AFOSR Grant F49620-97-1-0398 [CIT 61051]

Robust Nonlinear Control Theory with Applications to Aerospace Vehicles

AASERT Grant

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Progress Report
1 August 1998 to 31 July 1999

1 Objectives

The objective of this research is to develop real-time algorithms for generation of feasible trajectories for mechanical systems that respect the input constraints (actuator magnitude and rate limits).

2 Status of Effort

This is an AASERT award that funds Mark Milam, a fifth year CDS student. The work to date has concentrated on methods for real-time generation of trajectories that extend traditional optimal control techniques to allow real-time operation. The current approach being studied is to begin with trajectories using a differentially flat approximation of the system, followed by a homotopy technique to transform the trajectory into a feasible, optimal trajectory that satisfies the constraints. Substantial progress has been made in getting the code to run at real-time speeds using a dedicated DSpace real-time computing sysystem.

3 Accomplishments

We have succeeded in putting into place a basic algorithm for computing feasible trajectories using a combination of differential flatness and homotopy techniques. These techniques are being implemented on a real-time control system for the Caltech ducted fan experiment. The computing platform is a DSPace system using a DEC Alpha co-processor board. Substantial work has been done on connected the ducted fan to this computing platform and porting the algorithms required to control the system. Closed loop control has been demonstrated on the new platform.

In addition, the experimental platform has been updated to better reflect the longitudinal dynamics of an aircraft. This involved reconstructing the thrust vectoring nozzle and using a larger wing surface. System identification experiments on the new system show long and short period instabilities that are consistent with a vehicle at this scale. The experimental modifications have been reported in a paper presented at the Conference on Control Applications.

4 Personnel Supported

Mark Milam, Caltech graduate student (5th year).

5 Publications

[1] M. Milam and R. M. Murray. A testbed for nonlinear flight control techniques: The caltech ducted fan. In *Proc. IEEE International Conference on Control and Applications*, 1999.