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File Number: T 809/90 - 3.5.1

Application No.: 84 104 087.6

Publication No.: 0 123 214

Title of invention: Operation teaching method and apparatus for industrial robot

Classification: G05B 19/42

**D E C I S I O N**  
of 30 October 1992

Applicant: HITACHI, LTD.

Opponent: Siemens Aktiengesellschaft, Berlin und München

Headword:

EPC Article 56

Keyword: "Inventive step (yes)"



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Boards of Appeal

Chambres de recours

Case Number : T 809/90 - 3.5.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.5.1  
of 30 October 1992

**Appellant :**  
(Opponent)

Siemens Aktiengesellschaft,  
Berlin und München  
Postfach 22 16 34  
W - 8000 München 22 (DE)

**Respondent :**  
(Proprietor of the patent)

HITACHI, LTD.  
6, Kanda Surugadai 4-chome  
Chiyoda-ku  
Tokyo 100 (JP)

**Representative :**

Patentanwälte  
Beetz sen. - Beetz jun.  
Timpe - Siegfried - Schmitt-Fumian  
Steinsdorfstrasse 10  
W - 8000 München 22 (DE)

**Decision under appeal :**

Decision of the Opposition Division of the  
European Patent Office dated 4 September 1990  
rejecting the opposition filed against European  
patent No. 0 123 214 pursuant to Article 102(2)  
EPC.

**Composition of the Board :**

**Chairman :** P.K.J. van den Berg  
**Members :** A. Clelland  
C. Holtz

## Summary of Facts and Submissions

- I. European patent No. 0 123 214 was granted on 28 January 1987 on the basis of European patent application 84 104 087.6.
- II. An opposition was filed on 28 October 1987 on the grounds that the subject-matter of the patent did not fulfil the requirements of Articles 52 to 57 EPC. The Opponent referred, inter alia, to the following prior art documents:
- D1: IEEE 1982 IECON PROC., 15-19.11.1982, pp. 191-195  
"Microcomputer control of an arc welding robot with visual sensor" Kodaira et al.;
- D2: "Handhabungstechnik", Information sheet No. 14,  
published by KUKA Augsburg, March 1981;
- D3: CIRP Annals 1982 "Manufacturing Technology"  
31.01.1982, pp. 387-390 "Optimierung von Robotersteuerungen" Spur et al.
- III. By its decision of 4 September 1990 the Opposition Division rejected the opposition.
- IV. In a notice of appeal received 17 October 1990 the Appellant (Opponent) lodged an appeal against this decision and paid the prescribed appeal fee. In the Grounds of Appeal received on 11 January 1991 the Appellant requested that the decision of the Opposition Division be set aside and that the patent be revoked. As an auxiliary request the Board was asked to appoint oral proceedings. A further document was cited in support of the Appellant's request:

D4: "Robot control M", RCM2, Programmieranleitung,  
October 1982, pp. 1-4, Siemens Aktiengesellschaft.

V. In a submission dated 18 July 1991 the Respondent (Patentee) advanced arguments in support of the patentability of the existing claims and requested that the appeal be dismissed.

VI. ~~In a communication pursuant to Article 11(2) of the Rules of Procedure of the Boards of Appeal dated 30 July 1992 the Rapporteur commented on the documents on which the Appellant relied, namely D1 to D4, and drew the Appellant's attention to the established jurisprudence of the Board on late-filed documents.~~

VII. Oral proceedings were held on 30 October 1992.

The Appellant's arguments can be summarised as follows:

The operation teaching method of Claim 1 of the patent differed from the disclosure of D1 and D2 primarily in a kinematic inversion, i.e. in that in the invention the robot was moved relative to a stationary workpiece whereas in both D1 and D2 the robot was fixed in position and the workpieces were moved relative to it on a conveyor belt. It was obvious that in both cases the same adjustments would have to be made for each workpiece. D1 was particularly relevant in this respect in that it performed a coordinate transformation for each workpiece relative to absolute coordinates, making use of reference points on the workpiece. This was the same procedure as was used in the patent.

