OPTIMAL DESIGN OF PHOTONIC CRYSTAL FIBER STRUCTURES AND EM-BASED SYSTEMS USING MODIFIED TRUST REGION OPTIMIZATION ALGORITHMS

By

Eng. Ahmed Essam Hammad Haggag Ahmed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in

ENGINEERING MATHEMATICS

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Under the Supervision of

Prof. Dr. Abdel-Karim S. O. Hassan
Faculty of Engineering, Cairo University

Assoc. Prof. Mohamed F. O. I. Hameed
Faculty of Engineering, Mansoura University

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Approved by the Examining Committee

Prof. Dr. **Abdel-Karim S. O. Hassan**, (Thesis Main Advisor)

Prof. Dr. **Adel H. Philips**, (External Examiner)
- Faculty of Engineering, Ain-Shams University

Prof. Dr. **Galal A. El-Kobrosy**, (External Examiner)
- Faculty of Engineering, Alexandria University

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Engineer's Name: Ahmed Essam Hammad Haggag
Date of Birth: 20/11/1986
Nationality: Egyptian
E-mail: aessam_2008@yahoo.com
Phone: 0100-6581309
Address: Giza

Registration Date: 1/10/2014
Awarding Date: …./…./2018
Degree: Doctor of Philosophy
Department: Engineering Mathematics and physics

Supervisors:

Prof. Abdel-Karim S. O. Hassan
Assoc. Prof. Mohamed F. O. Hameed
- Faculty of Engineering, Mansoura university

Examiners:

Prof. Abdel-Karim S. O. Hassan (Thesis main advisor)
Prof. Adel H. Philips (External examiner)
- Faculty of Engineering, Ain-Shams university

Prof. Galal A. El-Kobrosy (External examiner)
- Faculty of Engineering, Alexandria university

Title of Thesis:

Optimal designs of photonic crystal fiber structures and EM-based systems using modified trust region optimization algorithms.

Key Words:
Trust region; Design centering; Box constrained optimization; photonic crystal fiber; yield optimization.

Summary:

Two modified derivative free trust region algorithms have been proposed. The first is an unconstrained trust region (UTR) algorithm, while the other is a constrained trust region (CTR) algorithm. Both algorithms use quadratic surrogate models as a function approximation. The accuracy of the two modified algorithms is measured by applying them to some bench-mark and test functions. The CTR is used to obtain an optimal design for a photonic crystal fiber (PCF) polarization rotator. Further, the UTR algorithm has been employed in the optimization of the PCF dispersion and some practical polarization devices for the (PCFs) and EM-based systems.

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Ahmed Essam

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List of Abbreviations

PCF	Photonic Crystal Fiber
EM	Electromagnetic
LHS	Latin Hyber-cube Sampling
GSM	Generalized Space Mapping
DFO	Derivative Free Optimization
MCS	Multilevel Coordinate Search
RSMs	Response Surface Methods
SMF	Surrogate Management Framework
NEWUOA	New Unconstrained Optimization Algorithm
BOBYQA	Bound Constrained Optimization by Quadratic Approximation
Phcs	Photonic Crystals
LC	Liquid Crystal
PRs	Polarization Rotators
MUX-DEMUX	Multiplexer-Demultiplexer
FVFDM	Full Vectorial Finite Difference Method
FVFDBPM	Full Vectorial Finite Difference Beam Propagation Method
NLC-PCF	Nematic Liquid Crystal PCF
UTR	Unconstrained Trust Region
CTR	Constrained Trust Region
TIR	Total Internal Reflection
PBG	Photonic Bandgap Guiding
BPMs	Beam Propagation Methods
FDM	Finite Difference Method
MM	Mode Matching

FVBPM	Full Vectorial Beam Propagation Method
PML	Perfect Matched Layer
FFTBPM	Fast Fourier Transform Beam Propagation Method
TE	Transverse Electric
TM	Transverse Magnetic
DC-PCF	Dispersion Compensating PCF
DCCFs	Dual Concentric Core Fibers
CT	Cross Talk
SM	Space Mapping
LINACs	Linear Accelerators
UWB	Ultra-Wideband
MIMO	Multiple-Input- Multiple-Output
PM	Planar Monopole