



- (51) International Patent Classification:
G06N 3/04 (2006.01) G06N 3/08 (2006.01)
G06N 3/063 (2006.01)
- (21) International Application Number:
PCT/US2021/039504
- (22) International Filing Date:
29 June 2021 (29.06.2021)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
63/051,847 14 July 2020 (14.07.2020) US
63/154,502 26 February 2021 (26.02.2021) US
- (71) Applicant: VICARIOUS FPC, INC. [US/US]; 2 Union Square, Suite 302, Union City, CA 94587 (US).
- (72) Inventor: KANSKY, Kenneth, Alan; 2 Union Square, Suite 302, Union City, CA 94587 (US).

- (74) Agent: SCHOX, Jeffrey; 501 3rd Street, Suite 300, San Francisco, CA 94107 (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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, 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, ST, 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,

(54) Title: METHOD AND SYSTEM FOR PREEMPTIVE PLANNING

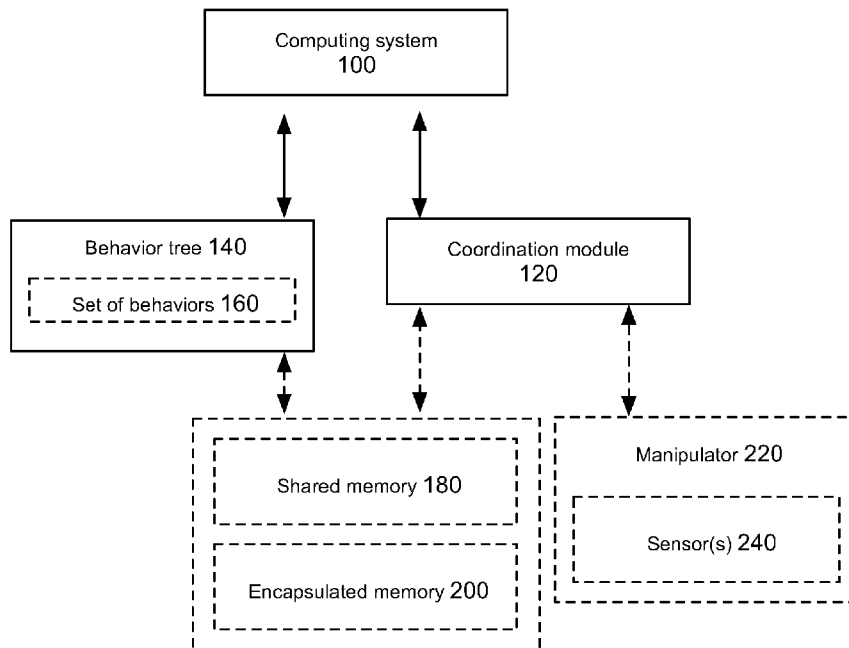


FIGURE 1

(57) Abstract: A method for preemptive control planning can include: optionally determining a graph that defines dependencies between behaviors; executing an execution plan for an executing behavior; generating a set of predictions with the executing behavior; propagating the set of predictions to child behaviors of the executing behavior; determining child execution plans and child predictions with the child behaviors; repeating the above for descendant behaviors of each child behavior; determining a realized world state associated with completion of the execution plan; and executing a child execution plan associated with a world state prediction matching the realized world state.



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:

17 February 2022 (17.02.2022)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US21/39504

A. CLASSIFICATION OF SUBJECT MATTER

IPC - G06N 3/04; G06N 3/063; G06N 3/08 (2021.01)

CPC - G06N 3/008; G06N 3/0472; G06N 3/086; G06N 3/088; G06N 20/10; G06N 20/20; G06N 3/0427; G06N 3/0445; G06N 3/063; G06N 3/084

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	US 2003/0167265 A1 (CORYNEN, G) 04 September 2003; abstract; paragraphs [0021], [0026], [0047], [0048], [0273], [0277]; claims 13, 29	1-12
A	US 2020/0027006 A1 (KNEXUS RESEARCH CORPORATION) 23 January 2020; entire document	1-12
A	US 2017/0102961 A1 (COMPUTATIONAL SYSTEMS, INC.) 13 April 2017; entire document	1-12
A	US 2005/0288819 A1 (DE GUZMAN, N) 29 December 2005; entire document	1-12

 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

"D" document cited by the applicant in the international application

"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

05 October 2021 (05.10.2021)

Date of mailing of the international search report

DEC 30 2021

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US21/39504

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:
-***-Please See Supplemental Page-***-

- 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.:
1-12

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/US21/39504

-***-Continued From 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. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-12 are directed towards a system comprising a coordination module to receive predictions associated with exit statuses.

Group II: Claims 13-20 are directed towards a method comprising executing an execution plan for an executing behavior and changing a world state.

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 at least a system; a planning model and a prediction model; and a coordination module, configured to: "a" receive world state predictions associated with exit statuses that are output by the prediction models of parent behaviors, wherein a child behavior executes a predetermined execution plan, repeat "a" and "b", which are not present in Group II.

The special technical features of Group II include at least a method; executing an execution plan for an executing behavior and changing a world state, repeating "b"-"d", executing a child execution plan associated with a world state prediction matching the realized world state, which are not present in Group I.

The common technical features shared by Groups I-II are a graph defining hierarchical dependencies between behaviors; propagating world state predictions to child behaviors; planning child execution plans with the child behaviors and outputting child state predictions; repeating steps for descendants of the child behaviors; and determining a realized world state.

However, these common features are previously disclosed by US 2020/0097014 A1 to MITSUBISHI ELECTRIC RESEARCH LABORATORIES, INC (hereinafter "MITSUBISHI"). MITSUBISHI discloses a graph defining hierarchical dependencies between behaviors (a graph using doubletree construction (hierarchical) with an initial tree of nodes originating at the initial node and a target tree of nodes originating at the target node (dependencies) for exploring the state space and selecting control actions (between behaviors); abstract; para [0009]); propagating world state predictions to child behaviors (incorporating (propagating) global information relating to possible decisions (world state predictions) to a target tree of nodes (child behaviors); para [0015]); planning child execution plans with the child behaviors (adding a child node connected to an expandable node with an edge defined by a collision free primitive motion, such that a cost of the child node is less than the cost of the expandable node (planning child execution plans) using the target tree of nodes (child behaviors); para [0017], [0018]) and outputting child state predictions (motion planner is configured to select an expandable node in the target tree based on a cost of the expandable node, and expand the graph (outputting) by adding a child node connected to the expandable node with an edge defined by a collision free primitive motion (child state predictions); para [0022]); repeating steps for descendants of the child behaviors (iterating (repeating steps) by selecting expandable nodes and adding child nodes (descendants of the child behaviors); para [0079]-[0081]); and determining a realized world state (realizing global information (world state); para [0015]).

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