DEVELOPMENT OF A SOFTWARE PACKAGE FOR DATA INTERPRETATION AND MODEL CALIBRATION SYSTEM

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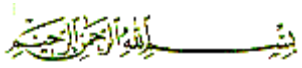
DEDICATION

Dedicated to my loving husband, Solihin Sidqi, my loving parents Maziah Abdullah and Ahmed Azhar Jaafar
and my adorable kid Umar Haziq

ACKNOWLEDGEMENT



First and foremost, الحمد لله , thank to Allah, I praise God for the blessings endowed upon me and provide me perseverance and patience to complete the work entrusted to me.

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ABSTRACT

The purpose of this thesis is to present an implementation of least square method on estimating unknown coefficient parameters in system transfer function. Graphical User Interface (GUI) is expected to be develop adapting least square method and interface user to perform estimation on system that user interested to study on by only providing input and output data. Concept of least square is initially being elaborated on how this estimation method works to provide unknown parameters. Both offline and online least square formulation were being tested in Matlab software to ensure the formulations were correctly programmed provided with input and output files. Visual C++ and Matlab software were being tested in this project in order to engage least square formulas into GUI software or application. Comparison between these two software in GUI implementation is being discussed whereby Matlab offers better engineering tools and controls to develop GUI, whereas Visual C++ required interface in order to reflect least square algorithm to be presented to end user.

ABSTRAK

Tujuan tesis ini adalah untuk mempersembahkan pelaksanaan kaedah kuadrat terkecil untuk estimasi parameter pekali yang tidak diketahui dalam fungsi sistem transfer. Graphical User Interface (GUI) dijadikan perantara kepada pengguna untuk melakukan estimasi pada sistem supaya pengguna dapat mendapatkan estimasi parameter pekali menggunakan kaedah kuadrat terkecil dengan hanya menyediakan data input dan output yang diperolehi daripada eksperimen. Formulasi kuasa dua terkecil diterjemahkan dan bagaimana kaedah ini berfungsi untuk menyediakan parameter yang tidak diketahui dipersembahkan dalam tesis ini. Baik formulasi offline dan online; kedua-duanya dibincangkan dan diuji dalam perisian Matlab untuk memastikan formulasi ini diprogramkan dengan tepat berpandukan dengan input dan output data. Visual C + + dan perisian Matlab diuji dalam projek ini menggunakan rumus kuadrat terkecil ke dalam aplikasi GUI. Perbandingan antara dua perisian dalam pelaksanaan GUI diperbincangkan di mana Matlab menawarkan alat teknik kejuruteraan yang lebih baik untuk merangka GUI manakala Visual C + + memerlukan perisian perantara untuk merefleksikan algoritma kuadrat terkecil untuk disampaikan kepada pengguna akhir.

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LIST OF ABBREVIATIONS

ODE	ordinary differential equations
GUI	Graphical User Interface
PARES	Parameter Estimation Software
LS	Least Square
IV	Instrumental Variable
PE	Prediction Error
RELS	Recursive Extended Least Square
RGELS	Recursive General Extended Least Square
SG	Stochastic Gradient
PRBS	Pseudorandom Binary Signal
RLS	Recursive Least Square
DLL	Dynamic Link Library
EME	Embedded Matlab Editor

LIST OF SYMBOLS

k	discrete time index
u(k)	system input at discrete-time k
y(k)	measured system output at discrete-time k
$\theta(k)$	unknown parameter vector to be estimated
$\hat{\theta}(k)$	estimate of $\theta(k)$
φ(k)	vector of input, outputor delayed signals
$\in (1)$	rsidual
J	cost function

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Most of the current existing systems are now developed with closed loop system and sensors in order to control and manipulate the system or plant behavior to fulfill human needs. Even though some purchased systems are already equipped with plant specifications and established transfer function, realistically, the given transfer functions might not be working fine with the plant. In the manufacturing industry, failure of a system can be contributed by sensors and parts which are approaching to lifespan. As the result, the real time system modeling and transfer function might be changed as well and caused controller unable to compensate real time error and reduce system accuracy and stability. Thus, it is crucial to obtain system transfer function and this project will describe method of obtaining system transfer function in pro-active and interactive way.

