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**Datasheet for the decision
of 7 December 2022**

Case Number: T 2014/21 - 3.5.03

Application Number: 17192593.6

Publication Number: 3301522

IPC: G05B17/02, G05B23/02

Language of the proceedings: EN

Title of invention:

Plant simulation device and plant simulation method

Applicant:

Yokogawa Electric Corporation

Headword:

Simulation accuracy/YOKOGAWA

Relevant legal provisions:

EPC Art. 56

Keyword:

Inventive step - all requests (no): improvement of simulation accuracy not credible over the whole scope of the claim

Decisions cited:

G 0001/19, T 0583/93, T 1341/16



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Case Number: T 2014/21 - 3.5.03

D E C I S I O N
of Technical Board of Appeal 3.5.03
of 7 December 2022

Appellant: Yokogawa Electric Corporation
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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 29 June 2021
refusing European patent application
No. 17192593.6 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair K. Bengi-Akyürek
Members: R. Gerdes
F. Bostedt

Summary of Facts and Submissions

I. The examining division refused the present patent application on the grounds that the subject-matter of claim 1 of the applicant's main and auxiliary requests 1 to 7 did not involve an inventive step (Article 56 EPC) in view of the following prior-art document:

D1: JP 2009 163507 A with

D1T: machine translation of D1.

II. The applicant (appellant) appealed against this decision and requested that the decision under appeal be set aside and that a patent be granted based on the claims of one of the auxiliary requests 4 to 7 filed with letter of 19 May 2021, these claim requests being identical to the ones underlying the decision under appeal.

III. Oral proceedings before the board were held on 7 December 2022. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of one of the claim sets of **auxiliary requests 4 to 7**. At the end of the oral proceedings, the board's decision was announced.

IV. Claim 1 of **auxiliary request 4** reads as follows (with the board's feature labelling):

- (a) "A plant simulation device (1) comprising:
- (b) a first storage (14) storing a model (M) which models a state of a facility in a plant (PL),
- (c) a first parameter (FP) which is adjusted at the start operation of the plant (PL),

- (d) and a second parameter (VP) which is varied during the operation of the plant (PL),
- (e) the first parameter (FP) and the second parameter (VP) being set in the model (M);
- (f) a simulator (10) configured to compare a process value of the facility with a simulated value which is calculated using the model (M) and to adjust the first parameter (FP) at the start operation of the plant (PL), and then, to compare the process value of the facility with the simulated value which is calculated using the model (M) in which the adjusted first parameter is set and to adjust the second parameter (VP) during the operation of the plant (PL);
- (g) a diagnoser (18) configured to diagnose the facility using change information of at least one of the first parameter (FP) and the second parameter (VP) which are adjusted by the simulator (10); and
- (h) a display (20) configured to display diagnosis results of the facility inputted from the diagnoser (18)."

V. Claim 1 of **auxiliary request 5** contains the following amendments to features (c) and (f) (insertions underlined)

- (c') "a first parameter (FP) which is adjusted at the start operation of the plant (PL) in the introduction's trial operation phase of the plant (PL) and in periodic maintenance's trial operation phases of the plant (PL),"
- (f') "a simulator (10) configured to compare a process value of the facility with a simulated value which is calculated using the model (M) and to adjust the first parameter (FP) at the

start operation of the plant (PL) in the introduction's trial operation phase of the plant (PL) and in periodic maintenance's trial operation phases of the plant (PL), and then, to compare the process value of the facility with the simulated value which is calculated using the model (M) in which the adjusted first parameter is set and to adjust the second parameter (VP) during the operation of the plant (PL)."

- VI. Compared with claim 1 of auxiliary request 4, claim 1 of **auxiliary request 6** contains the following additional phrase inserted between features (f) and (g):

" , wherein the simulator (10) is configured to:
determine whether an operating status of the facility satisfies adjustment conditions of the second parameter (VP) during the operation of the plant (PL);
adjust the second parameter (VP) when the simulator (10) determines that the operating status of the facility satisfies the adjustment conditions of the second parameter (VP); and
prevent the adjustment of the second parameter (VP) when the simulator (10) determines that the operating status of the facility does not satisfy the adjustment conditions of the second parameter (VP);
wherein the plant simulation device (1) further comprises:".

