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**Datasheet for the decision
of 16 October 2015**

Case Number: T 1806/11 - 3.5.05

Application Number: 06786952.9

Publication Number: 1913506

IPC: G06F19/00

Language of the proceedings: EN

Title of invention:
Intelligent condition monitoring and fault diagnostic system
for predictive maintenance

Applicant:
Brooks Automation, Inc.

Headword:
Machine condition monitoring and fault diagnosis/BROOKS
AUTOMATION

Relevant legal provisions:
EPC 1973 Art. 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 1806/11 - 3.5.05

**D E C I S I O N
of Technical Board of Appeal 3.5.05
of 16 October 2015**

Appellant: Brooks Automation, Inc.
(Applicant) 15 Elizabeth Drive
Chelmsford, MA 01824 (US)

Representative: Ipside
7-9 Allées Haussmann
33300 Bordeaux Cedex (FR)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 7 March 2011
refusing European patent application
No. 06786952.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair A. Ritzka
Members: P. Cretaine
G. Weiss

Summary of Facts and Submissions

I. The appeal is against the decision of the examining division, posted on 7 March 2011, to refuse European patent application No. 06786952.9 on the grounds of Article 123(2) EPC with respect to a main request and an auxiliary request 2, lack of clarity (Article 84 EPC 1973) with respect to auxiliary requests 1 and 3, and lack of inventive step (Article 56 EPC 1973), having regard to the disclosure of

D1: US 6 434 512,

with respect to auxiliary request 4.

II. Notice of appeal was received on 6 May 2011 and the appeal fee was paid on the same day. The statement setting out the grounds of appeal was received on 12 July 2011. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of a main request or auxiliary request 1, both filed with the statement setting out the grounds of appeal. The claims of the main request were identical to the claims of auxiliary request 4 on which the contested decision was based. Oral proceedings in French were requested.

III. A summons to oral proceedings scheduled for 16 October 2015 was issued on 16 July 2015. In an annex to this summons, the board gave its preliminary opinion on the appeal pursuant to Article 15(1) RPBA. Objections were raised under Article 56 EPC 1973 with respect to the main request and to auxiliary request 1 on file, having regard to the disclosures of **D1** or

D2: DE 44 47 288.

- IV. With a letter dated 16 September 2015, the appellant filed auxiliary requests 2 and 3 and provided arguments in support of inventive step for all the requests on file.
- V. Oral proceedings were held as scheduled on 16 October 2015. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the main request or auxiliary request 1, both filed with the statement setting out the grounds of appeal, or on the basis of auxiliary requests 2 and 3, both filed with letter dated 16 September 2015.

At the end of the oral proceedings, the decision of the board was announced.

- VI. Claim 1 of the **main request** reads as follows:

"A system a system [sic] for component condition monitoring and fault diagnosis in a machine, characterized in that the system includes:

- a component controller configured to operate a data collection function that acquires time histories of selected variables for one or more of the components;
- a mechatronic device controller configured to operate a pre-processing function that calculates, using predetermined mathematical operations, specified characteristics of the time histories;
- a group controller for a group of mechatronic devices, the group controller configured to operate an analysis function for evaluating the characteristics to produce one or more hypotheses of a condition of the one or more components;

- a system controller configured to operate a reasoning function for determining the condition of the one or more components from the one or more hypotheses; and
- said system controller being further configured to operate a manager function that determines the selected variables acquired by the data collection function, triggers data processing in the pre-processing function for calculating the specified characteristics, initiates evaluation of the characteristics by the analysis function to yield the hypotheses, and triggers derivation of the component conditions by the reasoning function,
wherein said machine being implemented in a hierarchical distributed manner and having different level controllers, each one of the subsequent functions is associated with progressively higher level controllers within said machine, each controller receiving data from a lower level, processing the data according to the function associated and passing the processed data to the next level controller or ultimately to a user or higher level system."

