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- (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, 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, 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.

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Declarations under Rule 4.17:

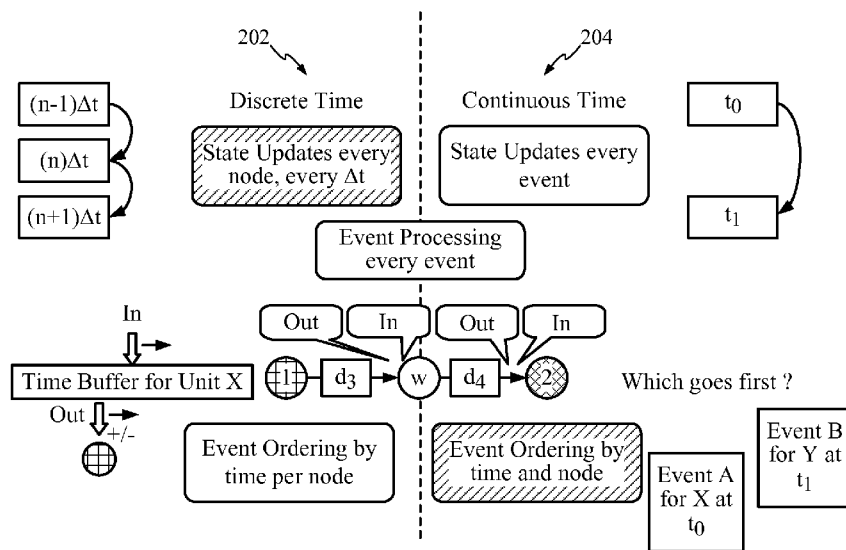
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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:
10 April 2014

(54) Title: CONTINUOUS TIME SPIKING NEURAL NETWORK EVENT-BASED SIMULATION



(57) Abstract: Certain aspects of the present disclosure provide methods and apparatus for a continuous-time neural network event-based simulation that includes a multi-dimensional multi-schedule architecture with ordered and unordered schedules and accelerators to provide for faster event sorting; and a formulation of modeling event operations as anticipating (the future) and advancing (update/jump ahead/catch up) rules or methods to provide a continuous-time neural network model. In this manner, the advantages include faster simulation of spiking neural networks (order(s) of magnitude); and a method for describing and modeling continuous time neurons, synapses, and general neural network behaviors.

WO 2013/181410 A3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/043390

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06N3/04
ADD.
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)
G06N

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)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	R. R. Carrillo Sánchez: "Simulación eficiente de estructuras neuronales basadas en el sistema nervioso", Doctorado de la universidad de Granada, 20 July 2009 (2009-07-20), XP055103249, Retrieved from the Internet: URL:http://hdl.handle.net/10481/2404 [retrieved on 2009-12-04] Capítulo 2 ----- -/--	1-68

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 3 March 2014	Date of mailing of the international search report 12/03/2014
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Douarche, Nicolas

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/043390

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	A. Mouraud: "Approche distribuée pour la simulation événementielle de réseaux de neurones impulsionsnels: application au contrôle des saccades oculaires", Doctorat de l'université des Antilles et de la Guyane, 29 June 2009 (2009-06-29), XP055103248, Retrieved from the Internet: URL:http://liris.cnrs.fr/Documents/Liris-4292.pdf [retrieved on 2014-02-14] Chapitres 2-4	1-68
X	M. Neumann: "Yinspire: ein performance-effizienter Simulator für gepulste Neuronale Netze", Studienarbeit der Universität Karlsruhe (TH), 8 May 2008 (2008-05-08), XP055103254, Retrieved from the Internet: URL:http://www.ntecs.de/projects/documents/yinspire_thesis/yinspire_thesis.pdf [retrieved on 2008-06-10] Abschnitte 2, 8 und 10	1-68
X	R. C. Agis Melero: "Arquitecturas para el procesamiento de sistemas neuronales para el control de robots bioinspirados", Doctorado de la universidad de Granada, 8 October 2007 (2007-10-08), XP055103251, Retrieved from the Internet: URL:http://hdl.handle.net/10481/1635 [retrieved on 2009-10-26] Capítulos 3 y 4	1-68
X	S. SCHOLZE, H. EISENREICH, S. HÖPPNER, G. ELLGUTH, S. HENKER, M. ANDER, S. HÄNZSCHE, J. PARTZSCH, C. MAYR, R. SCHÜFFNY: "A 32 GBit/s communication SoC for a waferscale neuromorphic system", INTEGRATION, THE VLSI JOURNAL, vol. 45, no. 1, 1 June 2011 (2011-06-01), pages 61-75, XP028324682, DOI: 10.1016/J.VLSI.2011.05.003 Section 3.2.1	1-68
X	R. D. STEWART, K. N. GURNEY: "Spiking neural network simulation: memory-optimal synaptic event scheduling", JOURNAL OF COMPUTATIONAL NEUROSCIENCE, vol. 30, no. 3, 3 November 2010 (2010-11-03), pages 721-728, XP019912205, DOI: 10.1007/S10827-010-0288-6 Sections 2 and 4	1-68
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/043390

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>R. BRETTE ET AL: "Simulation of networks of spiking neurons: a review of tools and strategies", JOURNAL OF COMPUTATIONAL NEUROSCIENCE, vol. 23, no. 3, 12 July 2007 (2007-07-12), pages 349-398, XP019552702, DOI: 10.1007/S10827-007-0038-6 Sections 2.3 and 2.4 -----</p>	1-68

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/043390

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.: **69-196**
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:
see FURTHER INFORMATION sheet PCT/ISA/210

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:

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 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.:

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 69-196

Under Article 6 PCT, the claims shall define the matter for which protection is sought. The claims shall be clear and concise and be fully supported by the description.

The application counts one hundred and ninety-six claims, of which twelve have been drafted as separate independent claims. Not only do the claims lack conciseness (Article 6 PCT), but they also cannot be fully supported by the forty-five pages of description--i.e. more than four claims per page, on average--(Article 6 PCT). In addition, such a lack of conciseness is bound to reflect on a clear definition of the matter for which protection is sought (Article 6 PCT).

Therefore, the claims do not meet the requirements of Article 6 PCT to such an extent that no meaningful search is at present possible in relation to independent claims 69, 90, 111, 132, 153, 164, 175, 186 and their one hundred and twenty dependent claims.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.