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NASA TECH BRIEF

New Procedure for Design of Self-Adaptive Control Systems

An improved procedure has been developed for specifying the design of self-adjusting or adaptive control systems capable of rapidly compensating for changes in the dynamic characteristics of linear controlled elements. Adaptive systems designed by earlier procedures either cannot be simply mechanized or are very limited in their range of applicable problems; they cannot be proven stable by analysis; and they either require explicit identification of the plant, or treat single control-point plants only.

The theoretical development of the new procedure, designated the adaptive control function approach, deals with linear, constant-coefficient controlled elements only. With this restriction, the number of linearly independent controlled-element responses that can be arbitrarily specified is equal to the number of independent controls. These specified responses determine what the (ideal) control inputs should be. In practice, the controlled element need only be linear.

Adaptive control function systems are mechanized so that the actual input of each control approaches the ideal input because of a steepest-descent feedback mechanism. The error functions used in this mechanism are chosen so that they are dependent on the modulating signals. When the errors are so chosen, the difference between the ideal and true control inputs can be made arbitrarily close to zero by increasing the rate of descent in the steepest-descent procedure. This rate is increased by increasing the adaptive loop gains; thus the rate at which the gains modulating the feedback and feedforward signals can be changed is increased. Selection of the adaptive loop gains is at the option of the designer. In principle, adaptive loop gains may be set arbitrarily high but, when practical devices are used to realize the system, there is in fact a finite upper limit.

The adaptive control function approach has been applied to the design of an augmentation system for a hypothetical, manned lifting-body entry vehicle. The purpose of the application is to minimize erratic lateral displacements of this vehicle. Data from a simulation of the system demonstrate its effectiveness.

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-1152 (N68-33904),
New Methods in Adaptive Flight Control

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No patent action is contemplated by NASA.

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