Claim 1 of the **auxiliary request 1** replaces the last passage of claim 1 of the main request "wherein said machine...to a user or higher level system" with the following: "wherein said component controller, mechatronic device controller, group controller and system controller form different levels of a hierarchical chain of controllers where each level has a respective data processing capability, each one of the reasoning function, analysis function and pre-processing function is subsequent respectively from the analysis function, pre-processing function and data collection function and each of the subsequent functions is resident within progressively higher level controllers within the hierarchical chain of

controllers of said machine, each controller receiving data from a lower level, processing the data according to the functions resident within the controller, and passing the processed data to the next level controller or ultimately to a user or higher level system and where the controller does not process data that is passed to the next level controller for processing."

Claim 1 of the **auxiliary request 2** adds to claim 1 of the main request, after the wording "a mechatronic device controller configured to operate a pre-processing function that calculates, using predetermined mathematical operations, specified characteristics of the time histories", the wording ", where the predetermined mathematical models are based on dynamic models of the machine;".

Claim 1 of the **auxiliary request 3** adds to claim 1 of the main request, after the last passage, the wording ", where the progressively higher level controllers process the data at a level controller that includes intelligence to process the data."

Each request comprises further independent claims for a corresponding method (claim 10) and a corresponding computer program (claim 18).

Reasons for the Decision

1. The appeal is admissible.
2. Main request

- 2.1 D1 discloses, according to the essential features of claim 1, a system for condition monitoring and fault diagnosis in a machine (see column 6, lines 30 to 47 and from column 8, line 27 to column 9, line 48, in relation to Figures 3 and 4a) comprising:
- sensors for collecting time histories of variables for one or more components of the machine (see column 6, lines 33 to 37: "sensors 62"; column 9, lines 21: "over a preset time interval");
 - a signal conditioner for calculating characteristics of the time histories (column 9, lines 18 to 21: "root-mean square value of the motor current signal");
 - a diagnostic module for determining the condition of one or more components based on the characteristics (see column 9, lines 30 to 36; column 11, lines 63 to 67; column 12, lines 1 to 3), the diagnostic module comprising a processor which determines the selected variables (see column 13, lines 34 to 38) and triggers the calculation of the characteristics and the determination of the condition (see from column 10, line 64 to column 11, line 2).

The sensors, signal conditioner and diagnostic module of D1 are implemented in a hierarchically distributed manner, whereby the data issued from the sensors are sent to the signal conditioner for processing and the data issued from the signal conditioner are sent to the diagnostic module for processing.

Therefore, the component controller of claim 1 can be read onto the group of sensors of D1, the mechatronic controller of claim 1 can be read onto the signal conditioner of D1, and the association of the group controller and system controller of claim 1 can be read onto the diagnostic module of D1.

2.2 The only difference between the subject-matter of claim 1 and the disclosure of D1 is thus that the task of the diagnostic module is divided in claim 1 between a group controller and a system controller, whereby the last controller in the hierarchical chain, namely the system controller, receives data that has been already processed by the previous controller, namely the group controller, and that consists in hypotheses of a condition of one or more components. This was not challenged by the appellant during the oral proceedings.

The technical effect of this task splitting is that, due to the pre-processing of data by the group controller, the amount of data which has to be transmitted from the group controller to the system controller is reduced, thereby reducing the overall network traffic.

The objective technical problem can thus be formulated as how to optimise the data processing in the fault diagnostic system of D1.

The skilled person would first note that D1 teaches that some of the sensors, i.e. the component controller in the terminology of claim 1, may perform, in addition to their task of data collection, local pre-processing on the collected data, such as filtering, smoothing, etc..., to maximise the efficiency of the system (see column 18, lines 20 to 34). Therefore, D1 itself gives a hint to the skilled person that the distribution of functions between controllers on adjacent levels in the hierarchical chain of controllers may be changed in order to optimise the system.

