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opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.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. 22

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte PIERO P. BONISSONE,
JAMES B. COMLY, and MARK E. DAUSCH

Appeal No. 96-0361
Application 08/288,154[1]

ON BRIEF

Before THOMAS, MARTIN, and BARRETT, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

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[1] Application for patent filed August 10, 1994, entitled "Compilation Of Rule Bases For Fuzzy Logic Control," which is a continuation of Application 07/775,873, filed October 15, 1991, now abandoned.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1-9, 26, 27, 29, 30, and 32. Claims 10 and 28 have been canceled. Claims 11-25 and 31 have been withdrawn from consideration pursuant to a restriction requirement.

We affirm-in-part but denominate the affirmance a new ground of rejection because of new reasoning.

BACKGROUND

The disclosed invention is directed to a fuzzy logic control system that replaces the knowledge base of fuzzy logic rules, which must be executed at each iteration during runtime, with a look-up table having a compilation of values that have already been derived from executing a fuzzy logic rule base. In one example, the compiled look-up table is established by dividing the state space (i.e., fuzzy sets) of the state variables into partitions as shown in figure 13 where a single rule is executed for each partition.

Claim 1 is reproduced below.

> 1. A compiled fuzzy logic control system for controlling a process, comprising:

means for sensing at least two continuously defined state variables of the process;

means for receiving the sensed state variables from the sensing means;

a memory having a look-up table stored therein at a plurality of memory locations, the look-up table being a compilation of values derived from executing a fuzzy logic rule base for the sensed state variables, such that each of said plurality of memory locations stores a value representative of an output derived from an operation of the fuzzy logic rule base;

means for generating an address for the sensed state variables to a location in the look-up table of the memory;

means for reading the look-up table in the memory location corresponding to the generated address and outputting the stored value derived from executing the fuzzy logic rule base therefrom; and

actuating means coupled to the reading means for receiving the stored value and outputting a control action to the process in accordance with the stored value derived from executing the fuzzy logic rule base.

The examiner relies on the following prior art reference:

Basehore	5,245,695	September 14, 1993 (filed June 12, 1991)

Claims 1-9, 26, 27, 29, 30, and 32 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Basehore.

We refer to the Examiner's Answer (Paper No. 19) (pages referred to as "EA__") for a statement of the examiner's

position and to the Brief (Paper No. 18) (pages referred to as "Br__") for appellants' position.

OPINION

Claims 1-9 and 32

Appellants argue (Br9-10; Br14-15) that Basehore does not disclose the look-up table limitation of claims 1 and 32.

Claim 1 recites:

> a memory having a look-up table stored therein at a plurality of memory locations, the look-up table being a compilation of values derived from executing a fuzzy logic rule base for the sensed state variables, such that each of said plurality of memory locations stores a value representative of an output derived from an operation of the fuzzy logic rule base . . . .

The look-up table limitation in claim 32 is essentially identical except that it recites "the plurality" in the third from last line quoted above. Appellants argue that "Basehore does not disclose a memory having a look-up table having a compilation of values derived from executing a fuzzy logic rule base for the sensed state variables, wherein each of the look-up table locations stores a value representative of an output derived from an operation of the fuzzy logic rule base" (emphasis omitted) (Br9-10; Br14).

The examiner states (EA3 and EA5): "see column 1 and figure 3, element 200, his plurality of fuzzifier registers which correspond to the plurality of input signals." Column 1 of Basehore states (col. 1, lines 10-21):

> Control systems and computer-controlled electronic devices have historically been controlled by digital control systems. Such control systems use bi-state digital logic which requires a value of either "TRUE" or "FALSE", so that approximations are often required of real-world control problems. For example, an input/output relationship y=f(x) would be specified either as mathematical function or as a series of points using, for example, a look-up table . . . .

Basehore discusses that an alternative approach to control theory, known as "fuzzy logic," was developed in 1963 (col. 1, lines 38-39). There is no teaching in column 1 of using a look-up table with fuzzy logic as required for a § 102 rejection.

The examiner also points to registers 200 in figure 3. The input signals are "mapped" to fuzzifier registers 200, which each contain data necessary to fuzzify input data according to a predetermined fuzzy set (col. 6, lines 25-41). "According to the preferred embodiment, each of the input fuzzifier registers 200 is a 24-bit register having 8 bits for crisp input data, 8 bits for the center location of the fuzzy

set membership function, 5 bits for the width of the membership function, and 3 bits identifying the input addressed by the address signal (FIG. 6)." (Col. 9, lines 5-11). These values are used to fuzzify the input signals and do not contain output information. Therefore, the registers 200 do not "store a value representative of an output derived from an operation of the fuzzy logic rule base" (emphasis added), as claimed.

The examiner also states with respect to claim 1 that "the row of registers in figure 3 act as the memory having look-up table with each register being a separate memory location, and each register contains a fuzzy set, a compilation of values, which is derived from the rule memory, see figure 3, element 700, the rule memory is the claimed fuzzy logic rule base" (EA6) and makes a similar response with respect to the argument corresponding to claim 32 (EA6-7). Each register stores the value of one piece of input data (sensed state variable) along with membership function information needed to calculate a fuzzified input signal as discussed in the preceding paragraph. The registers 200 do not "store a value representative of an output derived from an

operation of the fuzzy logic rule base," as claimed. The rules in rule base 700 are not employed until the minimum comparator 500. The examiner has failed to establish a prima facie case of anticipation.

