AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics Engineering and Electrical Communications

Optical Fiber Sensors

A Thesis submitted in partial fulfillment of the requirements of
Master of Science in Electrical Engineering
Electronics Engineering and Electrical Communications

by
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Bachelor of Science in Electrical Engineering
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Faculty of Engineering, Ain Shams University, 2011

Supervised By
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Dr. Tarek A. Ramadan

Cairo, 2016

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Acknowledgment

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Thesis Summary

The thesis is divided into six chapters as listed below:

Chapter 1

It introduces the work done in this thesis including the importance of the topic as well as the motivation for studying PM fibers in fiber optic sensors. Finally the organization of the thesis is presented.

Chapter 2

A review on the techniques of polarization mode coupling measurements is presented highlighting its main advantages and limitations.

Chapter 3

A review on fiber optic Michelson interferometers in the literature is presented.

Chapter 4

An All fiber Michelson interferometer with single fiber loop mirror is introduced. The theoretical analysis of this fiber interferometer is given as well as the experimental results that demonstrate its operation and limitations.

Chapter 5

The application of all fiber interferometer in optical coherence domain polarimetry (OCDP) system used for characterization of PMFs and couplers is demonstrated. Measurements of polarization mode coupling, group birefringence and group birefringence dispersion of PMFs are demonstrated. The performance limits of the all fiber OCDP system are also discussed to evaluate the tolerance of the fiber components effect on the measurements accuracy.

Chapter 6

The main conclusions obtained in this thesis and the future directions proposed to extend the work in this topic are presented.

Key words:

Polarization maintaining fibers, Fiber Characterization, Optical coherence domain polarimetry,Fiber loop mirrors, Fiber optic sensors.

Abstract

Faculty of Engineering – Ain Shams University
Electronics and Communication Engineering Department

Thesis title: **"Optical Fiber Sensors"**
Submitted by: **Abdelrahman Emad El-Din Hussien Mohamed Afifi**
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Abstract

Polarization Maintaining fibers (PMFs) are gaining more interest in fiber optic sensors such as current, rotation rate ... etc as well as high performance optical links. Thus accurate hands on characterization of PMFs is required for the evaluation of its performance. Optical Coherence Domain Polarimetry (OCDP) is the main method for measuring not only the polarization mode coupling distributed along PMFs under test but also the group birefringence and group birefringence dispersion.

This thesis presents an all PM fiber Michelson interferometer using single PM fiber loop mirror (FLM) instead of free space mirrors for OCDP applications. The system in this thesis offers simpler setup realization and lower cost compared to free space one. Thermal variation of the two fiber arms delay difference of the Michelson interferometer is partially overcome by fitting one arm with Piezo-electric fiber stretcher driven near resonance. The analytical model of the PM fiber interferometer is developed as well as a set of experimental results to demonstrate its operation.

Also, in this thesis an all-fiber OCDP setup is built for polarization mode coupling measurements in PMFs. PMF parameters such as group birefringence and group birefringence dispersion are also measured using the proposed system. The performance limitations of the new setup are estimated theoretically and verified experimentally. The limitations of this proposed system are deviation of the splitting ratio of the PM couplers from 50/50 and finite polarization extinction ratio (PER) of the fiber components used.

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