

PREDICTION OF FRUIT QUALITY USING NEAR-INFRARED
VIA NARX MODEL

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Dedicated, in thankful appreciation to my beloved husband, Rizman A. Majid for supporting, understanding loves and, encouragement. To my daughter and my sons, Nur Aina Batrisyia, Muhammad Ammar Uwais and Muhammad Amir Zubair thanks for being my spirit of inspiration. Dedication also to my parents, parents in law, brothers and sisters for their supporting all these years

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ABSTRACT

Nowadays, the awareness of health and safety among consumers has been increase. This scenario caused them become willing to pay more for high quality fruit products. However, it is not easy to grade fruits by using only our eyes. Therefore non-destructive fruits internal quality assessment technique is an area that both technology and market section concern about. The objectives of this project are to study about Near Infrared Spectroscopy (NIRS) as a fruit quality measurement method, to evaluate the use of NIRS for nondestructive measuring SSC of apples and to predict the best model of the measurement data by using Auto-Regressive with Exogenous Input (ARX) Model and Nonlinear Auto-Regressive with Exogenous Input (Nonlinear ARX) Model. The Near-Infrared (NIR) reflectance spectra and the soluble solids content (SSC) of apples data have been recorded before from an experiment. The impact of the orders or numbers of poles of the model has been investigated based on the performance (best fit) of the model. The ARX Model and Nonlinear ARX Model indicate excellent prediction performance of the model with the best fit value were 87.11% and 100% respectively.

ABSTRAK

Pada masa kini, kesedaran tentang kesihatan dan keselamatan dikalangan pengguna telah meningkat. Senario ini mengakibatkan para pengguna sanggup mengeluarkan kos yang tinggi atau membayar lebih untuk produk buah yang berkualiti tinggi. Walaubagaimanapun, pengredan buah tidak mudah dilakukan dengan hanya menggunakan mata kasar. Maka, teknik penilaian kualiti dalaman buah-buahan yang '*nondestructive*' adalah aspek yang amat diperhatikan oleh kedua-dua teknologi dan seksyen pasaran. Objektif projek ini adalah mengkaji tentang '*near infrared spectroscopy*' sebagai satu kaedah pengukuran kualiti buah – buahan, untuk menilai penggunaan '*near infrared spectroscopy*' bagi pengukuran '*soluble solid content*' (*SSC*) epal yang '*nondestructive*' dan menganggarkan model terbaik terhadap pengukuran data dengan menggunakan Model '*ARX*' dan Model '*Nonlinear ARX*'. Data berkenaan '*Near-Infrared (NIR) reflectance spectra*' dan '*soluble solid content*' (*SSC*) epal telah direkodkan sebelum ini melalui satu eksperimen. Kesan peringkat sesuatu model atau bilangan kutub sesuatu model telah dikaji berdasarkan persembahan model tersebut. Model '*ARX*' dan Model '*Nonlinear ARX*' menunjukkan prestasi anggaran model yang terbaik dengan nilai '*best fit*' nya masing – masing adalah 87.11% dan 100%.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENTS	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	LIST OF ABBREVIATIONS	xiii
	LIST OF APPENDICES	xiv
1	INTRODUCTION	1
	1.1 Background	1
	1.2 Problem statements	2
	1.3 Objectives of the project	3
	1.4 Scope of the project	3
	1.5 Report outline	4
2	LITERATURE REVIEW AND THEORETICAL BACKGROUND	5
	2.1 Introduction	5
	2.2 Near Infrared Spectroscopy (NIRS) Technique	5
	2.2.1 Theory of NIR Spectroscopy Technique	6
	2.2.2 Frank – Condon Principle	8

2.3	NIRS Analysis	8
	2.3.1 Advantages of NIR	9
	2.3.2 Disadvantages of NIR	10
2.4	SSC Analysis	11
2.5	Composition Of An Apple	11
	2.5.1 Sugar content	12
2.6	System Identification	12
	2.6.1 ARX Model	13
	2.6.2 Nonlinear ARX Model	15
3	FRUIT QUALITY PREDICTION EXPERIMENT	17
	3.1 Introduction	17
	3.2 Sample of labelling	17
	3.3 Instruments	19
	3.3.1 Analytical Spectral Devices (ASD) Field Spec HandHeld Spectroscopy	20
	3.3.2 ATAGO Digital Hand-Held “Pocket” Refractometer	21
	3.4 Procedure of spectrum acquisition	22
	3.5 Procedure of real SSC acquisition	26
4	METHODOLOGY	28
	4.1 Introduction	28
	4.2 Principal Component Regressions (PCR)	29
	4.2.1 Principal Component Analysis (PCA)	30
	4.2.2 SVD (singular value decomposition)	31
	4.3 Data Processing	34
	4.4 System Identification	35
5	RESULT AND DISCUSSION	47
	5.1 Introduction	47
	5.2 ARX Model	47
	5.3 Nonlinear ARX Mode	53