- VII. Claim 1 of **auxiliary request 7** contains the features of claim 1 of auxiliary request 5 and auxiliary request 6 in combination.

Reasons for the Decision

1. The application

The present application concerns a plant simulation device and a plant simulation method, which contains a simulator for simulating a facility in the plant. The simulator adjusts a simulation model on the basis of actual data of the plant and executes simulation in parallel with operation of the plant using the adjusted simulation model in order to improve the calculation accuracy of the simulator. Some parameters of the simulation model may be considered as depending on the operating status of the plant, whereas others relate to construction conditions. According to the application, when both kinds of parameters are adjusted simultaneously, the simulation may fail to converge, because the parameter related to the construction conditions may have an influence on other parameters.

In order to improve the simulation accuracy of the plant, according to the application, a first, "fixed parameter FP" is adjusted and fixed under actual operating conditions of the facility, for example, in a "trial operation phase" of the plant. Subsequently, the fixed parameter FP is not changed or adjusted, whereas the "varying parameter VP" is adjusted under actual operating conditions of the facility. The varying parameter VP changes depending on the operating status of the facility. An example of the simulated facility in the plant relates to a "heat exchanger", wherein the first parameter may be a value ("proportional index α ") indicating a flow-rate dependency of a heat transfer coefficient of the heat exchanger and the second parameter may be a reference heat transfer coefficient

at a reference flow rate of the heat exchanger ("U_{des}").

2. *Auxiliary request 4 - inventive step, Article 56 EPC*

2.1 It is common ground that document **D1** represents the closest prior art with respect to the subject-matter of present claim 1.

2.2 Document D1 discloses a plant simulation device (see paragraph [0007]) comprising a first storage unit storing a model which models a state of a facility in a plant (paragraphs [0010] and [0062]) with first and second parameters being set in the model (paragraph [0008]). The simulator is configured to compare a process value of the facility with a simulated value which is calculated using the model and to adjust the first parameter, and, to compare the process value of the facility with the simulated value (paragraphs [0021] and [0030]). In addition, D1 discloses a "diagnoser" configured to diagnose the facility using change information of at least one of the first parameter and the second parameter which are adjusted by the simulator. D1 also discloses a display configured to display diagnosis results of the facility inputted from the diagnoser (paragraphs [0025] and [0034]).

2.3 Hence, the subject-matter of claim 1 differs from D1 in that the first parameter is adjusted at the start of the operation of the plant and the second parameter is varied during operation, while the first parameter is kept constant at this stage (see features (c) and (f) above).

2.4 According to the decision under appeal and as argued by the appellant, these features have the technical effect that they "enhance the model used for providing diagnostic results via the simulator thanks to successive adjustments of the first parameter and the second parameter, resulting in better process diagnosis for estimating possible deterioration". The objective technical problem could, therefore, be seen in "how to improve the modelling accuracy of a simulator." The appellant argued in this respect that divergence was likely to occur as the number of parameters increased, irrespective of whether the parameters were arbitrarily chosen. As a consequence, it was desirable to reduce the number of parameters to be adjusted at the same time.

2.5 The board is not convinced that the technical problem of "improving the modelling accuracy of a simulator" is actually achieved by those distinguishing features. First, the board points out that establishing a model is a purely mental act (see e.g. G 1/19, Reasons 106). Consequently, improving such a model, e.g. in terms of accuracy, also represents a purely mental act and thus corresponds to a *non-technical* problem. Secondly, claim 1 does not specify any of the parameters that are adjusted, nor the type of plant that is controlled or the relationship between the first and the second parameter. A reduction of arbitrarily chosen parameters also does not necessarily improve "modelling accuracy" because models with arbitrary parameters may never converge irrespective of the number of fixed or adjusted parameters. Thus, the distinguishing features cannot credibly relate to increasing the accuracy of the simulation process used for controlling or optimising the simulated system (the "heat exchanger" here). At best, they could serve the purpose of

distinguishing between the impact of each of the two parameters on the simulation results. In conclusion, it is not credible that the alleged technical effect is achieved for arbitrary parameters in arbitrary plants.

