THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 14

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte HIROHIKO KOBAYASHI

Appeal No. 1998-1083
Application 08/402,606[1]

HEARD: June 8, 2000

Before JERRY SMITH, BARRETT, and FRAHM, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

DECISION ON APPEAL

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[1] Application for patent filed March 13, 1995, entitled "Robot Path Planning Method Where Bending Owing To Load Is Taken Into Consideration," which claims the foreign filing priority under 35 U.S.C. § 119 of Japanese patent application 72747/1994, filed March 16, 1994.

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1-5.

We reverse.

BACKGROUND

The invention is directed to a robot path planning method where bending due to load is taken into consideration. When a heavy tool is mounted to a robot, there is a discrepancy between the robot position measured by the robot controller and the actual robot position caused by bending. The method determines (measures or computes) the positional displacement (a "bending amount") between the measured and actual position of the end of the robot tool at the start and end points of the robot tool path. Positional displacements (bending amounts) at interpolation points intermediate the start and end points are calculated from the bending amounts at the start and end points using one of the linear interpolation equations on page 8 of the specification and are subtracted from the measured positions at the interpolation points to provide target positions that are actually used by the robot controller. That is, the method reverse calculates the angular adjustment necessary

to compensate for the positional displacement at each interpolation point along the path.

Claim 1 is reproduced below.

> 1. A robot path planning method where bending owing to load is taken into consideration, comprising steps of:
>
> (a) calculating a linear section to be drawn by a distal end of a robotic tool, by using said distal end of said robotic tool at a starting point and at an ending point of said linear section as recognized by a robot controller;
>
> (b) setting a first plurality of interpolation points on said linear section as calculated in step (a);
>
> (c) determining a bending amount at said distal end of said robotic tool at said starting point and at said ending point, respectively, of said linear section;
>
> (d) calculating said bending amount at said distal end of said robotic tool at each said first plurality of interpolation points, based on said bending amount of said distal end of said robotic tool at said starting point and at said ending point of said linear section as determined in step (c), and set a position of each of said first plurality of interpolation points on said linear section; and
>
> (e) setting a second plurality of interpolation points to be used in said robot controller by subtracting said bending amount at said distal end of said robotic tool at each of said first plurality of interpolation points calculated in step (d), from each of said second plurality of interpolation points of step (e).

The Examiner relies on the following prior art:

Engelberger et al. (Engelberger)	4,132,937	January 2, 1979
Ishiguro et al. (Ishiguro)	4,967,127	October 30, 1990
Furukawa	5,418,441 (§ 102(e) date August 24, 1992)	May 23, 1995

Claims 1-5 stand rejected under 35 U.S.C. § 103 as being unpatentable over Ishiguro and Furukawa.

Claim 5 stands rejected under 35 U.S.C. § 103 as being unpatentable over Ishiguro and Engelberger.

We refer to the Final Rejection (Paper No. 5) (pages referred to as "FR__") and the Examiner's Answer (Paper No. 9) (pages referred to as "EA__") for a statement of the Examiner's position and to the Appeal Brief (Paper No. 8) (pages referred to as "Br__") for a statement of Appellant's arguments thereagainst.

OPINION

Claims 1-4

Claim 1 is taken as representative of claims 1-4.

The Examiner finds that Ishiguro teaches "[p]oint to point values of target positions are updated and determined independently of previous target points" (FR2). While this is true, as evidenced by the abstract, it is of little use in addressing the actual claim limitations. The only citation to the record by the Examiner is to column 6, lines 16-23 and 57-68, which the Examiner finds to teach "[p]ath interpolating circuit 402 interpolates teaching point data 400 and calculates a standard path data" (EA6). This provides little guidance as to how the Examiner reads the claims onto Ishiguro. We assume that the claimed "linear section to be drawn" in step (a) corresponds to a line between two teaching-point data in the teaching-point memory 400 and the claimed "first plurality of interpolation points on said linear section" in step (b) corresponds to the interpolation points. The "linear section" also corresponds to the "standard path" in Ishiguro.

The Examiner finds that the difference between Ishiguro and the claimed subject matter is that "the claims recite determining and calculating a bending amount at the distal end of the tool" (FR2). Appellant interprets this to mean that Ishiguro fails to teach or suggest steps (a) to (c) of independent claims 1 and 2 (Br7). Actually, the Examiner appears to be finding that Ishiguro does not disclose the "determining" step of step (c) and the "calculating" step of step (d) of claim 1.

We find that Ishiguro does not teach steps (c), (d), or (e). Ishiguro is a force-controlled robot that compensates for the difference between the actual reaction force and a predetermined target force (abstract). Ishiguro does not detect (e.g., by measuring or computing) or compensate for the bending amount caused by the robotic tool.

