N93-22572

COMPUTER AIDED CONTROL SYSTEM DESIGN (CACSD)

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Joint University Program
for Air Transportation Research

Quarterly Meeting
2-3 April 1992

The design of modern aerospace systems relies on the efficient utilization of computational resources and the availability of computational tools to provide accurate system modeling. This research focuses on the development of a computer aided control system design application which provides a full range of stability analysis and control design capabilities for aerospace vehicles.

BACKGROUND

- Purpose: Develop an application which provides a full range of stability analysis and control design capabilities for aerospace vehicles.

- Motivation for CACSD:

  - Computationally Demanding Modern Design Techniques

  - Increased Performance Expectations of Modern Systems

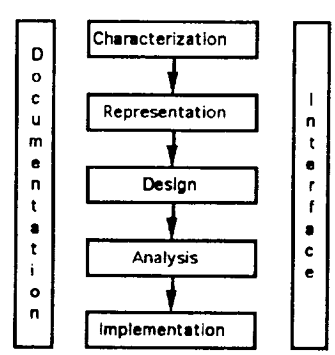
  - Increasing Availability of High-Performance, Low-Cost Computer Products

The application must address the concerns which arise during all five phases of the design process: Characterization, Representation, Design, Analysis and Implementation.

Characterization is the phase during which system requirements and parameters are defined. In the Representation phase, structural and behavioral models of the system are developed. Control theory is then applied during Design to realize the controlled system. Values of control system parameters and overall system performance are assessed during the Analysis phase. Hardware and/or Software generation is then required in the implementation of the control system.

In addition, the CACSD application should provide (1) an effective user interface, and (2) requirements traceability and configuration control through documentation of the control system and control system design process.

PROCESS DESCRIPTION



Work has progressed in the development of Flight CAD, a menu-driven, multi-window, desktop metaphor environment which provides modeling, synthesis, analysis, and simulation capabilities focused on the design of flight control systems for modern aircraft.

WORK TO DATE

- **Flight CAD (S. Sircar)**
  - **Menu-driven, Multi-window, Desktop Metaphor Environment**
  - **Modeling, Synthesis, Analysis, and Simulation Capabilities**
  - **Focus on Design of Flight Control Systems of Modern Aircraft**

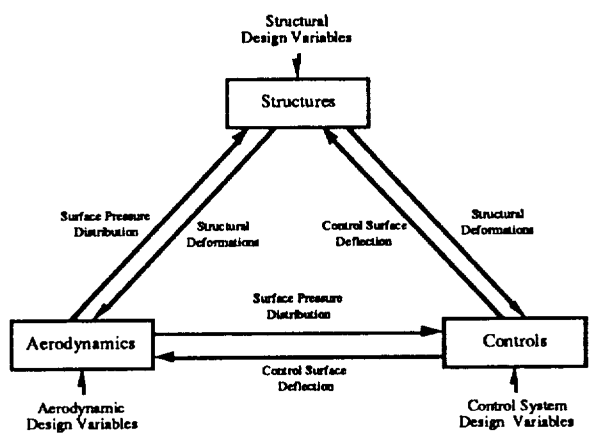
Current research focuses on the development of multidisciplinary design and analysis capabilities within Flight CAD. While early aerospace vehicles were designed primarily for optimum mission performance, the design of modern vehicles must address many considerations: mission performance, air worthiness (including structural durability), manufacturing and maintenance considerations, operational requirements, the environmental impact from noise and pollution, as well as life cycle cost. Design decisions made during the initial phases of the design process may effect up to 85% of the total program cost. These design decisions typically involve some interdisciplinary trade-offs. Multidisciplinary techniques are crucial to the analysis and design of control systems for modern aerospace vehicles.

Focus on Multidisciplinary Design and Analysis Capabilities

- Early aerospace vehicles were designed primarily for optimum mission performance.
- Modern aerospace vehicle design must address many considerations.
- Design decisions made during the initial phases of design may significantly affect the total program cost.
- Answers to design decisions typically must be based on interdisciplinary trade-offs.
- Multidisciplinary techniques must be employed to effectively analyze and design control systems for modern aerospace vehicles.

As an example of the interdisciplinary coupling between vehicle subsystems, consider the subsystem relationships for an actively controlled flexible wing. The complete set of system design variables includes structural, aerodynamic, and control system design variables. Each of these groups of design variables has a direct effect upon the behavior of its corresponding subsystem. Output variables which include the wing surface pressure distribution, structural deformations, and control surface deflections provide coupling between the subsystems which indirectly links each group of design variables to the remaining subsystems.

An Example of Interdisciplinary Coupling



Subsystem interactions for an actively controlled flexible wing

Many issues must be addressed in order to incorporate multidisciplinary design and analysis features within Flight CAD. Efficient mathematical models must be employed for representation of vehicle subsystems. Parallel processing capabilities must be exploited to maintain a high level of interaction with the designer. Representation of the interdisciplinary coupling within the user interface must also be considered. It may also be desirable to allow the user to define "Design Rules" which may be incorporated in an expert system to help automate the design process; determining when to regenerate reference trajectories, or when to re-analyze aerodynamic characteristics. Current research will focus on these issues and their impact on computer aided control system design.

Issues To Be Addressed

- Efficient Mathematical Models for Subsystem Representation
- Identification of Parallel Processing Opportunities
- Impact of Interdisciplinary Coupling on User Interface
- Development of Expert System "Design Rules"