Instead, the objective technical problem has to be derived from technical effects that are based on *objectively* established facts and are directly and causally related to the technical features of the claimed invention (see e.g. T 583/93, Reasons 7.5 and T 1341/16, Reasons 2.1.7). As a consequence, the above objective technical problem cannot qualify as a valid objective problem in the framework of the problem-solution approach in the present case. Hence, the board rather considers the objective technical problem to be "how to provide a plant simulation device having an alternative simulation algorithm compared to that of D1".

- 2.6 The appellant argued that even if the objective technical problem was formulated in such a less ambitious manner, the skilled person would not have arrived at the claimed subject-matter when starting from D1. Document D1 did not present any hints towards fixing some parameters and adjusting others *successively*. This solution implied a change of perspective compared to D1 which adjusted all parameters *simultaneously*.
- 2.7 The board considers that a sequential tuning of single parameters, or as put by the appellant: adjusting the parameters *successively*, to be a usual approach that is ubiquitously used in manual tuning of control systems. Hence, the board agrees with the decision under appeal that adjusting a first parameter at the *start* of the operation of the plant and varying the second parameter

during *operation* is a mere straightforward choice which the skilled person would have selected depending on the circumstances (see also Reasons 13 of the decision under appeal).

2.8 Hence, starting from D1, the skilled person would have readily arrived at the subject-matter of claim 1 without the need for any inventive skill. It follows that the subject-matter of claim 1 lacks an inventive step in view of D1 (Article 56 EPC).

3. *Auxiliary request 5 - inventive step, Article 56 EPC*

3.1 Claim 1 of auxiliary request 5 additionally specifies that the first parameter is adjusted during the "introduction's trial operation phase" of the plant and during the "periodic maintenance's trial operation phases" of the plant (cf. point V above).

3.2 The appellant argued that the additional features of auxiliary request 5 provided the possibility of updating the value of the first parameter in the case that the maintenance operation had an impact on the deterioration of the plant, thereby keeping the first parameter as up-to-date as possible without risking non-convergence of the simulation. This was not known from D1.

3.3 As set out above, the board is not convinced that the plant simulation device of the present application necessarily improves the convergence of the simulation as compared to D1. In addition, it is obvious that parameters which might have been changed from their initial values cannot be assumed to be constant in the subsequent simulation so that they may need to be updated in subsequent "trial operation phases".

3.4 Hence, the subject-matter of claim 1 of auxiliary request 5 also lacks an inventive step (Article 56 EPC).

4. *Auxiliary request 6 - inventive step, Article 56 EPC*

4.1 Claim 1 of auxiliary request 6 specifies that the adjustment of the second parameter is allowed/prevented in dependence on "adjustment conditions", which are not further specified in claim 1 (cf. point VI above).

4.2 The appellant argued that the conditions avoided situations in which the simulation would diverge and lead to unrealistic values. This enabled a continuous "tracking simulation", which remained sound, even in the presence of turbulence or transient situations, by only adapting the simulation model to "stable" situations.

4.3 The board agrees with the decision under appeal, and the appellant did not dispute, that these features are already disclosed in D1 (see Reasons 23.2 of the decision under appeal). Hence, the reasoning regarding inventive step as to auxiliary request 4 applies *mutatis mutandis*.

4.4 As a result, the subject-matter of claim 1 of auxiliary request 6 also lacks an inventive step (Article 56 EPC).

5. *Auxiliary request 7 - inventive step, Article 56 EPC*

5.1 Claim 1 of auxiliary request 7 contains the features of claim 1 of auxiliary request 5 and auxiliary request 6 in combination (cf. point VII above).

5.2 However, no specific technical effect can be recognised that would result from that combination. Hence, the reasoning above applies *mutatis mutandis*.

5.3 Hence, the subject-matter of claim 1 of auxiliary request 7 also lacks an inventive step (Article 56 EPC).

6. Conclusion

It follows from the above that none of the appellant's claim requests is allowable and that therefore the appeal is to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chair:



B. Brückner

K. Bengi-Akyürek

Decision electronically authenticated