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

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

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by

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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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June 23, 2008

Abstract

SINCE the laser technlology 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 analysze 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 an 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 OFMSI 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.

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Publications

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Contents

List of Figures

List of Tables