Moreover, the skilled person trying to solve the above-mentioned problem would come across document D2 which relates to a hierarchical fault diagnosis system. D2 discloses a diagnostic system for a machine, based on a four-level hierarchical structure of processors (see Figures 4 and 7; page 6, line 53 to page 7, line 17; page 8, lines 27 to 29):

- a data collection level ("Datenerfassungsmodul 410; "Sensor-Eingaben")
 - a pre-processing level ("AR", "RMS", "EWMA"),
 - an analysis level ("FDN = fault diagnostic network"),
 - a reasoning level ("FRES = fault reasoning expert system").
- Although Figure 7 only shows the last three hierarchical levels of processing functions, it is implicit that the data collection function is provided upstream of the pre-processing functions EMMA and RMS.

By applying to the system of D1 the teaching of D2 with respect to the therein disclosed four-level hierarchical chain of controllers, the skilled person would arrive at the subject-matter of claim 1, without the exercise of inventive skills.

Therefore, the board judges that claim 1 does not meet the requirements of Article 56 EPC 1973, having regard to the combination of D1 and D2.

- 2.3 The appellant argued that the analysis function, which according to claim 1 produced the hypotheses of a condition of one or more components, and the reasoning function were both performed in the same controller of D1, namely the master diagnostic module MDM, contrary to what is required by claim 1. Moreover, D2, in particular Figure 7, would also not disclose a distribution of the analysis and reasoning functions over two entities. The board is however not convinced

by this argument, since D2 discloses (see page 8, lines 40 to 47 in relation with Figure 7) that the fault identification level 720, i.e. the third level in the hierarchical chain of D2, employs a fault diagnostic network FDN to identify machine faults from the sensor data and that, if the fault diagnostic network is not able to generate any hypothesis, a model-based reasoning approach will be applied to find possible faults. This is a clear disclosure that the fault identification level actually does generate hypothesis of a condition of the components, as required by claim 1. Moreover, as already mentioned in paragraph 2.2 above, the skilled person will be prompted by the use of intelligent sensors in D1 to consider a splitting of tasks between two adjacent controllers as disclosed in D2.

3. Auxiliary request 1

Claim 1 adds to claim 1 of the main request only features which aim at clarifying and defining more precisely the hierarchical structure of the controllers' assembly. In its argumentation with respect to the main request (see paragraph 2 above), the board has already taken these features into account and considers that D2 discloses that each controller receives data from a lower-level controller, if provided, processes the data according to the functions resident within the controller, and passes the processed data to the next-level controller, if provided, as required by claim 1.

Therefore, the board judges that claim 1 does not meet the requirements of Article 56 EPC 1973, having regard to the disclosure of D1 or D2.

4. Auxiliary request 2

The board decided to admit this request into the proceedings under Article 13(1) RPBA.

Claim 1 adds to claim 1 of the main request the feature that the predetermined mathematical models are based on dynamic models of the machine. Since the feature "the predetermined mathematical models" has no antecedent definition in claim 1, the board has, in agreement with the appellant, interpreted it as meaning "the predetermined mathematical operations".

D2 discloses on page 8, lines 27 to 33, that the sensor inputs, such as vibrations, are preprocessed using an autoregressive model and, further, that abnormal machine conditions are detected based on the result of the mathematical operations performed on the sensor data. This amounts to the use of dynamic models of the machine, defining when the machine is or is not in an abnormal condition.

The board therefore judges that claim 1 does not meet the requirements of Article 56 EPC 1973, having regard to the combination of D1 and D2.

5. Auxiliary request 3

The board decided to admit this request into the proceedings under Article 13(1) RPBA.

Claim 1 adds in substance to claim 1 of the main request the feature that a controller includes intelligence to process the data it receives from the controller below it in the hierarchical chain.

As the appellant argued, the term "intelligence" refers to the processing power and programming capabilities of a computer processor.

D1 and D2 both clearly disclose this feature, since each processor in the hierarchical controller chains therein disclosed is adapted to perform its allocated functions, and thus necessarily possesses the required computing capabilities.

Therefore, the board judges that claim 1 does not meet the requirements of Article 56 EPC 1973, having regard to the disclosure of D1 and D2.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chair:



K. Götz-Wein

A. Ritzka

Decision electronically authenticated