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I. Topics Covered During the Grant-Reporting Period

The research activities during the grant reporting period covered following topics.

1. Non-Linear White Noise Theory
2. Stabilization of Distributed Parameter Systems by Boundary Feedback
3. System Modelling and Identification
4. Control of Flexible Flight Vehicles
5. Random Fields: Filtering and Estimation
6. Control of Randomly Varying Systems
7. Control of Large Space Structures

The progress made on each of them is described below under the corresponding heading. The numbers in parentheses are keyed to the list of publications.
1. **Non-Linear White Noise Theory**

   In a series of papers, including [1], [3] a theory of white noise defined by "finitely additive" or "weak distributions" in a Hilbert space was developed as being closer to the physical noise models than the Wiener process model in the Ito theory. One significant result was a new likelihood-ratio formula which was applied successfully to the problem of identification of aircraft stability and control derivatives from flight-data containing gust response.

2. **Stabilization of Distributed Parameter Systems by Boundary Feedback**

   The problem of controlling systems governed by parabolic or hyperbolic partial differential equations by means of feedback on the boundary was investigated in a number of papers ([7], [8], [14], [15], [22], [23], [24], [25]). Both Dirichlet and Neumann boundary feedback have been treated, following the basic work [38] of the Principal Investigator.

3. **System Modelling and Identification**

   In cooperation with AFFTC Edwards, California, the system identification theory developed by the Principal Investigator was applied to the problem of modelling excess-thrust from flight-test data [2].

   The problem of identifying aircraft stability and control derivatives from flight data containing gust response
in which the gust is modelled by the more realistic Von Karman model (nonrational spectrum) as opposed to the simplex (rational spectrum) Dryden model was the subject of a doctoral thesis [13], in which the algorithms were applied to actual flight data.

4. Control of Flexible Flight Vehicles

A technique of generating successively higher order approximations to optimal flap control for a three-degree-of-freedom airfoil in subsonic inviscid flow was presented in [12] based on the earlier general theory [2].

5. Random Fields: Filtering and Estimation

Exact formulas for likelihood ratios for random fields as well as an exact Kalman filtering theory for line-scan of two-dimensional fields were developed in [19] and for circular scan in [20]. In addition a linear smoothing theory and a nonlinear parameter estimation theory using the author's likelihood functional formula based on the white-noise theory are developed in [21]. An application of this theory to geophysics of importance in missile-guidance was presented in [29].
6. **Control of Randomly Varying Systems**

The problem of feedback control of systems which are subject to random variation of structure modelled as a sudden change from one structure to another at a random time was presented in [28].

7. **Control of Large Space Structures**

The concept of "strong stability" and "strong stabilizability" was introduced in [30] (as an alternative to exponential stability) of a distributed parameter system with "compact" controller, and feedback controls were developed using (infinite-dimensional) Riccatti equations. This concept was further investigated for colocated sensors and controllers for a beam-like structure in a Ph.D. dissertation [31].
II. List of Publications


BOOK

III. Principal Investigator: Biography

2. Invited Speaker: Seminar on Global and Large-Scale System Models, Dubrovnik, Yugoslavia, August 1978.


18. Chairman, External Review Committee on Control Sciences Programs, University of Minnesota, Minneapolis, May 1980.


22. Member, Large Scale Systems Steering Committee, IEEE.


24. Chairman, Subcommittee on Large Space Structures, COLSS, IEEE.


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