Nevertheless, for reasons not stated by the examiner, we find that Basehore appears to teach the claimed invention.

Basehore discloses that the minimum comparator 500 processes the fuzzified input signals in accordance with a predetermined fuzzy logic rule selected from the rule memory 700 (col. 6, line 48 to col. 7, line 4). The maximum comparator 600 identifies the rule which has the maximum value for the minimum term rule (col. 7, lines 11-16): "The identified rule, selected as having the highest overall degree of correlation and, therefore, the optimum output, is addressed from the rule memory 700 and the corresponding rule output is provided to an output register 800" (emphasis added). Basehore states (col. 7, lines 18-19): "The output register 800 modifies the existing (or initial) output on the basis of the rule output provided." The output register is shown in figure 10. Basehore states (col. 15, lines 29-33): "The MAX RULE signal from the maximum comparator 600 is

supplied to the rule memory 700 in order to access the action value signal ACTION which provides the offset to be added to the existing output signal." Therefore, the rule base 700 is a look-up table addressed by the identified MAX RULE. The rule base 700 is a compilation of rules for sensed state variables, and the rule memory stores a value ACTION representative of an output. The rule base 700 in Basehore is "a compilation of values derived from executing a fuzzy logic rule base for the sensed state variables" in the same way as appellants' rule base in figure 13. It is true that Basehore continuously evaluates all of the fuzzy logic at each iteration in order to determine the MAX RULE to address the ACTION signal, however, this is not excluded by the language of claims 1 and 32. Unfortunately, we do not have the benefit of appellants' arguments about these teachings of Basehore. Because the rejection is still based on anticipation over Basehore, we sustain the rejection of claims 1 and 32. However, because we rely on different teachings of Basehore, we denominate this decision as containing a new ground of rejection under 37 CFR § 1.196(b).

Claims 2 and 5 have not been separately argued; however, we consider them because of the new ground of rejection. The stored ACTION value in Basehore is representative of an output from executing a single rule as claimed in claim 2; therefore, the rejection of claim 2 is sustained. The stored value in Basehore does not appear representative of a means of maxima defuzzification as recited in claim 5, but is an output corresponding to the optimum rule; therefore, the rejection of claim 5 is reversed.

Appellants argue that claim 3 recites that each memory location corresponds to a partition in state space in which a corresponding rule is dominant. Since Basehore selects the MAX RULE for an optimum rule from among the rules of the rule base, and since the rule base represents a partition of the state space in the same manner as appellants' figure 13, each address in the rule base 700 can be said to correspond to a partition in state space in which a corresponding rule is dominant (optimum). The rejection of claim 3 is sustained.

Appellants argue that claim 4 recites that boundaries between adjacent partitions are defined by points of intersection between adjacent terms in a subset. Since

Basehore appears to partition the state space according to the rules, the boundaries appear to be defined by points of intersection between adjacent terms in a termset. The rejection of claim 4 is sustained.

We find that Basehore does not suggest the limitations of claims 6-9, which are separately argued by appellants. Therefore, the rejection of claims 6-9 is reversed.

Claims 26, 27, 29, and 30

Appellants argue (Br13) that Basehore does not disclose the look-up table limitation of claim 26. Claim 26 recites:

> a compilation memory having a look-up table stored therein at a plurality of memory locations, each of said plurality of memory locations having one or more pointers, each pointer corresponding to each rule from said rule base which has a non-zero output when the state variables have values corresponding to the address of that memory location . . . .

The look-up table of claim 26 differs from the look-up table of claims 1 and 32 in that it stores pointers to rules and recites "means for executing the rules corresponding to the read out of the pointers."

The examiner makes the same arguments with respect to the look-up table of claim 26 as for claims 1 and 32. These arguments are again nonpersuasive. The rule base 700 in

Basehore, which we have relied on as a look-up table in the rejection of claims 1 and 32, does not disclose storing pointers to rules. Accordingly, the anticipation rejection of claims 26, 27, 29, and 30 must be reversed.

CONCLUSION

The rejection of claims 1-4 and 32 is sustained.

The rejection of claims 5-9, 26, 27, 29, and 30 is reversed.

The rejection of claims 1-4 and 32 is denominated as a new grounds of rejection pursuant to 37 CFR § 1.196(b)(amended effective Dec. 1, 1997, by final rule notice, 62 Fed. Reg. 53,131, 53,197 (Oct. 10, 1997), 1203 Off. Gaz. Pat. & Trademark Office 63, 122 (Oct. 21, 1997)). 37 CFR § 1.196(b) provides that, "A new ground of rejection shall not be considered final for purposes of judicial review."

37 CFR § 1.196(b) also provides that the appellant, WITHIN TWO MONTHS FROM THE DATE OF THE DECISION, must exercise one of the following two options with respect to the new

ground of rejection to avoid termination of proceedings (§ 1.197(c)) as to the rejected claims:

> (1) Submit an appropriate amendment of the claims so rejected or a showing of facts relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the application will be remanded to the examiner. . . .
>
> (2) Request that the application be reheard under § 1.197(b) by the Board of Patent Appeals and Interferences upon the same record. . . .

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED-IN-PART - § 1.196(b)

JAMES D. THOMAS)
Administrative Patent Judge)
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) BOARD OF PATENT
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