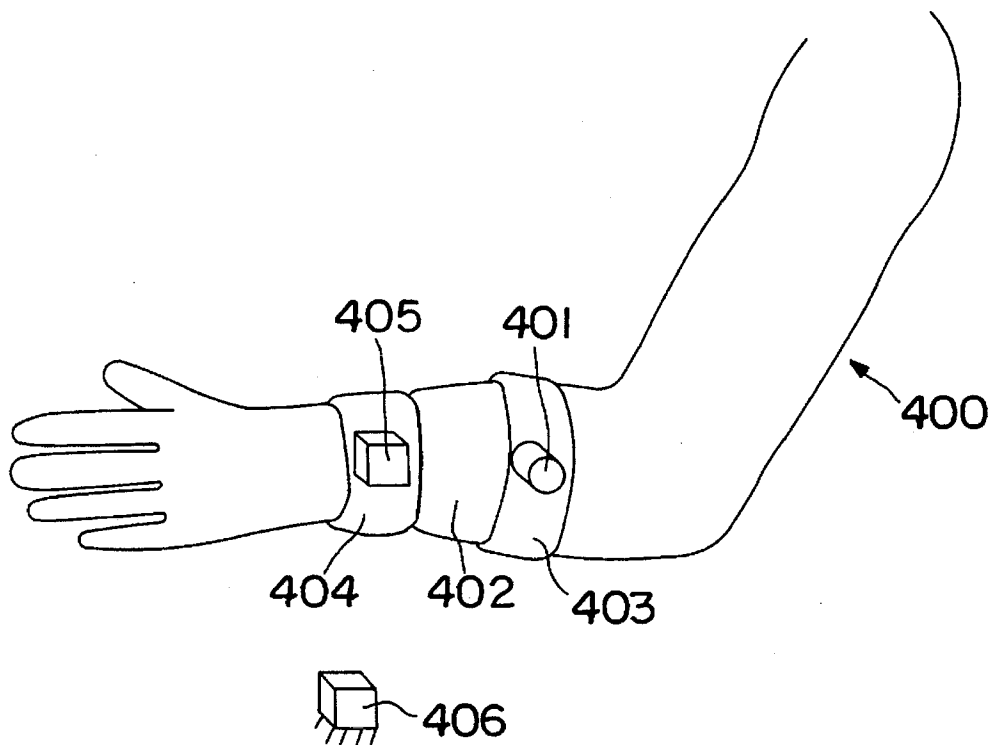


FIG. 4

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