



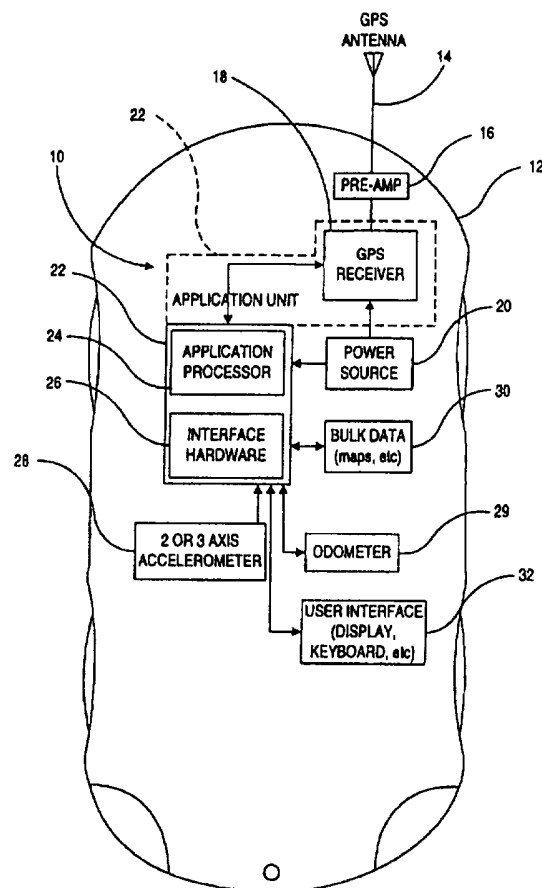
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : G01C 21/20, G01S 5/14		A3	(11) International Publication Number: WO 97/24577
			(43) International Publication Date: 10 July 1997 (10.07.97)
(21) International Application Number: PCT/US96/20849		(81) Designated States: JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 27 December 1996 (27.12.96)		Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
(30) Priority Data: 08/580,150 28 December 1995 (28.12.95) US		(88) Date of publication of the international search report: 16 October 1997 (16.10.97)	
(71) Applicant (for all designated States except US): ROCKWELL INTERNATIONAL CORPORATION [US/US]; 2135 West Maple Road, Troy, MI 48084 (US).			
(72) Inventors; and (75) Inventors/Applicants (for US only): CROYLE, Steven, R. [US/US]; 27201 Gardenway Road, Franklin, MI 48025 (US). SPENCER, Larry, E., II [US/US]; 525 Joslyn Road, Lake Orion, MI 48362 (US). SITTARO, Ernie, R. [US/US]; 420 Wonder Lane, Romeo, MI 48065 (US).			
(74) Agent: SLENZAK, Laura, M.; Rockwell International Corporation, 2135 West Maple Road, Troy, MI 48084 (US).			

(54) Title: IMPROVED VEHICLE NAVIGATION SYSTEM AND METHOD

(57) Abstract

The improved vehicle navigation system and method uses information from a Global Positioning System (GPS) to obtain velocity vectors, which include speed and heading components, for "dead reckoning" the vehicle position from a previous position. If information from the GPS is not available, then the improved vehicle navigation system uses information from an orthogonal axes accelerometer, such as two or three orthogonally positioned accelerometers, to propagate vehicle position. Because the GPS information should almost always be available, the improved vehicle navigation system relies less on its accelerometers, thereby allowing the use of less expensive accelerometers. The improved vehicle navigation system retains the accuracy of the accelerometers by repeatedly calibrating them with the velocity data obtained from the GPS information. The improved vehicle navigation system calibrates the sensors whenever GPS data is available (for example, once a second at relatively high speeds). Furthermore, the improved vehicle navigation system does not need to rely on map matching to calibrate sensors. System flexibility is improved because map matching is oblivious to the hardware, and the system hardware can be updated without affecting map matching or a change in the map database.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

Internal Application No
PCT/US 96/20849

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01C21/20 G01S5/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G01C G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>PROCEEDINGS OF THE VEHICLE NAVIGATION AND INFORMATION SYSTEMS CONFERENCE, DEARBORN, OCT. 20 - 23, 1991, vol. PART 2, 20 October 1991, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, pages 635-643, XP000357137</p> <p>WEI-WEN KAO: "INTEGRATION OF GPS AND DEAD-RECKONING NAVIGATION SYSTEMS" see page 640, column 2 see page 638 see page 642, column 2 - page 643, column 1</p>	1-8
A	<p>---</p> <p>-/--</p>	13,20, 21,23, 24,28,29

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention.

