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(54) Title: SYSTEMS AND METHODS FOR HUMAN AND ROBOT COLLABORATION

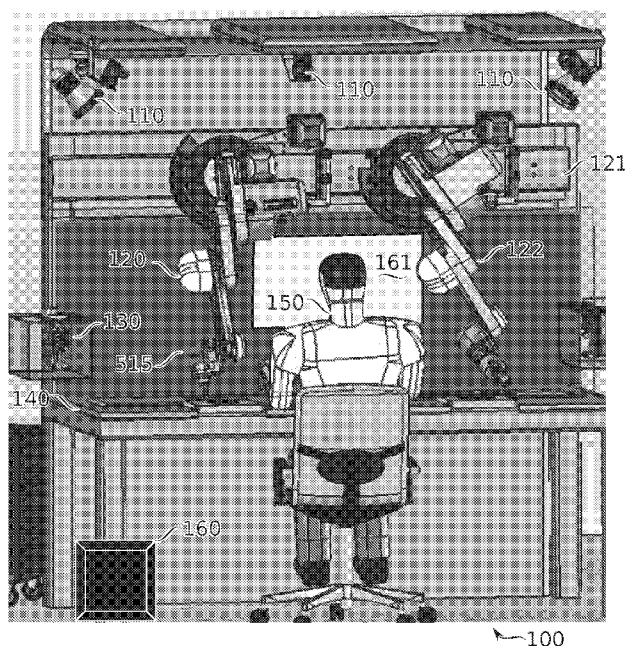


FIG. 1A

(57) Abstract: Robotic systems for simultaneous human-performed and robotic operations within a collaborative workspace are described. In some embodiments, the collaborative workspace is defined by a reconfigurable workbench, to which robotic members are optionally added and/or removed according to task need. Tasks themselves are optionally defined within a production system, potentially reducing computational complexity of predicting and/or interpreting human operator actions, while retaining flexibility in how the assembly process itself is carried out. In some embodiments, robotic systems comprise a motion tracking system for motions of individual body members of the human operator. Optionally, the robotic system plans and/or adjusts robotic motions based on motions which have been previously observed during past performances of a current operation.





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).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 17/50367

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 19/00 (2017.01)

CPC - G06N3/008, B62D57/032, G05D1/0274, G05D1/0255, G05D1/0246, B25J9/1682, G05B19/41815, B25J9/1617, B25J9/1697, G05B19/4182, B25J9/161, B25J9/1661, B25J9/1666, B25J9/1664

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)

See Search History Document

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

See Search History Document

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

See Search History Document

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 2014/0067121 A1 (Brooks et al.) 06 March 2014 (06.03.2014), para. [0009], [0022]-[0023], [0026], [0028]-[0029], [0031]-[0032], and [0034]-[0036], and Figs. 1-3B.	1-3, 6-8, 12-14 ----- 4-5, 9-11, 15-32
Y	US 2012/0173021 A1 (Tsusaka) 05 July 2012 (05.07.2012), para. [0142], [0213]-[0215], [0271]-[0273], [0364], [0367], and [0438], and Fig. 1A.	4-5, 11, 15-17, 21-32
Y	US 2009/0222149 A1 (Murray et al.) 03 September 2009 (03.09.2009), para. [0007]-[0008], [0038], and [0041], and Figs. 2-4.	9-10
Y	US 2015/0355805 A1 (Quantum Interface, LLC) 10 December 2015 (10.12.2015), para. [0028], [0035], [0050], [0071], [0082], [0105], [0108], and [0178].	18-22, 31

☐ 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 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

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 17/50367

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:

--- 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 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.:
1-32

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.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 17/50367

Continuation of Box No. III, Observations where unity of invention is lacking:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

Group I: Claims 1-32, directed to a robotic system and method for controlling motion of a robot, including recording positions of human body members.

Group II: Claims 33-35, directed to a robotic system with a robotic member having a mounting and releasing mechanism.

Group III: Claims 36-38, directed to a robotic member with a plurality of robotic segments joined by a joint comprising two plates held separate from one another.

Group IV: Claims 39-41, directed to a method of controlling a robotic system with a plurality of ordered operations of a task.

Group V: Claims 42-47, directed to a method of configuring a collaborative robotic assembly task comprising receiving a bill of materials and a list of tools.

Group VI: Claims 48-49, directed to a method of optimizing a collaborative robotic assembly task including a plurality of different task configurations.

The groups of inventions listed above 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 feature of the Group I invention is controlling motion of a robot, including recording positions of human body members, not required by Group II-VI.

The special technical feature of the Group II invention is a robotic member having a mounting and releasing mechanism, not required by Group I or III-VI.

The special technical feature of the Group III invention is a robotic member with a plurality of robotic segments joined by a joint comprising two plates held separate from one another, not required by Group I-II or IV-VI.

The special technical feature of the Group IV invention is controlling a robotic system with a plurality of ordered operations of a task, not required by Group I-III or V-VI.

The special technical feature of the Group V invention is receiving a bill of materials and a list of tools, not required by Group I-IV or VI.

The special technical feature of the Group VI invention is optimizing a collaborative robotic assembly task including a plurality of different task configurations, not required by Group I-V.

Groups I-VI share the technical features of, in various combination, a robotic system or robotic member. Additionally, some groups share the technical features of collaborative operations by a robotic system and a human within a collaborative workspace. Some groups share the technical features of robotic task configurations.

However, these shared technical features fail to represent a contribution over the prior art of US 2014/0067121 A1 to Brooks et al. (hereinafter "Brooks"), which discloses a robotic system (Brooks, para. [0026] and Figs. 2A-2B: robot 200) comprising: at least one robotic member (Brooks, para. [0026] and Figs. 2A-2B: robot 200) for performing collaborative operations with a human within a collaborative workspace (Brooks, abstract, para [0022], [0036], etc.) including robotic task configurations (Brooks, para [0025]).

Thus, the inventions listed as Groups I-VI lack unity of invention because they do not share a same or corresponding special technical feature providing a contribution over the prior art.