A common problem in dealing with dynamical systems is in the determination of the mathematical model that represents the systems. The goal of parameter estimation/system identification is to determine the values of the model parameters that provide the best fit to measured data, generally based on some type of least squares. In most cases, this requires the solution of a nonlinear and frequently non-convex optimization problem. Some of the available software are lacking in generality, while others do not provide ease of use. Graphical user-interactive parameter estimation software is needed for identifying unknown system

parameters. This project aims to develop a parameter estimation system that can suggest the transfer function equation of the system to be identified complete with validation testing and is equipped with friendly graphical user interface.

By developing a user-friendly Graphical User Interface (GUI) in order to assist engineers in getting the transfer function of any plant or system, it will be very helpful and useful as engineers just need to provide input and output data with certain signals in order to obtain system transfer function. This project will describe on the proposed method in order to develop the system GUI with embedded parameter estimation function for data processing.

1.2 Objective

The objective of this project is to develop software package with user-friendly graphical user interface (GUI), which suggest and validate the best transfer function for data interpretation and model calibration system using offline and online parameter estimation techniques.

1.3 Scope of Work

The scope of work is to clearly define the specific field of the research and ensure that the entire content of this thesis is confined to the scope. It is begun with the specifying the GUI functionalities to be developed to estimate the specified parameters of a plant/system.

An estimated transfer function is suggested based on the input and output data observed. The model is composed of transfer function describing the behavior of the plant with calibration process being performed to validate the estimated model with the actual experimental data.

An experimental evaluation of parameter estimation methods was being performed using the least-squares method for both offline and online estimation

methods. Although this can be extended to using various other types of parameter estimation algorithms to improve its effectiveness, this project focuses on the least-squares method only. Why least square method was being chosen as estimation method will be discussed in Chapter 3.

Visual C++ software is a tool for least square algorithm formulation and Visual Basic application was being use as the software presenting GUI interfacing with end user.

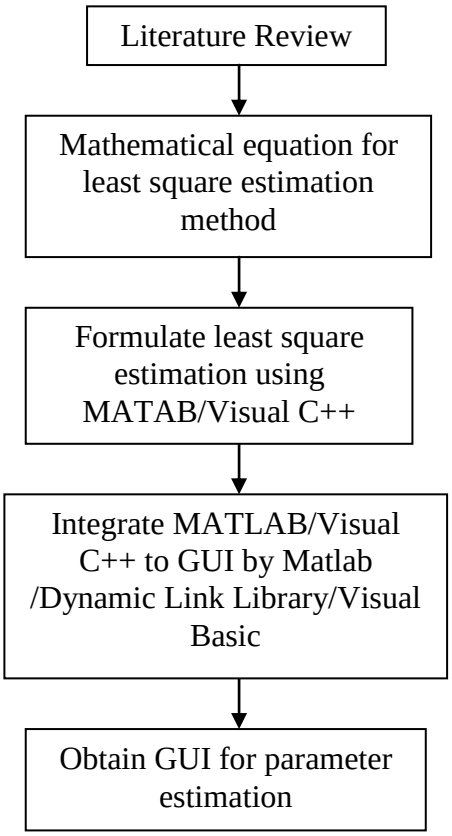

Figure 1.1: Flowchart represents the scope of work

1.4 Outline of the Thesis

The thesis presents the development method to design GUI for parameter estimation using least square method.

Chapter 2 is the literature review which introduces the overview of the existing GUI for estimation purpose. The explanation begins with the related existing work which is found to be related to this project. This chapter then describes the limitations of existing work and how this project going to add features to overcome the limitations.

Chapter 3 provides the methodology adapted throughout the work of this project. It covers the theoretical explanation for least square method and how to formulate this theory on programming language.

Chapter 4 deals with the results of the GUI features as the outcome of the least square formulation on estimation. The flow on processing the original formula and the process it takes to develop GUI will also be presented in this topic.

Chapter 5 presents the project outcome is as conclusion in this chapter. As for future developments, some suggestions are highlighted with the basis of the limitation of the software executed in this project.

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