The Appellant also referred to document D4 but subsequently asked that the document and the objection

based on it be withdrawn from further consideration in the proceedings.

- VIII. The Respondent argued that the skilled man would not find it obvious to modify D1 or D2 so as to move the robot rather than the workpieces and, even if he did so, would not arrive at the claimed combination of features. D1 in particular did not effect the kind of coordinate transformation performed by the patent and could not be modified to operate in the claimed manner.
- IX. The Appellant requested that the patent be revoked.
- X. The Respondent requested as a main request that the appeal be dismissed and as an auxiliary request that the patent be maintained in amended form on the basis of an independent method claim combining the subject-matter of Claims 1 and 2 with corresponding amendments to the remaining claims and description.
- XI. Claim 1 of the patent as granted reads as follows:

"An operation teaching method for an industrial robot adapted to be successively moved to and set at different positions along an objective structure to conduct a predetermined operation on working objects of the same configuration on the objective structure to which objects said different positions correspond, respectively, said method comprising:

teaching, when said industrial robot is set at a first position corresponding to a first working object, positions of base references and a locus of the robot operation assumed on said first working object, and storing such information as coordinate values given in terms of a first robot coordinate system assumed on said robot set in said first position;

teaching, when said industrial robot is set at a second position corresponding to a second working object, positions of comparison reference assumed on said second working object at positions corresponding to said base references, and storing such information as coordinate values given in terms of a second robot coordinate system assumed on said industrial robot set at said second position;

~~computing by using the coordinate values of said base reference on said first robot coordinate system and the coordinate values of said comparison references on said second robot coordinate system, correlation information concerning the relationship between said first robot coordinate system and said second robot coordinate system;~~  
and

correcting, by using said correlation information, the coordinate values representing said locus of the robot operation in terms of said first robot coordinate system to determine coordinate values representing said locus of the robot operation in terms of said second robot coordinate system."

Claim 10 of the patent as granted reads as follows:

"An operation teaching apparatus for an industrial robot adapted to be successively moved to and set at different positions along an objective structure to conduct a predetermined operation on working objects of the same configuration on said objective structure to which objects said different positions correspond, respectively, said apparatus comprising:

memory means (101, 102, 103) for storing the content of a robot operation on the working objects taught to said industrial robot;

first computing means (104, 105, 106) for obtaining correlation information between coordinate values of base

references assumed on a first working object and coordinate values of comparison references assumed on a second working object, said coordinate values of the base references being stored in said memory means in terms of a first robot coordinate system assumed on said industrial robot set at a first position corresponding to said first working object, said coordinate values of the comparison references being stored in said memory means in terms of a second robot coordinate system assumed on said industrial robot in a second position corresponding to said second working object; and

second computing means (107-109) for conducting, using said correlation information, correcting computation of coordinate values representing the taught operation of the robot and stored in said memory means in terms of said first robot coordinate system to determine coordinate values representing said taught operation in terms of said second robot coordinate system."

**Reasons for the Decision**

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.
  
2. Since the Appellant in the course of the oral proceedings withdrew the objections based on D4 it has not proved necessary to consider the admissibility of this document. It is however observed that the Boards of Appeal have regularly made clear that opposition and appeal proceedings should speedily be concluded and that this requires the parties to present their case in as complete a manner as possible at the earliest possible date. The Board has of its own motion examined D4 (Article 114(1))

EPC) and has concluded that the document is not of sufficient relevance to warrant its introduction to the proceedings at this late stage.

3. It was common ground between the parties that the subject-matter of each of Claims 1 and 10 is novel, the arguments raised by the Appellant being primarily on the basis of each of D1 and D2 and concerning the issue of inventive step.

