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Datasheet for the decision of 24 October 2023

Case Number: T 0182/20 - 3.5.01

Application Number: 15750319.4

Publication Number: 3183699

IPC: G06Q10/06

Language of the proceedings: EN

Title of invention:
CONFIGURATION OF MALFUNCTION PREDICTION FOR COMPONENTS AND UNITS OF TECHNICAL ENTITIES

Applicant:
Hitachi Energy AG

Headword:
Malfunction prediction/HITACHI ENERGY

Relevant legal provisions:
EPC Art. 56, 111(1)
RPBA 2020 Art. 11, 13(2)

Keyword:
Predicting a specific malfunction of a specific mechanical or electrical component based on specific parameters (technical)
Remittal to the department of first instance
Remittal - (yes - search required)

Decisions cited:
G 0001/19, T 0641/00, T 3226/19, T 0929/18

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Case Number: T 0182/20 - 3.5.01

D E C I S I O N
**of Technical Board of Appeal 3.5.01
of 24 October 2023**

Appellant: (Applicant)	Hitachi Energy AG Brown-Boveri-Strasse 5 8050 Zurich (CH)
Representative:	P&TS SA (AG, Ltd.) Avenue J.-J. Rousseau 4 P.O. Box 2848 2001 Neuchâtel (CH)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 12 August 2019 refusing European patent application No. 15750319.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	W. Chandler
Members:	I. Kürten
	E. Mille

Summary of Facts and Submissions

I. The appeal is against the examining division's decision to refuse the European patent application No. 15750319.4 for lack of inventive step (Article 56 EPC).

II. The examining division held that in claim 1 of all requests the technical features were notorious, and the non-technical features did not provide a technical effect. No prior art was cited - neither in the search report nor in the decision under appeal.

III. In the statement setting out the grounds of appeal, the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of one of four requests, essentially corresponding to four of the refused auxiliary requests.

IV. In the communication accompanying the summons to oral proceedings, the Board expressed its preliminary view that none of the requests appeared to involve an inventive step. According to the Board, predicting an unspecified malfunction of an unspecified mechanical or electrical component based on an unspecified parameter could not be seen as technical. Although the second auxiliary request narrowed down the claim to specific components, malfunctions, and parameters, the Board considered these limitations still too broad to credibly achieve a technical effect.

V. By letter of 24 August 2023, the appellant filed three new requests and supporting inventive step arguments.

VI. During the oral proceedings on 24 October 2023, held by videoconference jointly with those for T 1557/20, the appellant filed a new request and withdrew all previous ones. The appellant requested that the decision to refuse the application be set aside and the case be remitted to the examining division for further prosecution based on this new request.

VII. Claim 1 of the sole request reads:

Computer implemented method for predicting a malfunction of at least one mechanical and/or electrical component, comprising:

1- At the component, measuring with a sensor a current value ($a(t_0)$) of a parameter (a) of the component,

2- Transmitting over a communication network said current value ($a(t_0)$) to a server;

3- Determining a conditional probability distribution ($P_{t0+L*\Delta T}(a¦a(t_0))$) for the parameter (a) for a future point in time ($t_0+L*\Delta T$) given said current value ($a(t_0)$ of the parameter (a), which is a discrete value, using a transition matrix (T) stored in a transition matrix section (11) and which comprises for a plurality of discrete states (a_i) of each parameter the probabilities to switch from one of the discrete value states to another of the discrete values states within a certain time period (ΔT);

4- At the server, determining a conditional probability ($P_{t0+L*\Delta T}(M¦a(t_0))$) for a malfunction at the future point in time ($t_0+L*\Delta T$) given said current value ($a(t_0)$ of the parameter (a), based on:

said conditional probability distribution ($P_{t0+L*\Delta T}(a¦a(t_0))$) of the parameter (a) for the future point in time given the current value of the parameter;
and on
a conditional probability distribution (P(M¦a) for the malfunction (M) given the parameter (a), received, e.g. in a computer, server, database or other apparatus, or derived using a Bayesian assessment technique based on the probability ($P(a_i¦M)$) that the parameter is in a certain state (a_i) when the malfunction (M) occurs, on the probability (P(M)) of the single malfunction (M), and on the probability ($P(a_i)$) of the discrete state (a_i),

