WAVELET ANALYSIS: MULTIPATH MITIGATION FROM GPS CARRIER PHASE OBSERVATION

This thesis is presented in partial fulfillment for the award of the Bachelor of Electrical Engineering (Hons.) Universiti Teknologi MARA.

MOHD RIJAL BIN SHUKRI

Faculty of Electrical Engineering

UNIVERSITI TEKNOLOGI MARA

40450 SHAH ALAM, SELANGOR

ACKNOWLEDGEMENTS

بسم الله الرحمن الرحيم

In the Name of Allah, the Most Beneficent, the Most Merciful. All praise to Allah for the entire incredible gift endowed upon me and for giving the health and strength to keep up the study and enable me to prepare and complete this thesis.

I would like to acknowledge the people who made this project possible my supervisors, Mr. Mohamad Huzaimy Jusoh and Mrs. Norsuzila Ya'acob and also Dr. Ngah Ramzi Hamzah for their kindness, support, and concern in providing valuable ideas, suggestions and guidance's throughout the course. Their input has afforded immeasurable help during my study.

I am also indebted to the various help and discussion offered by my fellow friends to overcome the obstacles that arise during the implementation process. Thank you and may Allah bless and reward them for their generosity.

Last but not least, a special thank to my family for their prayer and support.

My sincere thank to all of you.

ABSTRACT

Multipath mitigation techniques using wavelet decomposition is proposed for extracting or modeling multipath from Global Positioning System (GPS) carrier phase observations. Multipath is a phenomenon whereby satellite signals can arrive at the receiver via multiple paths, due to reflections from nearby objects such as trees, buildings, the ground, water surfaces, vehicles, etc. It can be reduced by choosing sites without multipath reflectors or by using choke-ring antennas to mitigate the reflected signal. Wavelet transform (WT) is a new tool for signal analysis that can provide simultaneously, time and frequency information of a signal sequence. The wavelet is of interest for the analysis of non- stationary signal such as GPS observations because it provides an alternative to classical Fourier Transform, which assumes stationary in signals. Double Differencing (DD) technique was use to detect the multipath effect.

TABLE OF CONTENTS

DECLARATION		i
ACKNOWLEDGEMENTS		ii
ABSTRACT		iii
TABLE OF CONTENTS		iv
LIST OF TABLES		vii
LIST OF FIGURES		ix
LIST OF ABBREVIATIONS		xv

CHAPTER	DESCRIPTION	PAGE
1	**INTRODUCTION**	
	1.1 BACKGROUND	1
	1.2 OBJECTIVES	2
	1.3 SCOPE OF PROJECT	2
	1.4 ORGANIZATION OF PROJECT REPORT	3
2	**LITERATURE REVIEW**	
	2.1 GLOBAL POSITIONING SYSTEM (GPS)	4
	2.2 GPS SYSTEM SEGMENTS	4
	2.2.1 Space Segment	5
	2.2.2 Control Segment	6
	2.2.3 User Segment	7
	2.3 GPS SATELLITE SIGNAL CHARACTERISTICS	8
	2.4 GPS OBSERVABLES	9
	2.4.1 Code Pseudorange	9
	2.4.2 Phase Pseudorange	10
	2.5 GPS ERROR SOURCE	10

2.5.1 Selective Availability (SA) 11
2.5.2 Atmospheric Effects 11
2.5.2.1 Ionospheric Delay 12
2.5.2.2 Tropospheric Delay 12
2.5.3 Multipath Effect 13
2.6 BASELINE SOLUTION BY LINEAR COMBINATION 15
2.6.1 Single differencing 15
2.6.2 Double differencing 17
2.6.3 Triple differencing 18
2.6.4 Differencing Equations 18
2.7 SIGNAL PROCESSING USING WAVELET 20
2.7.1 Concept of Wavelet Transform 20
2.7.2 Selection of Mother Wavelet 21
2.7.3 Discrete Wavelet Transform 23
2.7.4 Discrete Wavelet Transform Algorithm 25

3 METHODOLOGY
3.1 INTRODUCTION 28
3.2 DATA ACQUISATION 29
3.2.1 GPS Data in RINEX Format 30
3.2.2 Software 31
3.2.2.1 TEQC Software 31
3.2.2.2 MATLAB Software 33
3.3 METHOD 33
3.3.1 Wavelet Transform Using MATLAB 33
3.3.1.1 Signal Conversion 33
3.3.1.2 Signal Decomposition 34
3.3.1.3 Signal Reconstruction 35
3.3.1.4 Signal De-noising 35