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4. The patent is concerned with an industrial robot which is movable to carry out the same operation on a plurality of identical parts at different locations on a single workpiece. Rather than teach a robot the same set of operations at each location, at a first location a set of base references by means of which a first robot coordinate system can be defined is taught and also a locus of operation defining the operations of the robot at the first workpiece location; this information is stored as a set of coordinate values in terms of the first robot coordinate system. The robot is then moved by unspecified means to a second location at which the same operations are to be carried out on a second, identical, part of the same workpiece and coordinate values for the corresponding base references are taught and stored for comparison purposes in terms of a second robot coordinate system. The coordinate values of the two coordinate systems are then used to derive correlation information in the form of a transformation matrix relating the one coordinate system to the other. This information is then used to translate the locus of operation taught at the first location into the second coordinate system so that it is not necessary to teach the robot separately at each location.
5. D1 discloses a teaching system for an industrial robot of fixed position. The disclosed application is arc welding.

A sensory feedback control system is initially used in a teaching mode to determine and store a locus of operation and thereafter to track the weld seam during welding. In operation the sensor data is transformed from a sensor to a robot coordinate system by means of a transformation matrix, as shown in Figure 5 and discussed in the associated text under the heading "Sensory Feedback Control" on pages 192 to 194. From the right-hand column on page 194 it appears that in use of the sensory feedback control system for path correction the sensor performs an evaluation "at several points which represent the shape of the workpiece" in order to compensate for tolerances in workpiece shape and location.

It appears to the Board that what is disclosed in D1 is primarily a compensation for deformation in the workpiece itself rather than a change in position as in the patent. In the course of the oral proceedings it became clear that welding gives rise to the specific problem of deformation of the workpiece in the course of the welding operation; this necessitates continual comparison with the stored path in order to ensure real-time corrections. In other words, the locus of operation is itself directly and continuously changed in a feedback loop involving a sensor which monitors the welding position and by way of a coordinate transformation controls the robot servo drives. Thus, the sensor system of D1 senses, and effects comparison with, a workpiece rather than a set of coordinates. Page 194, right-hand column, specifically states that "after the measurement at all reference points the robot knows a whole image of each workpiece"; correction is thus of welding position relative to specific locations on the workpiece.

6. Claims 1 and 10 both specify that, when in the first position, the industrial robot is taught two separate

operations: firstly positions of base references which define the relative position of the robot and first "working object" as coordinate values in terms of a first coordinate system; and secondly the operations to be performed on the "working object", the "locus of the robot operation", these also being defined and stored as coordinate values in the first coordinate system. These claims furthermore state that when the robot is set in the second position, ~~base reference positions are again~~ determined to define coordinate values in terms of a second coordinate system which is then by computation related to the first coordinate system and used to derive the correct locus of operation at the second location.

D1 is not however concerned with the relative positions of the robot and the workpiece; as noted above it is concerned with relating the stored locus of operation to the specific shape of the workpiece and compensating for deviations in shape, rather than with deviations in relative position. To this end D1 provides a closed feedback path for automatic correction of the locus of operation. It does not suggest or lead the skilled man in the direction of the measures quoted above.

Accordingly, the Board considers that the skilled man would not find it obvious to modify the D1 arrangement in such a manner as to arrive at the teaching method of Claim 1 or the teaching apparatus of Claim 10 of the patent.

7. D2 has a teaching of a feedback control system similar to that of D1. Although reference is made to "coordinate transformation" this appears to be in the context of programming which is carried out in Cartesian coordinates and thereafter transformed into the coordinates used by

the robot. The Board does not consider that D2 adds anything to what is already known from D1.

8. The Board has also considered the remaining documents cited in the course of the examination and opposition proceedings, in particular D3, referred to by the Appellant in his Grounds of Appeal, and concludes that no other document or combination of documents would give the skilled person teaching which would lead him to carry out the claimed subject-matter without the exercise of invention.
9. For these reasons, in the Board's view, the subject-matter of Claim 1 and Claim 10 of the main request involves an inventive step.
10. Claims 1 and 10 being allowable, the same applies mutatis mutandis to dependent Claims 2 to 9 and 11 to 18 respectively.

**Order**

**For these reasons, it is decided that:**

**The appeal is dismissed.**

**The Registrar:**

**The Chairman:**

**M. Kiehl**

**P.K.J. van den Berg**