Computer-aided Control Systems Engineering

Linearization Algorithm for Computer-Aided Control Engineering

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Generating a linearized dynamic system model corresponding to a nonlinear system at a specific operating point provides an important bridge between nonlinear simulation and linear analysis and design. Obtaining such a linearized model by numerical means (taking finite differences) is by no means a simple task. In some cases obtaining an accurate estimate of the derivative of a nonlinear function requires careful selection of the perturbation used in taking finite differences; in other cases the derivative is not defined and a simple numerical differentiation routine may lead to totally meaningless results. In this article we present numerical algorithms and heuristic logic for the accurate and robust linearization of nonlinear dynamic system models. The numerical algorithms deal with cases where the system nonlinearities are differentiable (possess a Taylor series expansion), and the logic handles a variety of anomalous situations.

This research in robust linearization methods has yielded new conventional methods and algorithms for linearization, as well as a new expert system to aid the controls engineer in determining linearized models for nonlinear systems. Some important aspects of this work include: an approach to minimize the effects of truncation and round-off errors incurred through numerical differentiation, and techniques for accurately identifying certain discontinuities in the mathematical description of a nonlinear systems and other problems that make linearization difficult or meaningless. We focus here on *conventional methods and algorithms*, which incorporate the knowledge gained in the course of this effort.

Development of CACE Environments

A substantial research effort at GE CR&D has been focused on the development of general environments for Computer-Aided Control Engineering (CACE), covering the traditional span from nonlinear modeling and simulation of the system to be controlled, through linear analysis and design, and culminating in nonlinear simulation of the controlled system [1]. This included both conventional software development [2], [3] and the investigation of expert system applications in a package referred to as CACE-III [4]-[7]. Throughout this work, linearization has played a pivotal role in the functionality of the environment [1], [6], and much has been learned. The results presented here represent the algorithmic and heuristic knowledge gained during this research.

Before beginning this work we surveyed the status of linearization in standard CACE packages that existed at that time (about 1983). ACSL [8] had a manual algorithm where the user supplied vectors of perturbations δx and δu; there was no safety net to detect anomalous situations (discontinuities etc.), and one could not individually choose perturbations that are best for each nonlinearity in each state equation. The SystemBuild algorithm [9] allowed the user to supply only a single perturbation to be used for every term in each state equation. Other nonlinear simulation environments at that time did not include linearization. We concluded that better support for linearization was required, to reliably deal with both numerical problems and anomalies. Other workers did, too – for example, the results described here have had a strong influence on the linearization algorithms in Model-C [10] and SimuLab [11], according to the vendors' representatives.

The software package used for the development of linearization techniques has been SIMNON, which supports modeling and simulation of nonlinear systems and has been extended with routines for equilibrium finding and linearization [3]. SIMNON [12] was developed by the Department of Automatic Control at Lund Institute of Technology, Lund, Sweden, and is now a commercial product of SSPA Systems, Göteborg, Sweden; versions extended by the authors while at GE CR&D are herein called SIMNON+. This package was incorporated both in the Federated System [2] and in CACE-III. The history of our studies of linearization demonstrate how conventional and expert-system software development can be synergistic – the first algorithms were implemented conventionally in SIMNON+, then "expert aided" in CACE-III, then improved in SIMNON+ to exploit the knowledge gained in expert system development without the overhead of an ancillary expert system shell. Finally, SIMNON+ has been made an integral part of MEAD [13] and was again refined in the process.

The purpose of this work was to develop the most appropriate linearized model for a nonlinear system at a given operating point, and to qualify that model in general terms (e.g., to establish what types of nonlinearities exist and provide a measure of validity of the linear model). This was motivated by the need to handle large and complicated models, e.g., high-order nonlinear models of aircraft and other systems where discontinuities and

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A systems engineering based methodology for control systems engineering will be presented. The need for such a methodology will be discussed.We report on recent progress in developing a computer-aided nonlinear control system analysis and design environment based on sinusoidal-input describing.Computer-Aided Control Systems Design: Practical Applications Using Make Control Engineering Come Alive with Computer-Aided Software.Modern computer-aided control system design (CACSD) has been made A control engineer often describes systems through the use of block diagrams.Computer Aided Design in Control and Engineering Systems contains the proceedings of the 3rd International Federation of Automatic Control/International .Computer Aided Design of Control Systems focuses on the use of computers to A Concept for A CAD Program-Package for the Control-Engineer Using Only.Dr. Cheng Siong Chin is a professional mechanical engineer with specialization in marine vehicle control systems design as well as the computer-aided.This paper reflects our experience with Computer Aided Control System Design Control Engineer Program Module Polynomial Matrix Transfer Function Matrix .lisamariekiss.com@lisamariekiss.com Abstract. Computer-aided control system design (CACSD) en- .. control system engineering, programming languages and techniques.This book is about Computer Aided Control System Design (CACSD) of the direct Readership: Control, electrical and mechanical engineers and students.This contribution describes a free computer-aided control system design (CACSD) tool for the numerical computing environment GNU Octave which is mostly.Computer Aided Control System Design (CACSD), IEEE International Symposium on. Persistent Link: lisamariekiss.com? punumber.Results 1 - 25 of 56 Computer-Aided Control System Design (CACSD), IEEE International Department of Electrical and Computer Engineering, The.THE problem of computer-aided control system design (CACSD) is one of the central problems in the modern control theory and engineering in Dorf, R.C. et al.Written for students and professionals, Computer-Aided Control Systems Design: Practical Applications Using MATLAB and Simulink supplies a solid foundation.Computer-Aided Control Systems Lab. Faculty: Martins, Nuno. Location: A.V. Williams Building. UMD Clark School   ECE Home   Site Map   Accessibility.An online systems engineering tool for flight research projects has been developed in document library, configuration control, hazard analysis, hardware.The ICCACSE 20th International Conference on Computer-Aided Control System Engineering aims to bring together leading academic scientists.Computer aided control systems engineering. Printer-friendly version PDF version. Author: Jamshidi, Mohammad. Shelve Mark: CHO TJ C Location.Previous article in issue: Control System Design: An Introduction To State-Space Methods, Bernard Friedland, McGraw-Hill (UK),

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