(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 June 2003 (05.06.2003)

PCT

(10) International Publication Number
WO 2003/045639 A3

(51) International Patent Classification[7]: G05B 15/00, 19/00

(21) International Application Number:
PCT/US2002/038280

(22) International Filing Date:
27 November 2002 (27.11.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/334,142	28 November 2001 (28.11.2001)	US
60/355,624	8 February 2002 (08.02.2002)	US
60/374,309	19 April 2002 (19.04.2002)	US

(71) Applicant *(for all designated States except US)*: **EVOLUTION ROBOTICS, INC.** [US/US]; 130 W. Union Street, Pasadena, CA 91103 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MURRAY, Thomas, J., IV** [US/US]; 451 E. Wilshire Avenue, Fullerton, CA 92832 (US). **PHAM, Baoquoc, N.** [US/US]; 291 S. Euclid Avenue #PH3, Pasadena, CA 91101 (US). **PIRJANIAN, Paolo** [US/US]; 1731 Golf Club Drive, Glendale, CA 91206 (US).

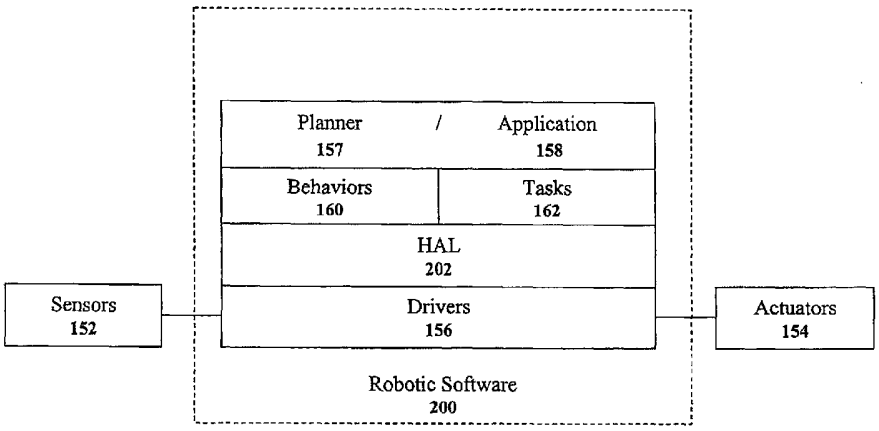
(74) Agent: **ALTMAN, Daniel, E.**; Knobbe, Martens, Olson & Bear, LLP, 2040 Main Street, 14th Floor, Irvine, CA 92614 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,

[Continued on next page]

(54) Title: SENSOR AND ACTUATOR ABSTRACTION AND AGGREGATION IN A HARDWARE ABSTRACTION LAYER FOR A ROBOT



(57) Abstract: The invention is related to methods and apparatus that provide a hardware abstraction layer (HAL) (202) for a robot. A HAL (202) can reside as a software layer or as a firmware layer residing between robot control software (157, 158, 160, 162) and underlying robot hardware (152, 154) and/or an operating system (156) for the hardware. The HAL (202) provides a relatively uniform abstract for aggregates of underlying hardware such that the underlying robotic hardware is transparent to perception and control software (157, 158, 160, 162), i.e., robot control software (157, 158, 160, 162). This advantageously permits robot control software (157, 158, 160, 162) to be written in a robot-independent manner. Developers of robot control software are then freed from tedious lower level tasks. Portability is another advantage. For example, the HAL (202) efficiently permits robot control software (157, 158, 160, 162) developed for one robot to be ported to another. In one example, the HAL (202) permits the same navigation algorithm to be ported from a wheeled robot (104) and used on a humanoid legged robot (106).

WO 2003/045639 A3

TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv)) for US only*
— *of inventorship (Rule 4.17(iv)) for US only*
— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
13 May 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/38280

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : G05B 15/00, 19/00
US CL : 700/245, 248, 259; 901/47
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)
U.S. : 700/245, 248, 259; 901/47

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,832,189 A (TOW) 03 NOVEMBER 1998 (03.11.1998), see entire document	1-14
A	US 6,038,493 A (TOW) 14 March 2000 (14.03.2000), see entire document	1-14
A	STEWART et al., Implementing real-time robotic systems using CHIMERA II, 1990, vol. 1, pages 598-603, see entire document	1-14
A	PAIDY et al., Software architecture for a cell controller, 8-11 January 1991, vol. ii, pages 339-349, see entire document	1-14

☐ Further documents are listed in the continuation of Box C. ☐ See patent family 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 application or patent 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	Date of mailing of the international search report
19 February 2003 (19.02.2003)	02 APR 2003
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer for McDieunel Marc Telephone No. (703) 305-4478

Form PCT/ISA/210 (second sheet) (July 1998)