6	CONCLUSION AND RECOMMENDATION	58
	6.1 Conclusion	58
	6.2 Recommendation	59
	REFERENCES	60
	Appendices	65

LIST OF TABLES

TABLE NO.	TITLE	PAGE
3.1	Specifications of Digital Hand-Held “Pocket” Refractometer	21
5.1	Performance of ARX Models	48
5.2	Performance of Nonlinear ARX Model	53
5.3	Value of regressors were used in the nonlinear block of NARX741	57

LIST OF FIGURES

FIGURE NO.	TITLES	PAGE
1.1	Food guide pyramid	2
2.1	A block diagram of basic NIR Spectroscopy	6
2.2	Some of the energy from spectra will be absorbed by the bonding between atoms	7
2.3	System identification procedure	13
2.4	The Nonlinear ARX Model block diagram	15
3.1	Sample of labelling	18
3.2	Instruments (i) ASD Field Spec HandHeld Spectroscopy; (ii) ATAGO Digital Hand-Held “Pocket” Refractometer; (iii) ASD Pro Lamp	19
3.3	Apparatus arrangement for white reference calibration	23
3.4	The platform for optical reflectance measurement of apple	24
3.5	The inner view of experimental instrument set up	24
3.6	The outer view of experimental instrument set up	25
3.7	Modified fruit knife	26
4.1	Overall methodology chart	29
4.2	Load folder contains the mat file and m file	37
4.3	Steps to load the data into workplace	37
4.4	Data were loaded at workplace	38
4.5	The m-file	38
4.6	Step to call System Identification Tool	39
4.7	System Identification Tool	39

4.8	Import Data Box (1)	40
4.9	Import Data Box (2)	40
4.10	System Identification window with measurement data	41
4.11	Step to select the data range	41
4.12	Data range for DATAe	42
4.13	Data range for DATAv	42
4.14	Drag DATAe and DATAv	43
4.15	Select models	43
4.16	Linear Parametric Models window	44
4.17	Order Editor window	44
4.18	New orders for the model	45
4.19	Nonlinear models	45
4.20	Estimated model output	46
5.1	Measured and simulated model output for ARX 881	49
5.2	Measured and simulated model output for NARX 741	54
5.3	Estimation Report	55
5.4	The nonlinearity for NARX 741	55

LIST OF ABBREVIATIONS

NIR	-	Near Infrared
NIRS	-	Near Infrared Spectroscopy
SSC	-	Soluble Solid Content
ARX	-	Auto-Regressive with Exogenous Input
NARX	-	Nonlinear Auto-Regressive with Exogenous Input
ASD	-	Analytical Spectral Devices
PCR	-	Principal Component Regression
PCA	-	Principal Component Analysis
MLR	-	multiple linear regression
PLS	-	partial least squares
PC	-	Principal Components
SVD	-	singular value decomposition
FPE	-	final prediction error

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	The Real Soluble Solid Content Data	66
B	Matlab Program	68
C	Gantt Chart	71

CHAPTER 1

INTRODUCTION

1.1 Background

According to general food guide pyramid in Figure 1.1, below, fruits and vegetables are located at stage two which have to eat a lot or two to five servings from our meal. Therefore, fruits are important to the human body because fruits can provide nutrients to us and also able to prevent some disease. This means that everybody has to concern about the quality of fruits.

In order to get best nutrients, high quality and safety standards are important issues that have to concern about. Generally, fruit quality only focuses on the basis of size, colour, and surface defects. However, dry matter content, total soluble solids content, sugar content, juice acidity and firmness are important internal quality attributes of fruit products [1]. Most instrumental techniques to measure these properties are time consuming, destructive and costly, and require professional operations. Three major parameters determine the internal quality and the taste of apples are hardness, sugar content and titratable acidity, which are still determined destructively [2]. Therefore, it is much needed for the development of a reliable, non-destructive method.

