

Description, in real time, of the uncertainties in nonlinear models



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Education and experiences

- Ph.D., Control Systems, Universidad Nacional del Sur, Argentina (2000)
- B.S., Electronic Engineering, Universidad Central de las Villas, Cuba (1993)
- Hope College, Assistant Professor (2004-)
- Curriculum Specialist/Engineering, Davenport University (2002-2004)
- Postdoctoral Researcher at Mathematical Modeling Laboratory, Cognitive Science, IU (2001-2002)

Areas of expertise

Modeling, Identification, Simulation and Control.

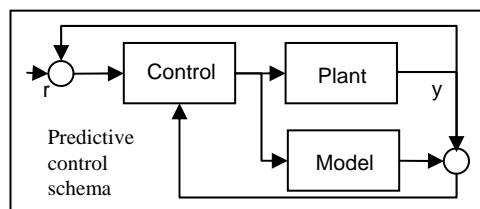
Grants and awards

- MUTIS fellowship for doctoral studies (for Spanish and Portuguese Commonwealth) (1996-2000)
- Co-Project Director of the SME-funded Articulation & Integration of Manufacturing Education (AIME). (2003-2004)
- Co-project Director for the Michigan Space Grant Consortium-funded "GRAPCEP High Powered Rocket Teams" (2004)

Key publications and presentations

- Abrahantes Vázquez, M.A. and O. Agamennoni, "Approximate models for nonlinear dynamical systems and its generalization properties", Mathematical and Computer Modelling, Vol. 33, No. 8-9, April-May 2001, Pergamon, pp 965-986
- John J. Krupczak, Jr., Christy Heid, Miguel Abrahantes, Tim Benson, Daniel Rodack, Jonathan Spauling, John, "A simple loudspeaker which students can build and take home", MSTA Journal, Fall 2004, Vol. 49, No. 2
- C.A. Heid, M. Abrahantes and D. Cherba "Tracked-Vehicle; A Hands-on Engineering Experience," MSTA Journal, 50, 7-12 (2005).

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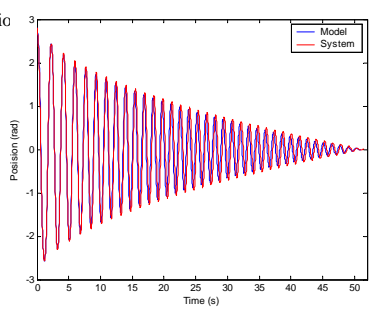
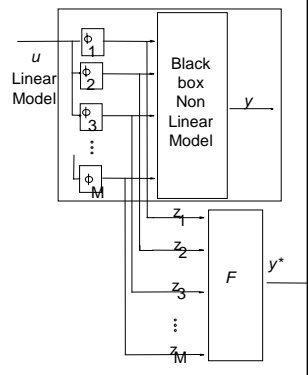


Modeling and Identification are vital parts of Control Theory. The quality of the model determine the quality of the control. Some control strategies are very model dependent like predictive control (figure). Other strategies like robust control try to compensate the uncertainties of the model's prediction, but yield controls that are not optimal.

When the control task is done using a linear approximation there is a well establish theory, but most of the systems are nonlinear. If a new technique of nonlinear control is used, we have to deal with the uncertainties of the model.

This research project intended to develop an algorithm to obtain, in real time, a description of the uncertainty of a nonlinear model (y^* in figure). In particular for a "black-box" nonlinear modeling approach. Black box structures copy the behavior of the systems but analytically it doesn't explain it, the precise variables acting on the system are not studied.

With the information from the description of the uncertainty (y^*) the control strategies could be designed more efficiently. In the case of systems, which are not controllable, like the weather or the path of a hurricane, it is well known that the prediction of the model is accompanied with a degree of confidence in the prediction. This degree of confidence (generally a statistic percentage) is as important as the output or prediction of the model itself.



Prototype Modeling

With the assistants of research student Karl Butter, during the summer of 2005 a pendulum prototype was built and modeled. An Inertial Wheel Pendulum Prototype is a good academic example to validated the study of the proposed technique. This kind of acrobat robot has been used extensively to present control strategy and validate any improvements.

Prototype Control

After a nonlinear model, that included different types of friction was obtained, a controller was designed to control the pendulum in its inverted position.

With the assistance from research student Jeff Mulder, during the summer of 2005, the interface to control the pendulum was developed and a nonlinear and linear control was successfully implemented with a swinging up and catching strategy.