and wherein
one of the components is a gas turbine, wherein the single malfunction of the gas turbine is a bearing defect, and one or any combination of the following parameters is used for predicting the single malfunction of the gas turbine: temperature, lubricant condition in the bearings or in the oil tank, shaft or casing vibration; or
one of the components is a transformer, and the single malfunction of the transformer is one of an insulation defect, or a cooling system defect of the transformer, and one or any combination of the following parameters is used for predicting the single malfunction of the transformer: temperature of the coils, vibration of the cooling fans, condition of the oil, or temperature of the oil, or
one of the components is a diesel engine, and the single malfunction of the diesel engine is a bearing defect, and one or any combination of the following parameters is used for predicting the single

malfunction of the diesel engine: temperature and/or vibrations.

Reasons for the Decision

1. The invention

1.1 The invention concerns predicting future malfunctions of mechanical or electrical components based on the current values of one or more parameters ([0001], [0005] of the published application).

1.2 Claim 1 specifies three components (gas turbine, transformer, and diesel engine), each with one or more potential malfunctions (e.g. a bearing defect in the case of the gas turbine) and a set of parameters for predicting each malfunction (e.g. temperature, lubricant condition in the bearings or in the oil tank, shaft or casing vibration for predicting a bearing defect of the gas turbine).

1.3 Essentially, the invention is calculating the probability ($P_{t0+L*\Delta T}(M|a(t_0))$) of a malfunction M, L time periods ΔT from the current time t_0 based on the current state of the parameter(s) $a(t_0)$. Mathematically, using the law of total probability, this is the sum of the conditional probabilities of the malfunction given each possible state of the parameter(s) ($P(M|a_i)$ multiplied by the probability of that state at time $t_0+L*\Delta T$, i.e. $P_{t0+L*\Delta T}(a_i|a(t_0))$, [0063] - first equation and claim 1, step 4. The latter is calculated using a Markov chain by multiplying the current state of the system $a(t_0)$ repeatedly by the transition matrix T representing the probabilities of each state after a time period ΔT given the previous state. Mathematically, this is $T^L * a(t_0)$ ([0063] - third equation - not claimed).

2. Admittance, Article 13(2) RPBA

The Board admitted the new request into the proceedings because it was filed in response to inventive step and clarity objections raised for the first time by the Board. In the Board's judgement, these are cogent reasons that justify the exceptional circumstances required by Article 13(2) RPBA.

3. Inventive step, Article 56 EPC

3.1 The division held that calculating the probability of a malfunction in a mechanical or electrical component constituted a non-technical modelling and forecasting process, which was an abstract intellectual activity. The calculated probability was deemed a piece of information, which lacked a technical effect in itself. Any effect depended on human decision-making.

The examining division also considered that the choice of parameters, components and malfunctions in claim 1 of the then fourth auxiliary request was not based on technical considerations. Therefore, these limitations could not confer technical character to the mathematical probability calculations. This led to the conclusion that claim 1 lacked an inventive step over notorious processing means.

3.2 The fourth auxiliary request considered by the examining division essentially corresponds to the second auxiliary request filed with the grounds of appeal. In its preliminary opinion, the Board essentially agreed with the examining division that not all of the parameters listed in claim 1 were suitable to predict the claimed malfunctions. Therefore, the Board tended to consider that the effect of predicting a malfunction, even if considered technical, was not credibly achieved.

3.3 However, after further limitations in claim 1 to specify how the conditional probability distribution P(M|a) in step 4) is obtained and deletion of some of the previously claimed malfunctions and parameters, the Board arrives at a different conclusion.

3.4 Beyond the server-based processing, the method in claim 1 comprises a number of technical features. Firstly, the method involves measuring specific parameters (e.g. temperature and lubricant condition in the bearings of a gas turbine), which is inherently technical (G 1/19, points 85, 99). Furthermore, these measurements are used to predict specific malfunctions in particular components (e.g. a bearing defect in a gas turbine or an insulation defect in a transformer). The Board considers that the choice of parameters for predicting the specified malfunctions reflects technical considerations about the functioning of the claimed mechanical or electrical components (i.e. gas turbine, transformer, and diesel engine).

