

(51) International Patent Classification:
G05B 17/02 (2006.01)(21) International Application Number:
PCT/EP2010/004674(22) International Filing Date:
30 July 2010 (30.07.2010)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): **ABB TECHNOLOGY AG** [CH/CH]; Affolternstr. 44, CH-8050 Zürich (CH).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GITZEL, Ralf** [DE/DE]; Augartenstr. 26, 68165 Mannheim (DE). **DIX, Marcel** [DE/DE]; Neckarpromenade 15/517, 68167 Mannheim (DE). **STICH, Christian** [DE/DE]; Obergasse 13, 69493 Hirschberg-Leutershausen (DE).(74) Agents: **MILLER, Tovia** et al.; ABB AG, GF-IP, wallstadter Str. 59, 68526 Ladenburg (DE).

(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, 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, KM, 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, PE, PG, PH, PL, PT, RO, RS, RU, 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.

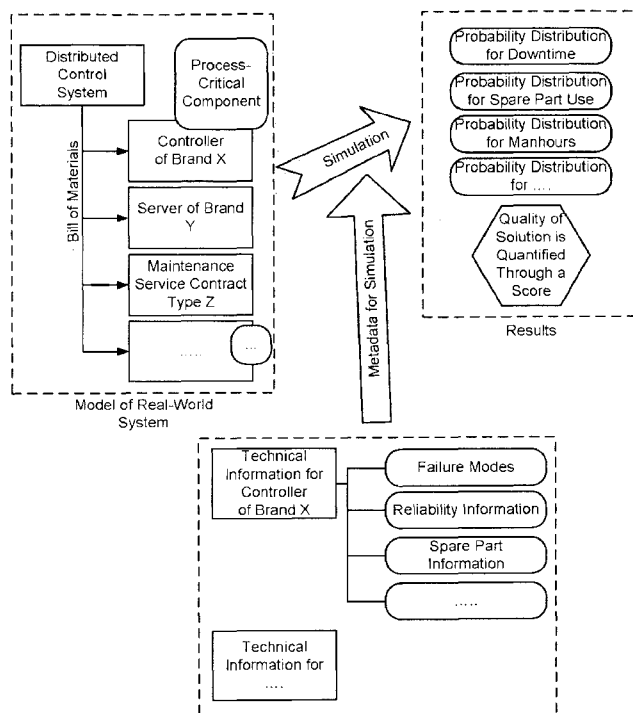
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE,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

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR IDENTIFICATION OF INDEXES, FOR DISTRIBUTED CONTROL SYSTEMS



(57) Abstract: The invention relates to a method system for identifying indexes for distributed control systems using simulation and stochastic models of the behaviour of components of a plant, whereas a model of a real world system is being defined by means of a bill of material which bill comprises a collection of data of features which are adopted from those components being critical for the respective process whereas the identified data are being used for simulation of the real world system.



— *of inventorship (Rule 4.17(iv))*

Published:

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

Method and System for Identification of Indexes for
Distributed Control Systems

Description

The invention refers to a method and system for identification of indexes for goods for distributed control systems, by evaluation of state variables of such goods e.g. as distributed control systems, field devices and personal computers and their respective spare parts which data concerning specific properties and/or features of these goods are used for simulation and stochastic models of the behaviour of components of a plant.

A distributed control system (DCS) refers to a control system usually of a manufacturing system, process or any kind of dynamic system, in which the controller elements are not central in location but are distributed throughout the system with each component sub-system controlled by one or more controllers. The entire system of controllers is connected by networks for communication and monitoring.

It is already known that any prediction of certain occurrences within the near or far future is desirable, but it is known, too, that such predictions often fail to become true.

Furthermore with the increase of calculation power the efforts for developing such methods and system which allow any reliable prediction or at least a safe estimation of selected criteria with respect to measurable properties or appreciable data of goods, in particular technical equipment such as distributed control systems, field devices and personal computers and their respective spare parts and the like have been raised.