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

*& document member of the same patent family

Date of the actual completion of the international search

12 August 1997

Date of mailing of the international search report

2.7.08.97

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+ 31-70) 340-3016

Authorized officer _____

Hunt, J

INTERNATIONAL SEARCH REPORT

Intern. Application No
PCT/US 96/20849

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 903 212 A (YOKOUCHI KAZUHIRO ET AL) 20 February 1990 see column 3, line 22 - column 4, line 45 see column 5, line 33 - line 67 see column 12, line 58 - column 13, line 3 see figure 8	20,21
Y	---	1-8
A	US 5 334 986 A (FERNHOUT HERMAN C) 2 August 1994 see the whole document	1-8
X	---	
X	EP 0 527 558 A (PIONEER ELECTRONIC CORP) 17 February 1993	20,21
Y	see abstract; claim 4 see column 5, line 56 - column 6, line 31 see column 5, line 11 - line 20 see column 3, line 27 - line 55	13,28,29
A	---	1,5,23, 24
X	PATENT ABSTRACTS OF JAPAN vol. 007, no. 078 (P-188), 31 March 1983 & JP 58 009017 A (NAIRUSU BUHIN KK), 19 January 1983,	9,10, 15-17
Y	see abstract	13,28,29
A	---	
A	EP 0 181 012 A (PHILIPS NV) 14 May 1986 see abstract; claim 11	1-8,13, 28,29
X	---	
X	US 5 166 882 A (STAMBAUGH JOHN S) 24 November 1992 see abstract see column 2, line 12 - line 62	9,10, 15-17
A	---	
A	US 4 930 085 A (KLEINSCHMIDT MICHAEL) 29 May 1990 see the whole document	9-12, 15-19
X	---	
X	US 5 331 563 A (MASUMOTO YUTAKA ET AL) 19 July 1994 see abstract see column 3, line 50 - column 4, line 35	25-27, 30,31
X	---	
X	EP 0 488 594 A (SUMITOMO ELECTRIC INDUSTRIES) 3 June 1992 see column 3, line 10 - column 4, line 42	25-27, 30,31
A	---	
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 482 (P-1119), 19 October 1990 & JP 02 194314 A (NISSAN MOTOR CO LTD), 31 July 1990, see abstract	25-27, 30,31

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 96/ 20849

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see extra sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 96/ 20849

FURTHER INFORMATION CONTINUED FROM PCT/ISA/210

1. claims 1-8,13,14,20-24,28,29,32-37:
improved navigation system using GPS velocity data & dead-reckoning system
for improved accuracy
2. claims 9-12,15-19:
accelerometer used to propagate a previous position to a current position
3. claims 25-27,30,31:
zero offset detection of motion detection sensor

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 96/20849

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4903212 A	20-02-90	JP 1053180 A JP 8003524 B	01-03-89 17-01-96
US 5334986 A	02-08-94	DE 4211933 A EP 0565191 A JP 6094472 A	14-10-93 13-10-93 05-04-94
EP 0527558 A	17-02-93	JP 5019036 A JP 5018776 A JP 5018777 A DE 69206073 D DE 69206073 T US 5276451 A	26-01-93 26-01-93 26-01-93 21-12-95 27-06-96 04-01-94
EP 0181012 A	14-05-86	NL 8402497 A AU 581244 B AU 4613985 A CA 1235508 A JP 7081868 B JP 61059386 A US 4758959 A	03-03-86 16-02-89 20-02-86 19-04-88 06-09-95 26-03-86 19-07-88
US 5166882 A	24-11-92	NONE	
US 4930085 A	29-05-90	EP 0263894 A CA 1277401 A JP 63109320 A	20-04-88 04-12-90 14-05-88
US 5331563 A	19-07-94	JP 5157572 A	22-06-93
EP 0488594 A	03-06-92	JP 4208808 A DE 69107586 D DE 69107586 T US 5296855 A	30-07-92 30-03-95 18-01-96 22-03-94