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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 December 2014 (11.12.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/197401 A3

(51) International Patent Classification:
A61F 2/30 (2006.01) *A61F 2/70* (2006.01)
A61F 2/68 (2006.01)

(21) International Application Number:
PCT/US2014/040569

(22) International Filing Date:
2 June 2014 (02.06.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/830,504 3 June 2013 (03.06.2013) US

(71) Applicant: **THE REGENTS OF THE UNIVERSITY OF COLORADO, A BODY CORPORATE** [US/US]; 1800 Grant Street, 8th Floor, Denver, CO 80203 (US).

(72) Inventors: **SEGIL, Jacob**; 1365 Hartford Drive, Boulder, CO 80305 (US). **WEIR, Richard**; 9162 Tollgate Drive, Longmont, Colorado 80503 (US).

(74) Agents: **BAILEY, Robert A.** et al.; Perkins Coie LLP, P.O. Box 1247, Seattle, Washington 98111-1247 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:
5 March 2015

(54) Title: POSTURAL CONTROL OF A MULTI FUNCTION PROSTHESIS

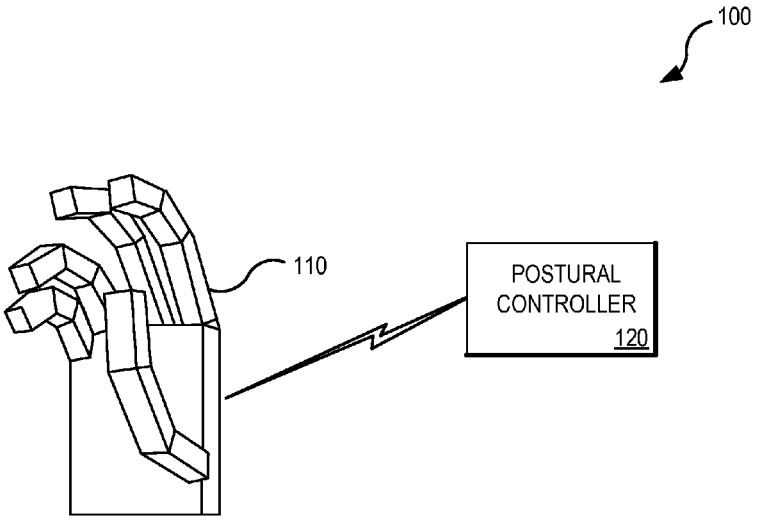

FIG. 1

(57) Abstract: Systems and methods for postural control of a multi-function prosthesis are provided. Various embodiments provide for a postural controller that use EMG signals to drive a point in a posture space and outputs continuously varying joint angles for a powered prosthetic hand. The postural controller can include an EMG signal processing unit to receive signals from electrodes for processing (e.g., band pass filtering, rectification, root mean square averaging, dynamic tuning, etc.). The processed EMG signals can then be combined or converted to produce a point in the postural control domain. The PC domain map defines the posture that corresponds to each PC cursor coordinate. This map can have limitless possible postures and limitless possible positions of the postures. The Joint Angle Transform converts the PC cursor coordinate into the joint angle array which is sent to the prosthetic hand thereby creating more natural movements.

WO 2014/197401 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/40569

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61F 2/30, 2/68, 2/70 (2014.01)
CPC - A61F 2/54, 2/60, 2/68, 2250/0096
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(8): A61F 2/30, 2/42, 2/48, 2/54, 2/68, 2/70, 2/72 (2014.01)
CPC: A61F 2/54, 2/60, 2/68, 2250/0096, G06N 3/008; B25J 9/1633; USPC: 623/24, 25, 27, 57; 700/258, 261

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 practicable, search terms used)
MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); ScienceDirect, Google/Google Scholar, ProQuest, IP.com; Search terms used: prosthet*, artificial*, limb, stump, amput*, sensor, knee, electrode*, actuator*, joint, angles, feedback, controller, module, EMG, electromy*, monitor, postur*, grip, grasp, poses, arraly, linear, pattern, control, vector, sum, algorithm

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2011/0264238 A1 (VAN DER MERWE, DA et al.) October 27, 2011; abstract; figures 1A, 2, 31A, 31B, 32, 43; paragraphs [0085]-[0088], [0128], [0187], [0191]	1-4, 6, 7, 15-20 ---------- 5
Y	WO 2012/123693 A1 (FRIPP DESIGN & RESEARCH LIMITED) September 20, 2012; paragraphs [0004], [0006], [0060]-[0061]; figures 1-3	5

☐ Further documents are listed in the continuation of Box C. ☐

* 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 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	Date of mailing of the international search report
31 October 2014 (31.10.214)	19 DEC 2014

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/40569

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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 No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

Group I: Claims 1-7 and 15-20 are directed toward a prosthetic device and method.

Group II: Claims 8-14 are directed toward a postural controller.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical features of Group I include a set of electrodes configured to monitor muscle contractions and generate EMG signals; a set of actuators configured to control joint angles of the prosthetic device, which are not present in Group II; the special technical features of Group II include a memory having stored thereon a postural control space having a set of preselected postures each defining joint angles of a mechanical device; wherein the point in the postural control space lies between two of the pre-selected postures, which are not present in Group I.

-***- Continued on Extra Sheer -***-

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 additional fees, this Authority did not invite payment of additional fees.

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.:
1-7, 15-20

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

-***-Continued from Box No. III - Observations where unity of invention is lacking-***-

The common technical features of Groups I and II are a postural controller comprising: a processor configured to receive processed EMG signals and determine desired set of joint angles defining a desired posture by controlling a point in a postural control space.

These common technical features are disclosed by EP 2497610 A1 (MENGA). Menga discloses a postural controller (a control system for a walking robotic device; abstract; figure 1) comprising: a processor configured to receive processed EMG signals (control unit 12 *receives EMG signals indicative of the patient intention, direction and strength of movement, from bioelectric sensors 14 placed on the* muscles involved in lower limb movements; paragraph [0019]; figure 1) and determine desired set of joint angles defining a desired posture by controlling a point in a postural control space (control unit 12 processes EMG signals and based on the control algorithms outputs suitable driving commands for the electric motors 10, in particular indicative of the torque that is to be applied to the ankle, knee *and hip joints 7, 8, 9, in order to cause their angular movement; paragraph [0020]; figure 1).*

Since the common technical features are previously disclosed by the Menga reference, the common features are not special and so Groups I and II lack unity.