

2008

## Analysis and pre-processing of signals observed in optical feedback self-mixing interferometry

Xiaojun Zhang  
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### Recommended Citation

Zhang, Xiaojun, Analysis and pre-processing of signals observed in optical feedback self-mixing interferometry, ME-Res thesis, School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, 2008. <http://ro.uow.edu.au/theses/102>

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# Analysis and Pre-processing of Signals Observed in Optical Feedback Self-Mixing Interferometry

A thesis submitted in fulfillment of the  
requirements for the award of the degree

**Master of Engineering (Research)**

from

UNIVERSITY OF WOLLONGONG

by

**Xiaojun Zhang**

School of Electrical, Computer and Telecommunications Engineering  
June 2008

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Xiaojun Zhang

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*Dedicated to  
dedicated to my Family*

# Declaration

This is to certify that the work reported in this thesis was done by the author, unless specified otherwise, and that no part of it has been submitted in a thesis to any other university or similar institution.

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Xiaojun Zhang  
June 23, 2008

# Abstract

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SINCE the laser technology has been applied for providing highly precise measurement, laser interferometry based systems have found increasing applications in the distance, displace measurement and related applications. Recently, a simple construction of laser interferometer with the use of so-called optical feedback self-mixing interferometry (OFSMI) effect has become a popular technique in optical measurement field. In comparison with conventional interferometer, OFSMI enables simple, compact size and cheap interferometer devices to be implemented.

This thesis studies the spectrum characteristics of OFSMI signals and outlines novel approaches to analyze and process the noisy signal at the time and frequency domain simultaneously. The work is motivated by the observation that, when OFSMI signal is given at weak feedback regime (feedback parameter  $C \leq 1$ ), the signal is strictly band-limited, consequently a linear band-pass filter can be applied to remove the noise disturbance while preserving the signals waveform unchanged. On the other hand, in case of OFSMI signal is obtained with  $C > 1$ , an efficient denoising algorithm based on joint time-frequency representation (TFR) can be applied. It has been found that TFR approach provides an sufficient prospective for study the behavior of OFSMI signals for  $C > 1$ .

This work contributes to the framework of pre-processing and analyzing of OFSMI signals. This thesis focus on the spectrum characteristics and the noise attenuation at weak and moderate feedback regime. To achieve this, the ability of band-pass FIR filters and TFR methods in OFSMI signal processing have been evaluated and compared. The results of this work lead to an significant improvement to the performance of OFSMI based laser measurement system.

# Acknowledgements

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I would like to express my sincere gratitude to my supervisor and co-supervisors: Professor Jiangtao Xi, Professor Luqi Sheng, Professor Yangguang Yu, Professor Xianjing Huang and Professor Joe Chicharo. Without them, this thesis would not have been possible. I thank them for their patience and encouragement that carried me on through difficult times. Their continuous supervision and mentoring assisted me to advance in my work and explore new territories in my research field step by step.

This work would also not have been possible without the great technical assistance given by the staff in SECTE and TITR, whose presences and kindness have given me a good memory of studying and living in this country. I am also appreciative of the casual teaching jobs provided by the school during my study which have given a valuable experience in addition to financial assistance during my study. I have been extremely fortunate to have the support of very special friends, Hong Meng, Chao Sun and his wife, Lu Wei and Yi Zhang, etc., to whom I am truly grateful.

Last but not least, I am also very grateful to my parents, my sister, my uncle Edin, aunty Xuling Zhang and friends who have always supporting me through the most difficult times of this work. Without their love and unstandaring, it is impossible to accomplish this work!



# Publications

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Xiaojun Zhang, Jiangtao Xi, Yanguang Yu, Joe Chichero, "The Fourier Spectrum Analysis of Optical Feedback Self-Mixing Signal under Weak and Moderate Feedback," *delta*, pp. 491-495, 4th IEEE International Symposium on Electronic Design, Test and Applications (*delta* 2008), 2008

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