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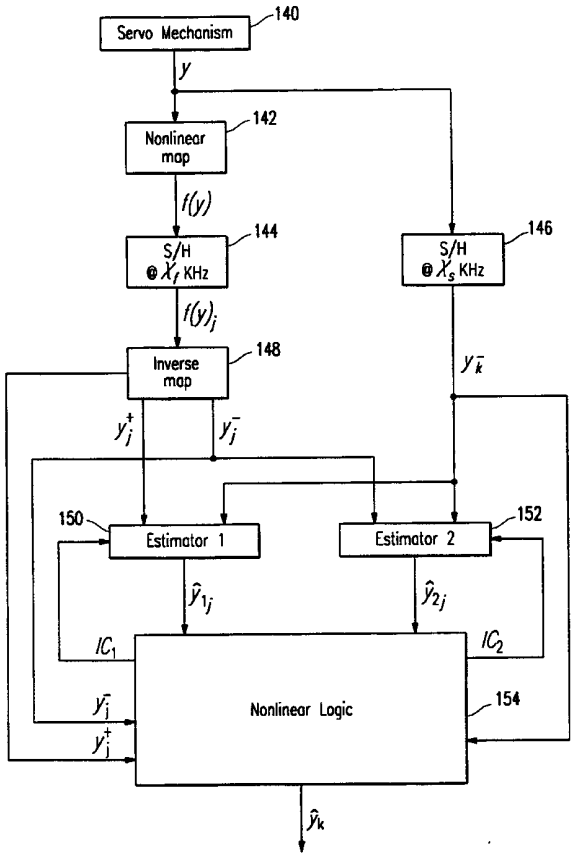
(54) Title: SERVO CONTROL APPARATUS AND METHOD USING ABSOLUTE VALUE INPUT SIGNALS



(57) Abstract: A servo control apparatus and method controls systems at least partially on the basis of an observable variable that has an absolute value functional relationship with the controlled variable and does not change sign for positive and negative variations from a nominal value. When applied to the positional control of an object, the control system observes a value of a position error signal and maps (148) that signal to two different potentially correct displacement values. Two estimators (150, 152) within the control system are initiated, one using the positive displacement and the other using the negative displacement, and the two estimators each predict the future position of the object and the corresponding position error signal for each estimated position. A new position error signal is detected and compared to the two estimated position error signals. After sufficient system evolution, the control system can select one or the other of the estimators as being correct and the associated displacement is identified as correct and is used for future positioning applications, preferably until the sign of the displacement of the head again becomes ambiguous. The control system can be used in combination with other control mechanisms including those using complimentary control information that provides more complete positioning information. The control method, system and apparatus find particularly advantageous application in magnetic storage hard disk drive systems.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

Int. ional Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05B13/02 G05B13/04 G05B21/02 G11B5/596 G11B5/55
G11B21/02 G11B21/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05B G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 36907 A (SEAGATE TECHNOLOGY) 22 July 1999 (1999-07-22) column 16, line 15 -column 17, line 18; figure 11 ---	1,5,8
A	US 5 585 975 A (BLISS WILLIAM G) 17 December 1996 (1996-12-17) cited in the application column 8, line 34 -column 10, line 4 ---	1,5,8
A	EP 0 298 475 A (NIPPON ELECTRIC CO) 11 January 1989 (1989-01-11) column 2, line 50 -column 6, line 24 ---	1,5,8
A	EP 0 331 189 A (HITACHI LTD) 6 September 1989 (1989-09-06) page 3, line 55 -page 6, line 46 ---	1,5,8
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 May 2001	28. 05. 2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Ressenaar, J-P

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 233 487 A (WORKMAN MICHAEL L ET AL) 3 August 1993 (1993-08-03) cited in the application figures 5,6	5,8
A	US 4 217 612 A (MATLA ARNO ET AL) 12 August 1980 (1980-08-12) column 3, line 48 -column 5, line 13	13-16
A	US 4 166 282 A (RAGLE HERBERT U ET AL) 28 August 1979 (1979-08-28) column 9, line 33 -column 18, line 27	13-16
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A	US 4 048 660 A (DENNISON JAMES CLIFFORD ET AL) 13 September 1977 (1977-09-13) column 9, line 43 -column 13, line 20	13-16

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INTERNATIONAL SEARCH REPORT

International application No.
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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-12

   A control system for adjusting a controlled variable using estimators and detrmining wich of the outputs of the estimators corresponds more accurately to theobserved variable

2. Claims: 13-16

   A servo system for positioning a magnetic head

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ..ional Application No
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