Today, the so-called "Mean Time to Failure" is used to calculate the average number of failures assuming a constant failure rate. Hence it is an object of the present invention to provide a method and a system for the identification of indexes for goods, in particular provided for distributed control systems, which are easily viable at rather low effort.

Accordingly the invention improves upon this method by using more realistic failure behaviour, i.e. the method according to the invention is characterized in that a model of a real world system is being defined by means of a bill of material which bill comprises a collection of data of features which are adopted from those components being critical for the respective process whereas the identified data are being used for simulation of the real world system.

The invention uses simulation combined with stochastic information about the system components to calculate the average values for the metrics.

As for the indexes to be generated they shall reveal the prospective performance of the respective goods in particular with special regard to the reliability of operation, the plant safety and its operability.

As a matter of course all data being identified are collected and stored in a comprehensive database in order to have all information about current products available for reliable assessment of the respective good.

Furthermore said bill of material is annotated with the respective information which is supposed to be critical for the respective process or sub-process with regard to the plant or equipment to be evaluated and rated.

Concretely the method according to the invention is characterized in that in a first step failures with the operation of the respective components are simulated, in a second step the number of failures per year is set at either 0 or 1 per instance, and in a third step the drivers of the different indexes are calculated as well as the average values of the calculated indexes

Preferably the average values are calculated by running the simulation multiple times whereas singular values of the indexes to be calculated may be changed.

According to preferred embodiment the method according to the invention is characterized in that the calculation of the drivers of the different indexes is based on the probability of failure as well as of redundancy.

An advantageous improvement of the method according to the invention provides for the simulation that it uses known failure data to calculate the probability of failure each year ignoring the fact that multiple failures could occur.

A system for identifying indexes for distributed control systems by using simulation and stochastic models of the behaviour of components of a plant, advantageously is characterized in that the system is a model of a real world system being defined by means of a bill of material which bill comprises a collection of data of features which are adopted from those components being rated to be critical for the respective process whereas the simulation of the real world system uses the identified data.

Preferably the system comprises a chain of products and decisions whereas a decision can be either "keep" or "replace" and whereas the chain describes an evolution plan, i.e. a schedule for changes to be observed during the life time of the system.

According to an improvement of the invention the system examines a class of components being regarded as critical for the operability of the component and reliability of operation.

In detail the system is designed for gathering all information of components belonging to the distributed control system in order to establish a model of a real-world system whereas the information comprises in particular the data of components being assessed to be critical for the respective process,

Furthermore the required technical information to be processed by the system provides data of the respective component and/or equipment whereas the data refer among others to failure modes, reliability information, spare part information each related to any component distinguished according to their manufacturers.

Finally the results of the simulation according to the system of the invention are data which reveal the probability distribution for several technical properties of the system, such as downtime, use of spare parts, or man-hours, and furthermore a score which

expresses the quantification of the quality of the achieved solution based on quantitative factors.

Summarizing the invention is an automated method for calculating crucial metrics or indexes for distributed control systems using simulation and stochastic models of the plant's components' behaviour whereas the problem to be solved is a proper calculation of metrics respectively indexes to measure the quality of a distributed control system (DCS) evolution plan.

For this purpose a comprehensive database with information about current products is created. Future products are described by a comparative estimation based on an existing product. The database contains information such as a cumulated probability function for reliability, additional failure information, and cost data and being represented by the cubes in the figure.

A system is modeled as a chain of products and decisions. The decisions can be either stay, in which case the product is kept, and replace, in which case a new instance of the same product or an instance of a follow-up product may be installed.

This chain describes an evolution plan, which is shown in the middle of the figure. Each pair of product instance and decision represents one year of planned time.

In order to calculate the desired metrics, failures are simulated. The number of failures per year is either 0 or 1 per instance. Based on the probability of failure as well as redundancy, the drivers of the different metrics are calculated. The averages are calculated by running the simulation multiple times.

As a simple example, a system consisting of only 2 controllers of the same type is examined. The intended metric to be calculated is the total system downtime within the next 15 years.

For each of the controllers a plan of future replacements exists whereas in this case, both controllers will be replaced by a follow-up product in 10 years. The simulation uses known failure data to calculate the probability of failure each year ignoring the fact that multiple failures could occur.