3.5 On the other hand, the mathematical calculations in steps 3) and 4), when considered in isolation, are non-technical. These computations generate numerical data, i.e. the conditional probability of a future malfunction in an electrical or mechanical component.

The key question thus is whether these calculations contribute to the technical character of the invention, i.e. whether they contribute to the solution of a technical problem by providing a technical effect. If they do, they must be examined for obviousness. If not, they can be incorporated into the formulation of the technical problem (T 641/00 - *Two identities/Comvik*).

3.6 G 1/19 identifies two main situations in which numerical calculations contribute to the technical character of the invention.

First, when the calculated numerical data provide a technical effect, which is at least implied in the claim. This is the case when their potential use is limited to technical purposes (G 1/19, points 124 and 128).

Second, when the calculated numerical data represent an indirect measurement of the physical state or property of a specific physical entity (G 1/19, point 99; see also T 3226/19 - *Opportunity estimation/LANDMARK GRAPHICS*, points 2.5 to 2.7). In this case, technicality is independent of the data's use.

3.7 The Board considers that the first situation does not apply here since the calculated conditional probability might be used for non-technical purposes. For example, it can be used to assess financial loss or determine insurance premiums due to potential component downtime.

3.8 However, the Board sees the conditional probability obtained by the method of claim 1 as an indirect measurement of the physical state (i.e. a particular failure) of a specific physical entity (i.e. a specific mechanical or electrical component). This conclusion is based on the following observations:

3.9 Firstly, the claimed method involves taking a measurement of a specific physical entity at a first point in time and estimating the state of this physical entity (i.e. its probability of failure) at another point in time. This is similar to the example in G 1/19, point 99, where the measurement of a specific physical entity at a specific location is obtained from measurements of another physical entity and/or measurements at another location.

3.10 Secondly, the estimate of the component's future state is based on a mathematical framework that credibly reflects reality. The Board considers this to be an essential factor in deciding whether the calculated numerical data can be seen as an indirect measurement. Arbitrary or speculative models and algorithms that are not grounded in reality are not capable of predicting the physical state or property of a real physical entity. Such abstract calculations cannot be regarded as (indirect) measurements.

In claim 1, however, the probability is calculated from the transition matrix T, the conditional probability distribution $P(M|a)$, and the current measurement of the parameter a. The mathematical framework in the claim is rooted in stochastic modelling and simulation, specifically Markov chains, which are recognised for credibly capturing and predicting the transition dynamics of systems based on empirical data.

The fact that the result is a probability does not detract from its ability to provide a technically meaningful estimate of the component's state. Making accurate predictions in the real world, given all its uncertainties, is rarely possible.

3.11 Lastly, there is a credible causal link between the measured parameters and the predicted malfunctions. For instance, a bearing defect in a gas turbine is likely to generate more heat, degrade lubricant, and cause vibrations in the shaft and/or casing. Therefore, temperature, lubricant condition, and shaft or casing vibrations are suitable parameters for predicting a bearing defect.

3.12 In summary, the Board is satisfied that the calculated probability provides a credible estimate of the future physical state of a specific physical entity and, therefore, can be seen as an indirect measurement.

3.13 For these reasons, the Board judges that the mathematical steps in claim 1 are part of a technical measurement method. Consequently, all features in the claim contribute to the technical character of the invention and must be examined for obviousness.

3.14 Notoriously known technical means are not an appropriate starting point for this examination. Hence, the Board deems a search necessary. This is a special reason for remitting the case (Article 11 RPBA).

3.15 Accordingly, the Board remits the case to the examining division for further prosecution including a search (Article 111(1) EPC). The search results must be documented and made accessible in the public file (see e.g. T 0929/18 - *Mobile location data sharing/ BLACKBERRY*, point 3.13).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division for further prosecution including a search.

The Registrar: The Chairman:

T. Buschek W. Chandler

Decision electronically authenticated