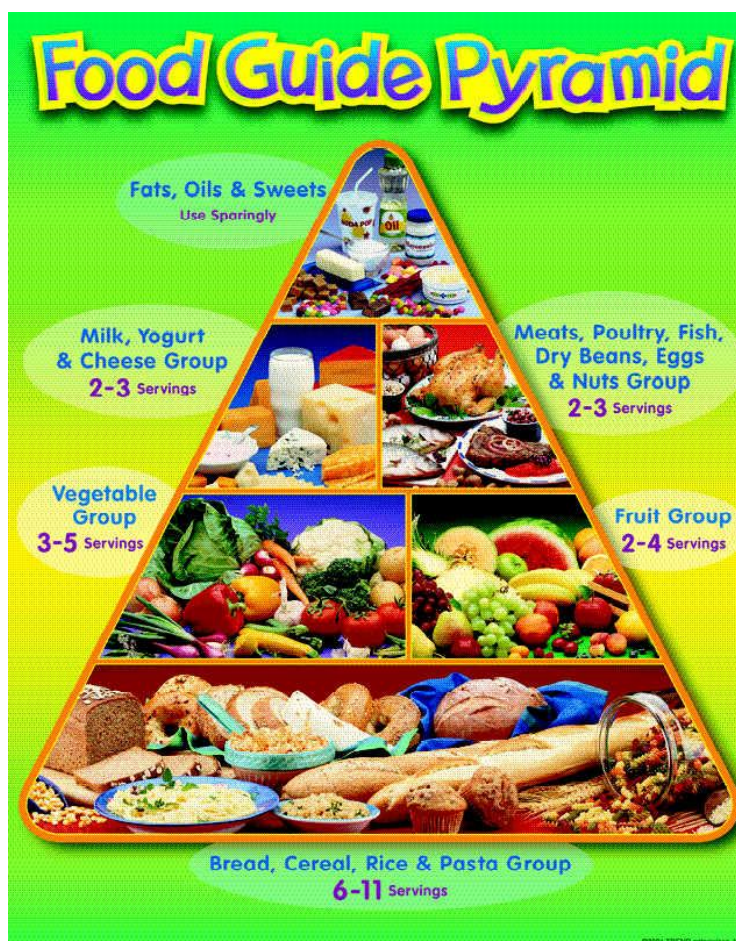


Figure 1.1 : Food guide pyramid

1.2 Problems statements

Nowadays, the awareness of health and safety among consumers has increase. This scenario caused them become willing to pay more for high quality fruit products. However, it is not easy to grade fruits using eyes. Any mistaken in grading process will contribute bad effects to consumers. Therefore, the Near infrared Spectroscopy (NIRS) is used to reveal all the internal quality attributes of fruits. Then for this study System Identification tool focusing to ARX (Auto-Regressive with Exogenous Input) Model and Nonlinear ARX (Nonlinear Auto-

Regressive with Exogenous Input) Model are applied to analyze the output spectra of NIRS.

1.3 Objectives of the project

The objectives of this project are listed below :

- i. To study about Near Infrared Spectroscopy as a fruit quality measurement method.
- ii. To evaluate the use of NIRS for nondestructive measuring SSC of apples
- iii. To predict the best model of the measurement data by using Auto-Regressive with Exogenous Input (ARX) Model and Nonlinear Auto-Regressive with Exogenous Input (Nonlinear ARX) Model

1.4 Scope of the project

The scope of this study are :

- i. Get the spectrum and SSC data from the fruit quality experiment.
- ii. Using matlab software to analyze the spectrum and SSC data.
- iii. Using ARX Model and Nonlinear ARX model in System Identification Tool to predict the best model of the measurement data.

1.5 Report outline

This report consists of six chapters were named as CHAPTER 1, CHAPTER 2, CHAPTER 3, CHAPTER 4, CHAPTER 5 and CHAPTER 6. Then, they followed by references and appendices.

In the first chapter, the background, problem statement, objectives, and scope of this project were stated out clearly.

Then, the literature reviews of this project which consist of NIRS and System Identification from previous researches and studies were written in chapter two.

Next, the procedure of the experiment to acquire spectra data and real SSC data that have done by Dr Herlina's Ph.D student, Mr Chia Kim Seng were recorded roughly in chapter three as a reference to this study .

In chapter four, the procedure of data processing using matlab program and System Identification Tool in the matlab software was recorded.

After that, the result and discussion about this project were presented in chapter five.

Lastly, conclusion and recommendation were presented in the chapter six.

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