Furukawa is relied on by the Examiner for its teaching of compensating for the deflection caused by the robot's own weight. Furukawa does teach compensating for bending (cols. 1-2). The Examiner concludes that it would have been obvious "to modify the taught path control of Ishiguro et

al. to include the deflection compensation of Furukawa" (EA4).

Appellant argues that the claimed invention requires measuring the positional displacement of a robot that has been loaded with robotic tools and one that has not, and then calculating the angular displacement of each axis to adjust the angle of each axis, whereas in Furukawa "the angular displacement is calculated based on the amount of torques experienced by each axis of the robot" (Br8).

The Examiner responds that Appellant fails to consider the teachings of Ishiguro, which teaches "an effective position control system and path teaching operation" (EA6).

We do not find the Examiner's statement to be responsive to Appellant's argument. However, we are likewise not persuaded by Appellant's argument. The torques in Furukawa relate to the displacement caused by bending and are determined from the angular configuration and robot motion equations (e.g., col. 5, lines 32-34), not actual torque measurements.

Appellant further argues (Br9): "The adjusted values [in Furukawa] are added at individual points along a path.

However, the present invention provides deflection correction covering an entire path, not merely individual points."

The Examiner responds that Appellant fails to consider the teachings of Ishiguro, which specifically shows in figure 12 the movement of the arm along a taught path and that the claims do not recite anything about the "entire" path (EA7).

We are not persuaded by Appellant's argument. A set of individual points determines a path. Moreover, it is clear that Appellants' path comprises a set of individual points.

Appellant lastly argues (Br10): "Furukawa fails to teach determining a bending amount at both the starting point and ending point of the linear section. Therefore, Furukawa cannot set a plurality of interpolation points between a starting point and an ending point. Ishiguro et al. also fails to disclose these features."

The Examiner does not appear to discuss these arguments.

Furukawa must determine a bending amount at the starting point and ending point of the linear section; i.e.,

it determines a bending amount at each point along a programmed path from start to finish. However, Furukawa does not disclose or suggest using these bending amounts to calculate the bending amount at the interpolation points as recited in step (d): "calculating said bending amount at said distal end of said robotic tool at each said first plurality of interpolation points, based on said bending amount of said distal end of said robotic tool at said starting point and at said ending point of said linear section" (emphasis added). Furukawa is strictly a point-by-point compensation method. For this reason, we conclude that the Examiner has failed to establish a prima facie case of obviousness. The rejection of claims 1-4 over Ishiguro and Furukawa is reversed. It is not necessary to address the arguments in the Reply Brief.

Claim 5

Claim 5 does not recite how the first and second traveling paths are determined and, in particular, it does not recite the disclosed method of determining the bending amounts at interpolation points from the bending amounts at the start point and end point as in claims 1 and 2, where the locus of bending amounts constitutes the second traveling path. Further, claim 5 does not require that the second traveling path is predetermined and, thus, it does not preclude "determining a second traveling path" on a point-to-point basis where a path consists of a set of points.

However, claim 5 recites "determining amount of displacements between said first traveling path and said second traveling path" which we interpret to exclude the second traveling path from being determined from the displacements. In Appellant's invention, the actual path points H1', H2', etc. are determined by interpolation from the displacements at the starting point and ending point and then the displacements between the desired path and the

actual path are determined. The Examiner has not explained how the references meet this limitation.

Ishiguro is a real time process that computes a target position based on the comparison of an ideal state to a reference state of the arm end on the taught path, where the ideal state is determined from the present state of the arm end and the difference between the actual reaction force and a predetermined target force (abstract). Ishiguro does not determine a second path and then determine a displacement between the first and second paths.

Furukawa computes the deflection angle)2d from a first path due to the weight of the robotic tool using the torque and deflection angle relationship equations (e.g., col. 5, lines 32-41). The deflection angle could be used to determine an actual position of the endpoint on the second path (col. 4, equation 2); however, this does not meet the terms of the claim which requires the displacement to be determined from the first and second paths. Further, Furukawa uses the deflection angle to determine a point on the target path (col. 5, lines 42-46, using equation 1), rather than a point on the second path. Furukawa does not

determine a second path and then determine a displacement between the first and second paths.

Engelberger is a real time process that senses dynamic feedback information from accelerometers 104 and 106 and tachometers 82, 84, and 86 and selectively combines it with the positional error signal to stabilize the positional servo loop (col. 7, lines 19-33). Therefore, Engelberger also does not determine a second path and then determine a displacement between the first and second paths.

Because the applied references do not determine a second path and then determine a displacement between the first and second paths, we conclude that the Examiner has failed to establish a prima facie case of obviousness with respect to claim 5. The rejections of claim 5 over Ishiguro and Furukawa and Ishiguro and Engelberger are reversed.

CONCLUSION

The rejections of claims 1-5 are reversed.

REVERSED

JERRY SMITH)
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