

# Control Performance Assessment for Block-Oriented Nonlinear Systems

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## Overview

Control performance assessment or CPA is a useful tool to establish the quality of industrial feedback control loops.

A recent specific example reported in BP's internal newsletter, *Technology in Action*, 2009, mentions savings of between \$1-5 million per refinery, per year, using commercial CPA software with a typical return on investment of 4 months.

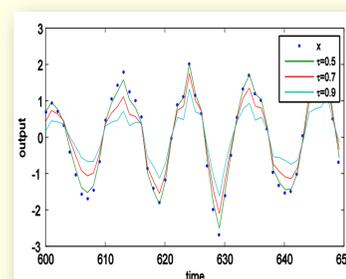
This work extends CPA to a popular class of nonlinear systems, specifically block-oriented nonlinear models.

For these systems, a semi-parametric method is proposed to estimate the minimum variance performance lower bound (MVPLB) and performance index.

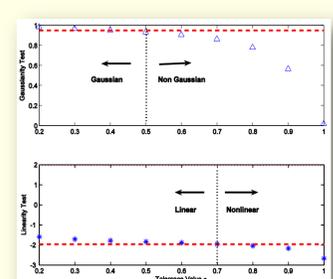
## Performance Index Estimation

- Use a B-spline to remove the nonlinearity
- The optimal B-spline is determined by the Hinich Gaussianity & linearity test
- The residual time-series between B-spline curve and the output  $y_t$  can be used to estimate the performance index

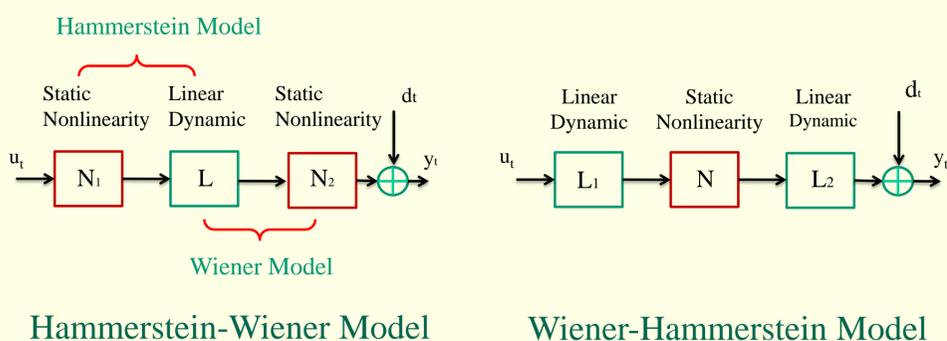
B-spline fitting curve



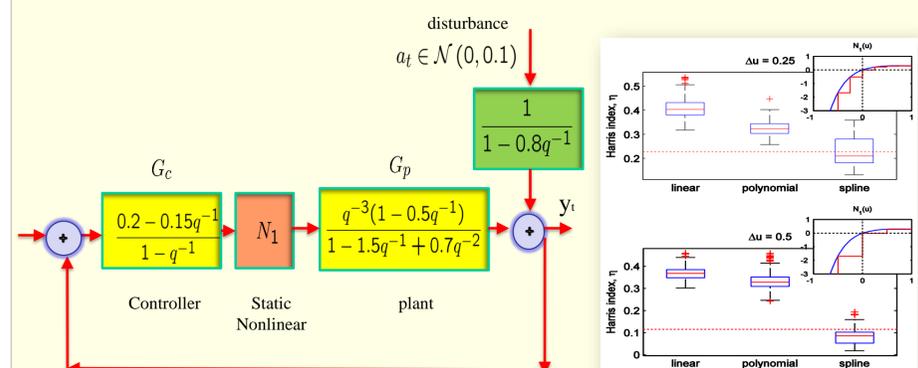
Hinich test



## CPA for Block-Oriented Nonlinear Systems



## Simulations



## Conclusions

- Extend the CPA to the block-oriented nonlinear systems
- Linearization results will provide bias
- A semi-parametric method for the nonlinear CPA is a reliable method to estimate performance index

## References

- [1] Yu, W., Wilson, D.I. & Young, B.R. (2010), Nonlinear control performance assessment in the presence of valve stiction, *Journal of Process Control* (in press).
- [2] Harris, T.J. & Yu, W. (2007), Controller assessment of a class of nonlinear systems, *Journal of Process Control*, 17: 607-619.

## Acknowledgments

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The performance index or Harris index is scaled to lie within [0,1], where values close to 1 mean better/tighter control.