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opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.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. 27

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte SI-ZHAO J. QIN
and GUY T. BORDERS

Appeal No. 1996-1922
Application 08/110,506[1]

ON BRIEF

Before URYNOWICZ, HAIRSTON and BARRY, Administrative Patent Judges.

URYNOWICZ, Administrative Patent Judge.

DECISION ON APPEAL

This appeal is from the final rejection of claims 1-6, 8-10, 12-20 and 22-34.

The invention pertains to a system for controlling a non-linear process. Claim 1 is illustrative and reads as follows:

[1] Application for patent filed August 23, 1993.

1. A control system for controlling a non-linear process as a function of a process error signal, the non-linear process having a plurality of regions of operation, the control system comprising:

means for producing an auxiliary variable signal which is indicative of an instantaneous region of operation for the non-linear process, the instantaneous region of operation being one of the plurality of regions of operation; and

a fuzzy logic controller for producing a process control output signal for controlling the non-linear process in the instantaneous region of operation as a function of the process error signal and the auxiliary variable signal.

The reference relied upon by the examiner is:

Aoki	5,272,621	Dec. 21, 1993 (filed Nov. 9, 1989)

The appealed claims stand rejected under 35 U.S.C. § 102(e) as being anticipated by Aoki.

The respective positions of the examiner and the appellants with regard to the propriety of the rejection are set forth in the examiner's answer (Paper No. 15) and the appellants' brief (Paper No. 14) and reply brief (Paper No. 16).

Appellants' Invention

Appellants' invention is a process control system 30 shown in Figure 3 for controlling a non-linear process 32 using a fuzzy logic controller 34. An auxiliary variable value 46 from process 32 allows controller 34 to differentiate between high gain regions of process operation represented by numeral II in the plot 24 of process input versus process output shown in Figure 2a, and low gain

regions represented by numerals I and III, and controller 34 is capable of assuring stability in the high process gain region II without sacrificing performance in the low process gain regions I and III. In addition, the auxiliary variable value 46 allows controller 34 to differentiate between a positive process gain region represented by numeral I and a negative process gain region represented by numeral II shown in Figure 2b. The controller is capable of providing a process control signal 50 that provides negative feedback in one region and positive feedback in the other, respectively.

Fuzzy logic controller 34 provides a process input signal 50 designated u_k based on an error signal 40 designated $e_{k,}$ a change in error signal 44 designated $\hat{I}e_k$ and an auxiliary variable signal 46 having an auxiliary variable value designated $AV_{k.}$ The error signal and change in error signal 40 and 44, respectively, are derived in a conventional manner subtracting the process output signal 38 from a set point signal or a system input signal 36.

Controller 34 contains a plurality of sets of fuzzy membership functions or inference rules which are defined based on prior knowledge or predetermined characteristics of the process 32. Each set of fuzzy membership functions is defined so that the process 32 is compensated for undesirable system behavior in a particular region of operation. A particular set of inference rules for the particular region of operation is selected using the auxiliary variable value. For example, an auxiliary variable is associated with each of the regions I, II and III of process operations shown in Figure 2a. Corresponding sets of fuzzy rules are then applied based on the auxiliary variable for providing fuzzy

control in the particular region of operation. In this manner, fuzzy control can be provided which assures stability in the high process gain region indicated by numeral II without sacrificing performance in the low process gain regions indicated by numeral I and III of Figure 2a. Fuzzy control systems that utilize conventional fuzzy logic controllers do not make use of an auxiliary variable signal 46 and therefore cannot differentiate between operation at different points in the process non-linearity.

The Prior Art

The Aoki reference discloses a method and apparatus for controlling a process having latency or dead time. The latency or dead time occurs between a process input u and a process output x. A fuzzy predictor is used to predict the process output for variation $\hat{\Delta}x$ occurring upon lapse of dead time L by a fuzzy inference. The fuzzy inference is based on the process input u, process output x, and a known disturbance d and other prior information. The predicted or inferred process output variation $\hat{\Delta}x$ is then used to compute an error function u(e) and a change in error function u(e) occurring upon lapse of dead time L. A conventional fuzzy proportional and integral controller 2 utilizes this error value u(e) and change in error value u(e) to infer a process input signal u for the dead time process 4.

Opinion

After consideration of the positions and arguments presented by both the examiner and the appellants, we have concluded that the rejection should not be sustained.

Appellants argue that each of their independent claims recites means for producing an auxiliary variable signal which is indicative of a present region of operation for a nonlinear process and that Aoki does not teach such a means. The response of the examiner is that Aoki discloses that his invention relates to the control of a nonlinear process, citing column 1, lines 60-65 and column 3, lines 35-60 and Figures 1 and 2. Although we agree with the examiner that Aoki relates to a nonlinear process for the reasons set forth at pages 4 and 5 of the examiner's answer[2], the examiner has not responded to appellants' argument and shown where Aoki discloses a means for producing an auxiliary variable signal as taught and claimed by appellants. Our own review of the reference reveals that it has no such disclosure. Whereas

[2] We also agree with the examiner that Aoki discloses a plurality of sets of fuzzy rules for the reason set forth at page 4, item 2, of the answer.

anticipation requires that all the elements of the claimed invention be described in a single reference, the rejection is not sustained. In re Spada, 911 F.2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990).

REVERSED

STANLEY M. URYNOWICZ, JR Administrative Patent Judge	)	
KENNETH W. HAIRSTON Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
LANCE LEONARD BARRY Administrative Patent Judge	)	

SMU/dal

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Application 08/110,506

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