EXTREMUM CONTROL IN THE PRESENCE OF VARIABLE PURE DELAY

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ABSTRACT
An extremum control system is considered which consists of a parabolic function in cascade with a first-order system having a pure delay. All parameters of the system are allowed to vary including the pure delay. A method is given for determining the extremum in the presence of disturbances and digital computer results are provided.

INTRODUCTION
To control an industrial process when complete information about its characteristics is available, the statistical control methods are to be recommended. In many cases such "a priori" information is absent, or if it is available initially it loses authenticity as time progresses due to changes in the system parameters. Under such conditions it is advisable to employ self-adjusting controllers.

In this paper a study is made of a continuous extremum control system having variable pure delay. Such systems occur often in practice and especially so in the chemical industry. System identification in the method proposed is obtained by measuring the sign and magnitude of a discontinuity in an appropriate derivative of the system output. This information is used in the control law proposed. Convergence and stability are studied and computer results verifying the theory are given.

The method suggested is an extension of previous work by the author.

THE SYSTEM
The system considered consists of the following in cascade: an integrator, a function of the parabolic type and a first-order system having a variable pure delay. A symbolic representation of such a system is given in Fig.1. K2, α, τ and δ of Fig.1 are permitted to vary with time. The pure delay may be a distributed one.

The system of Fig.1 without the pure delay, is the one most widely covered in the literature on extremum control.

Assuming no pure delay to be present, the equations of the extremum control system studied are the following:

\[ r(t) = \epsilon K_1 \]

\[ x(t) = \int_0^t r(\xi) \, d\xi + x(0) \]

\[ y = \alpha x^2, \quad \alpha > 0 \]

\[ \tau \frac{dc}{dt} + c = K_2 y \]

The above equations are valid during sufficiently short intervals of time to allow \( K_1, K_2, \tau \) and \( \alpha \) to be considered constant. \( \epsilon \) is a discrete variable which belongs to the set of permissible values \( \epsilon_r, r=1,2,\ldots,n \), and is governed by the extremum controller.

Starting from permissible initial
Fig. (1) The extremum control system