In each simulation run, a random variable is used to determine whether a controller fails in a given year or not. The average of all simulation runs is used to provide an estimate of the metric.

Typical metrics are downtime, number of failures, and service man hours.

The automated method can be run by itself or as part of a plant design/engineering tool. In the latter case it can support design decisions and evaluate their impact on life cycle cost.

Description

The attached figure reveals an exemplary system according to the invention where in a first box a model of the real-world system is being depicted with all its components and respective criteria to be observed. In particular those components are being depicted which are assessed to be critical for the respective process.

The model of the real-world system is defined as a bill of material wherein the respective components and criteria to be observed for the distributed control system are collected and wherein technical information, e.g. criticality, is annotated.

In a second box the technical information being available for any of the components belonging to the real-world system is shown whereas for any component the information as depicted has to be provided.

A third box contains the results gained by the simulation according to the invention.

Furthermore there are two arrows whereas the first arrow points from the first box which reveals the model of the real-world system to the third box and is labelled as "Simulation". The second arrow is labelled as "Metadata for Simulation" and points from the second box to the first arrow.

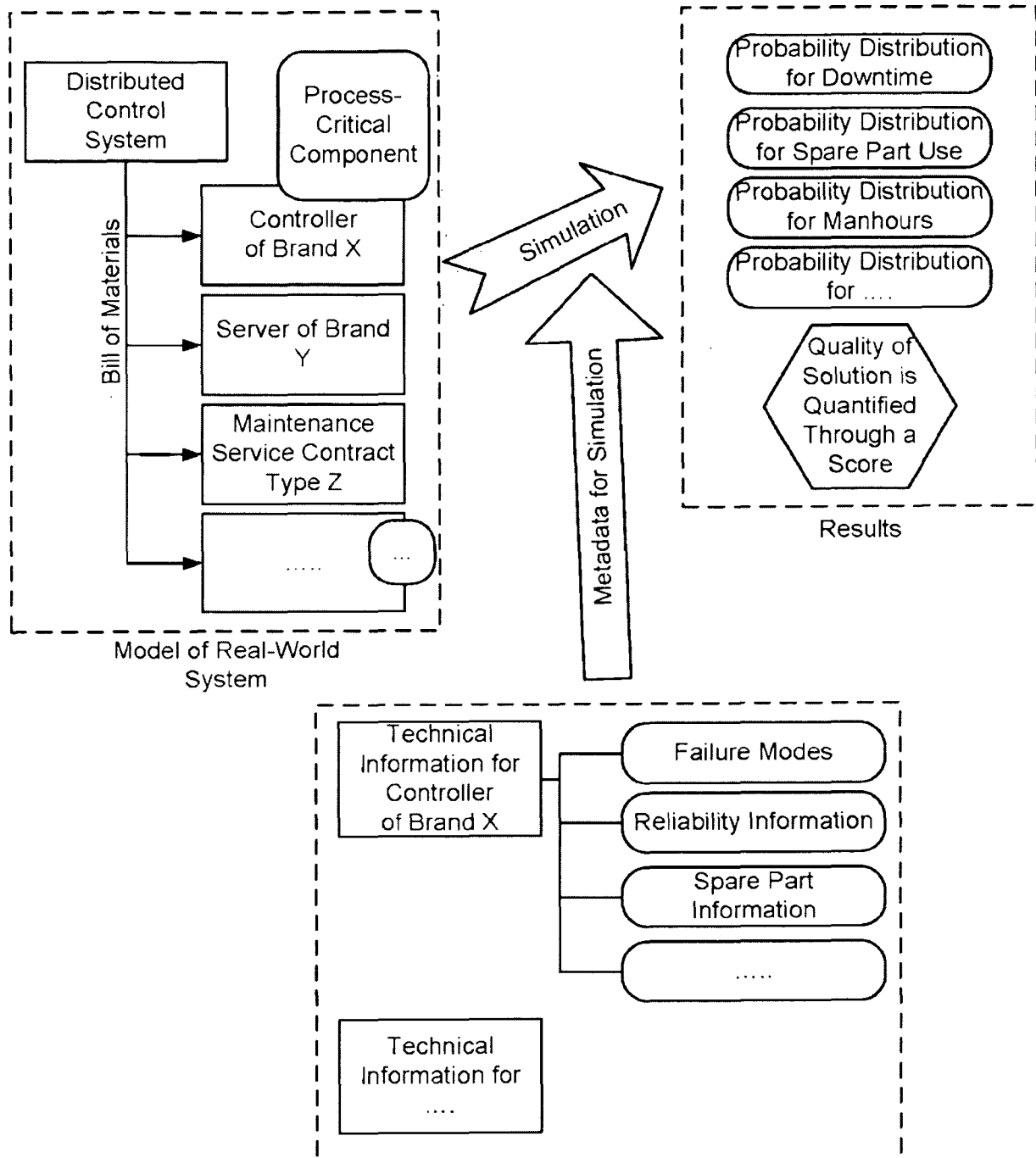
The arrows shall symbolize the main route of the claimed method according to the invention which is based on the simulation of a model of a real-world system by means of the necessary technical information and results in the desired predictions

