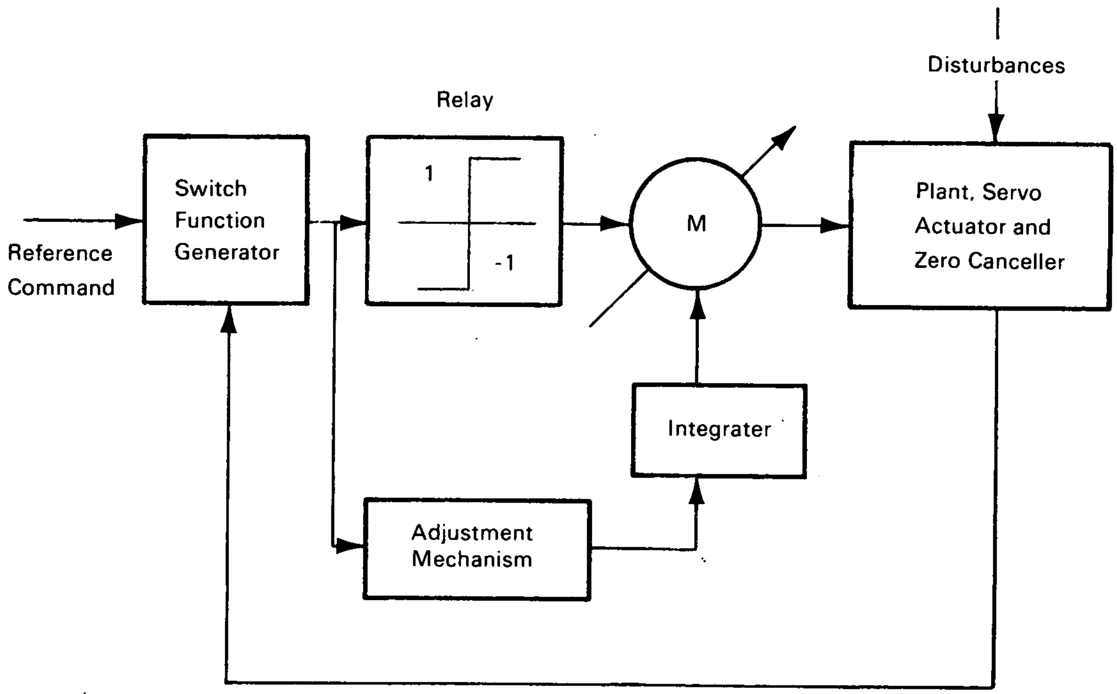
NASA TECH BRIEF

The Use of the Chatter Mode in Self-Adaptive Systems



Self-Adaptive System

Most conventional control systems, although adaptive to some extent, need not or cannot cope with a wide range of environmental conditions. They usually deal with a limited range of internal parameter variations, limited kinds of external disturbances and command reference inputs, which are anticipated in the design stage. A self-adaptive control system (defined as one which can maintain satisfactory performance over a wide range of changing conditions) has the capability of organizing itself to accomplish its objectives through the internal processes of measurement, evaluation and adjustment.

As a result of an analytical study of chatter motion (limit cycle oscillations when a linear switching function is non-optimum) in a control system with a simple relay as the controller, a new self-adaptive control principle, the block diagram shown in the figure, has been proposed which uses chatter motion advantageously. In the on-off control system under the chatter mode, the average motion of the plant is completely determined by the equation of the switching function. This relationship can then be applied in a self-adaptive control system in which the switching function describes the model dynamics, and the chatter mode is

(continued overleaf)

reached. A switching level adjustment can then reduce the chatter frequency and the control force magnitude, in addition to sustaining the chatter mode. The fundamental goal is to achieve the chatter mode as quickly as possible for any initial condition, and once it starts, to maintain it regardless of any change in operating conditions. An automatic adjustment device for the switching level or controllable gain has been proposed to meet this requirement. The scheme for the adjustment requires only two pieces of information: the instantaneous switching function and its time derivative. Furthermore, it can remove any excess amount of gain and reduce the chatter frequency as well.

The conclusions and recommendations of this study indicate advantageous use can be made of the chatter mode for self-adaptive control systems if the following basic requirements are met: the ideal model dynamics must be described by a switching function; the chatter mode must be reached quickly and then be sustained; the chatter frequency must be reduced; and, finally, any zero in the plant transfer function must be cancelled. Several examples are presented to demonstrate the analog computer simulation; the results indicate the gain adjustment mechanism performs satisfactorily.

In addition, known self-adaptive control systems are outlined with emphasis on those using a relay as a key element, and consideration is given for the application to a class of distributed parameter control systems. As a byproduct of this study, a numerical method without integrations is proposed for the solution of ordinary differential equations.

Note:

The following documentation may be obtained from:

Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.65)

Reference:
NASA-CR-88700 (N67-37384), The Use of the Chatter Mode in Self-Adaptive Systems

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