IDENTIFICATION OF HAMMERSTAIN MODEL USING STOCHASTIC PERTUBATION SIMULTANEOUS APPROXIMATION

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IDENTIFICATION OF HAMMERSTEIN MODEL USING SIMULTANEOUS PERTURBATION STOCHASTIC APPROXIMATION

NURRIYAH MOHD NOOR

This thesis is submitted as partial fulfilment of the requirements for the award of the Bachelor of Electrical Engineering (Hons.) (Electronics)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

DECEMBER 2016

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of the Bachelor Degree of Electrical Engineering (Hons.) (Electronics).

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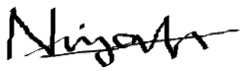
STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature	:	
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Dedicated to the most important persons in my life, the one with full faith in me and the never hesitated towards me,
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LIST OF ABBREVIATIONS

SPSA	Simultaneous Perturbation Stochastic Approximation
LTI	Linear-Time-Interval
SISO	Single-Input-Single-Output
PRBS	Pseudo Random Binary Sequence
MIMO	Multi-Input-Multi-Output

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ABSTRACT

This project study an identification of continuous Hammerstein based on simultaneous Perturbation Stochastic Approximation (SPSA). Furthermore, the Identification is done using MATLAB Simulink to simulate the Hammerstein Model. The structure of non-linear is assumed to be completely unknown. However, the system order assumed to be known For handling it, piecewise-linear function are used as a tool to approximate the unknown non-linear function. The SPSA algorithms was proposed to identify the problem of Hammerstein model. The main benefit of the SPSA-based method is it can be applied to identification of Hammerstein systems even though less restrictive assumptions. The SPSA based method is then used to estimate the parameters in both the linear and non-linear parts based on the given input and output data with the present of delay in time. Besides that, this project analysed the efficient of the SPSA in identify nonlinear system in term of object function and error with different noise variance. A numerical example is given to illustrate that the SPSA based algorithms can give accurate parameter estimate of the Hammerstein models with high probability through detailed simulation.

ABSTRAK

Kajian projek ini adalah untuk mengenalpasti model Hammerstein yang berterusan mengunakan Penghampiran Gangguan Secara Rawak dan Serentak (SPSA). D samping itu, MATLAB Simulink telah digunakan bagi mensimulasikn model Hammerstein. Struktur selari dianggap tidak diketahui. Walau bagaimanapun, susunan sistem yang diandaikan diketahui untuk mengendalikan masalah itu, fungsi Pecahan Garisan digunakan sebagai alat untuk menghampiri Garisan selari tersebut. Algoritma SPSA telah dicadangkan untuk mengenal pasti masalah Model Hammerstein. Faedah utama kaedah berasaskan SPSA ialah ia boleh digunakan untuk mengenalpasti andaian walaupun kurang ketat sistem Hammerstein. SPSA berdasarkan kaedah ini kemudiannya digunakan untuk menganggar parameter di dalam kedua-dua system selari dan tidak selari bahagian berdasarkan diberikan input dan output data dengan kehadiran kelewatan masa. Di samping itu, projek ini dianalisa yang cekap daripada SPSA di dalam mengenal pasti sistem tak linear segi fungsi objek dan ralat dengan varians bunyi yang berbeza. Contoh berangka yang diberikan untuk menggambarkan bahawa SPSA berasaskan algoritma boleh memberikan anggaran tepat parameter Hammerstein dalam model dengan kebarangkalian yang tinggi melalui simulasi yang terperinci.

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

System identification is the process of formulating a mathematical model of a system using examined data. Modelling is an essentially important way of analysing, learning and understanding the world around. All system in the world usually used model system as the simulation for the real system. One of the common model is Hammerstein Model.

The Hammerstein Model represented the series connection of static nonlinear system with linear system. Among various type of nonlinear system model, Hammerstein model is the most popular ones. It is an important block-oriented structure which from combination of simple of linear system with the general of nonlinear system. In this era of technology, there are many of solution has been proposed to identify the Hammerstein model.

In order to find the approximation parameter for Hammerstein Model, SPSA has been studied as a proper solution. SPSA known as Simultaneous Perturbation Stochastic Approximation will be used to solve the unknown parameter for Hammerstein Model.

1.2 PROBLEM STATEMENT

A variety of method has been proposed to estimate the parameter for Hammerstein model. Most of existing results discuss the models in discrete time, while the many of actual system are represented naturally in continuous time. In addition, the existing methods assume that the static nonlinear system can be presented by a linear combination of several numbers of known basic functions.

1.3 PROJECT OBJECTIVE

The main objective of this project is to estimate the parameter in Hammerstein model based on the given input and output data using Simultaneous Perturbation Stochastic Approximation (SPSA) method. Besides that, objective of this project is to analyse the efficient of the SPSA in identify nonlinear system in term of object function and error with different noise variance.

1.4 SCOPE OF THE PROJECT

This project covered overall estimation the parameter of both the linear and nonlinear parts in the Hammerstein model by using Simultaneous Perturbation Stochastic Approximation (SPSA) with MATLAB simulation. We use the SPSA method as a tool for identification system in nonlinear system part. While the non-linear part using piecewise approximation. The SPSA-based method will be utilized to identify the parameter in both linear and nonlinear subsystems based on the given input and output.

1.5 THESIS LAYOUT

This thesis discussed on how identification method using simultaneous perturbation stochastic approximation solved the Hammerstein system. It cover on five main chapters. Chapter 1 is discussed on the introduction of this project where the problem statement and the objective of project are stated. Next, chapter 2 described on the literature review that included on the research that had been done through the journal of the previous researcher. The main parts of this chapter are the method of identification for Hammerstein and the simulation by MATLAB. Chapter 3 discussed on the procedure of this project which it involved on the mathematical modelling and the coding has been simulated. For the chapter 4, all the results and discussion has been analysed and discussed. Finally, Chapter 5

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