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In the Name of Allah,
the Compassionate, the Merciful,
THE EFFECTS OF ANTI-ALIASING FILTERS ON
SYSTEM IDENTIFICATION

A thesis presented in partial fulfilment of the requirements for the degree of Master of
Technology in Production Technology Department at Massey University.

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CONTENTS

Acknowledgements ...................................................................................................... 3
Aims and Objectives of the Project ............................................................................. 4
Summary ...................................................................................................................... 6

CHAPTER 1 Introduction and Literature Review ...................................................... 7

1.1 Systems and Models .......................................................................................... 7
  1.1.1 Obtaining a Model of a System .................................................................. 8
  1.1.2 Model Classification ................................................................................ 9

1.2 System Identification ....................................................................................... 10
  1.2.1 Formulation and Classification of the System Identification ................... 11
  1.2.2 Parameter Estimation Methodology ......................................................... 13
  1.2.3 Classical Methods of System Identification ............................................. 15
    1.2.3.1 Frequency Response Method ......................................................... 15
    1.2.3.2 Identification From Step Response ................................................. 16
    1.2.3.3 Correlation Method ......................................................................... 17
    1.2.3.4 Spectral Density Function ................................................................ 18
    1.2.3.5 Pseudo Random Binary Sequences (PRBS) ..................................... 19

  1.2.4 Off-Line Methods for System Identification ............................................ 20
    1.2.4.1 Estimation of the Parameters of a Discrete-Time Model from Noise-Free Input-Output Data ................................................................. 21
    1.2.4.2 Weighted Least-Squares Estimates of Parameters from Noise-Contaminated Data ................................................................. 23
    1.2.4.3 Conditions for the Existence of the Weighted Least-Squares Solution ........................................................................................................... 25

1.3 Filtering .......................................................................................................... 25
  1.3.1 Butterworth and Chebychev Filters ......................................................... 25
  1.3.2 Sampling .................................................................................................... 27
  1.3.3 Nyquist Criterion (Sampling Theorem) .................................................... 27
  1.3.4 Anti-Aliasing ............................................................................................ 29

1.4 Simulation ......................................................................................................... 30
  1.4.1 Computer Simulation ................................................................................ 30
  1.4.2 Digital Representation of Signals ............................................................... 30
  1.4.3 Numerical Integration ............................................................................... 31
  1.4.4 Errors In Numerical Integration ................................................................. 33
  1.4.5 Simulation Software .................................................................................. 34
    1.4.5.1 ESL .......................................................................................... 36
CHAPTER 2 Model Selection and Simulation ...................................................... 37
  2.1. Second Order Linear System ..................................................................... 38
  2.2. Nonlinear Reaction System ....................................................................... 38
  2.3. Switched-Mode Power Regulator ............................................................... 38
  2.4. Simulation Structure ................................................................................... 41
    2.4.1 Pseudo Random Binary Sequence Generator ...................................... 42
    2.4.2 Noise Simulation ................................................................................ 42
    2.4.3 Filter Submodel ................................................................................. 44
    2.4.4 Linear System Submodel .................................................................. 44
    2.4.5 Nonlinear Reaction System Submodel .. .............................................. 44
    2.4.6 Switch Mode Power Regulator (SMPR) Submodel............................ 44

CHAPTER 3 Filter Selection and Simulation ....................................................... 45
  3.1 Simulation of Filters .................................................................................. 47

CHAPTER 4 Experiments .................................................................................... 49
  4.1 Experiments Without Filtering .................................................................... 50
  4.2 Filtered Noise Free Experiments ................................................................ 51
  4.3 Filtered Data with Noise Experiments ...................................................... 51
  4.4 Identification Methods Used in Experiments ............................................... 52

CHAPTER 5 Results and Discussion ............................................................... 54
  5.1 Second Order Linear System ...................................................................... 54
    5.1.1 Discussion (System 1) .......................................................................... 70
  5.2 Nonlinear Reaction System ......................................................................... 72
    5.2.1 Discussion (System 2) .......................................................................... 72
  5.3 Switched-Mode Power Regulator ................................................................ 82
    5.3.1 Discussion (System 3) .......................................................................... 82

CHAPTER 6 Conclusions ................................................................................... 92

References ........................................................................................................... 94

Appendix A ........................................................................................................... 95

Appendix B ........................................................................................................... 109

Appendix C .......................................................................................................... 115
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In order to satisfy the Nyquest criterion for sampling, signals must be band limited. This is usually achieved by using low pass analog filters which must be placed before sampling (these filters are called anti-aliasing filters). These filters have some effect on the identification of systems. The aim of this project was to determine these effects.

The objectives were to:
1) Choose systems with different natural frequencies
2) Simulate these systems
3) Apply a PRBS (Pseudo Random Binary Sequence) input and log the output
4) Sample this data
5) Transfer sampled data to MATLAB
6) Find the best model using the MATLAB identification toolbox
7) Simulate the filters
8) Pass the output data through these filters
9) Repeat (5) and (6)

10) Simulate additive measurement noise

11) Add noise to the output of the system

12) Repeat (8) and (9)

13) Compare the real data with model data

14) Calculate the error criterion \( J \) for each case

Finally, a suitable parameter was to be identified which could be used to design effective anti-aliasing filters.
Research was conducted to determine the effect of anti-aliasing filters on the identification of dynamic systems. Systems were simulated in the continuous simulation package ESL. The system response to a PRBS (Pseudo Random Binary Sequence) was recorded. Simulated noise was added and passed through a number of simulated analog filters. The systems were identified using the MATLAB identification toolbox.

Two standard filters (Butterworth and Chebychev) were used with cut-off frequencies between $\omega_s$ (natural frequency of the system) and 20 times $\omega_s$.

Results showed that carefully designed filters could improve the performance of the identification algorithm in the presence of non-white high frequency additive noise. However for noise free measurements the filters degraded the performance of identification algorithms. This performance could be observed in the identified models steady state error, overshoot and settling time when subject to a step input.

In the experiments performed, the lowest order (and in one case second order) filters with cut-off frequency of $\omega_p = 5\omega_s$, gave the best results.