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(54) Title: MULTIVARIATE DETECTION OF ABNORMAL CONDITIONS IN A PROCESS PLANT

(57) Abstract: Methods and systems to detect abnormal operations in a process of a process plant include collecting on-line process data. The collected on-line process data is generated from a plurality of dependent and independent process variables of the process, such as a coker heater. A plurality of multivariate statistical models of the operation of the process are generated using corresponding sets of the process data. Each model is a measure of the operation of the process when the process is on-line at different times, and at least one model is a measure of the operation of the process when the process is on-line and operating normally. The models are executed to generate outputs corresponding to loading value metrics of a corresponding dependent process variable, and the loading value metrics are utilized to detect abnormal operations of the process.



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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/079988

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05B23/02

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)
G05B

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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LI ERGUO ET AL: "An input-training neural network-based nonlinear principal component analysis approach for fault diagnosis" INTELLIGENT CONTROL AND AUTOMATION, 2002. PROCEEDINGS OF THE 4TH WORLD CONGRESS ON JUNE 10-14, 2002, PISCATAWAY, NJ, USA, IEEE, 10 June 2002 (2002-06-10), pages 2755-2759, XP010594089 ISBN: 0-7803-7268-9	1-3,6-9, 12
Y	page 2758, right-hand column, line 16 - page 2759, left-hand column, line 24	4,5,10, 11
Y	US 2003/139905 A1 (HELSPER DAVID [US] ET AL) 24 July 2003 (2003-07-24) paragraph [0048] - paragraph [0050]	4,5,10, 11
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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 document 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/US2007/079988

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>LE-JIE ZHAO ET AL: "A nonlinear modeling and online monitoring method for the batch process using multiple local PCA" MACHINE LEARNING AND CYBERNETICS, 2003 INTERNATIONAL CONFERENCE ON NOV. 2-5, 2003, PISCATAWAY, NJ, USA, IEEE, vol. 2, 2 November 2003 (2003-11-02), pages 1190-1194, XP010678342 ISBN: 0-7803-7865-2</p>	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/079988

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 additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable 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.:

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-12

A system for facilitating detection of an abnormal operation of a process in a process plant, the system comprising:
a data collection tool adapted to collect online process data from a process within the process plant, wherein the collected on-line process data is representative of an operation of the process when the process is on-line and wherein the collected on-line process data is generated from a plurality of process variables of the process including one or more independent process variables and one or more dependent process variables dependent upon at least one of the one or more independent process variables;
an analysis tool comprising a multivariate statistical analysis engine adapted to generate a first representation of the operation of the process based on a first set of the collected on-line process data generated from the plurality of process variables of the process, wherein the first representation of the operation of the process is adapted to be executed to generate a first outcome related to a dependent process variable, and wherein the multivariate statistical analysis engine adapted to generate a second representation of the operation of the process based on a second set of the collected on-line process data generated from the plurality of process variables of the process, wherein the second representation of the operation of the process is adapted to be executed to generate a second outcome related to the dependent process variable; and
a monitoring tool adapted to determine changes in the process based on the first and second outcomes related to the dependent process variable.

2. claims: 13-25

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

A method of facilitating detection of an abnormal operation of a process in a process plant, the method comprising: collecting on-line process data from a process control system within the process plant, wherein the data is representative of an operation of the process when the process is on-line, and wherein the collected on-line process data is generated from a plurality of dependent and independent process variables of the process comprising a first data space having a plurality of dimensions, wherein a dependent process variable describes the behaviour of the process and an independent process variable affects the behavior of the process;

generating a plurality of models of the operation of the process using a plurality of corresponding sets of the collected on-line process data generated from the process variables of the process, wherein each model comprises a measure of the operation of the process when the process is on-line at different times within a second data space having fewer dimensions than the first data space and at least one model comprises a measure of the operation of the process when the process is on-line and operating normally;

generating one or more outputs from each model of the operation of the process, wherein each output relates to a corresponding dependent process variable; and determining the presence of an abnormal operation based on a comparison of the outputs from the models.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2007/079988

Patent document cited in search report.	Publication date	Patent family member(s)	Publication date
US 2003139905	A1	NONE	