of various distribution probabilities e.g. for downtime, for spare part use, for man-hours and the like.

Claims

1. Method for identifying indexes for distributed control systems using simulation and stochastic models of the behaviour of components of a plant,
characterized in that
a model of a real world system is being defined by means of a bill of material which bill comprises a collection of data of features which are adopted from those components being critical for the respective process whereas the identified data are being used for simulation of the real world system.
2. Method according to claim 1, characterized in that all data being identified are collected and stored in a comprehensive database in order to have all information about current products available for reliable assessment of the respective good.
3. Method according to claim 1 or 2, characterized in that
 - failures with the operation of the respective components are simulated
 - whereas the number of failures per year is either 0 or 1 per instance,
 - the drivers of the different indexes are calculated as well as average values of the calculated indexes
4. Method according to claim 3, characterized in that the averages are calculated by running the simulation multiple times.
5. Method according to claim 3 or 4, characterized in that calculation of the drivers of the different indexes based on the probability of failure as well as of redundancy.
6. Method according to at least one of the preceding claims, whereas the simulation uses known failure data to calculate the probability of failure each year ignoring the fact that multiple failures could occur.

7. System for identifying indexes for distributed control systems using simulation and stochastic models of the behaviour of components of a plant,
characterized in that
the system is a model of a real world system being defined by means of a bill of material which bill comprises a collection of data of features which are adopted from those components being rated to be critical for the respective process whereas the simulation of the real world system uses the identified data.
8. System according to claim 1, characterized in that the system comprises a chain of products and decisions whereas a decision can be either “keep” or “re-place” and whereas the chain describes an evolution plan.
9. System according to claim 1, characterized in that the system examines a class of components being regarded as critical for the operability of the component and reliability of operation.



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/004674

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05B17/02
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)
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)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/126040 A1 (FRANKLIN KENT A [US] ET AL) 29 May 2008 (2008-05-29) page 1 - page 3	1-9
X	----- WO 01/84254 A2 (PROCTER & GAMBLE [US]; UNIV CALIFORNIA [US]) 8 November 2001 (2001-11-08) page 5 - page 7 page 9 - page 12	1-9
T	----- Wenyuan Li: "Risk Assessment of Power Systems: Models, Methods, Applications", 18 January 2005 (2005-01-18), John Wiley & Sons, XP002631127, ISBN: 9780471631682 pages 79-87, page 79 - page 87 -----	

☐ 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

26 April 2011

Date of mailing of the international search report

24/05/2011

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

Bassi, Luca

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2010/004674

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2008126040	A1	29-05-2008	NONE	

WO 0184254	A2	08-11-2001	AT 395646 T	15-05-2008
			AU 5938501 A	12-11-2001
			CA 2407775 A1	08-11-2001
			EP 1287410 A2	05-03-2003
			ES 2306713 T3	16-11-2008
