بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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قسم

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MEMS-Based Non-invasive Spectrometer

A Thesis
Submitted in partial fulfillment of the requirements of a Master of Science degree in Electrical Engineering

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Statement

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis was carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

This thesis aims to study the development of miniaturized systems for measurement of Blood Alcohol Concentration (BAC) and Blood Glucose Concentration (BGC) non-invasively through the human skin, using a Fourier Transform Infrared (FTIR) spectrometer based on Micro-Electro-Mechanical Systems (MEMS) technology. The spectrometer is micro-fabricated on a single silicon chip with Michelson interferometer as its core engine. This solution promises low cost and high scalability which is suitable for wearable applications. However, the miniature size of the system limits the optical throughput. Different aspects related to the MEMS spectrometer configuration and the safety of its operation on the skin are investigated. This is followed by the design and implementation of the optical probe used for the non-invasive measurements. This includes the modeling of light transport to acquire diffuse reflectance spectroscopy (DRS) from the human skin for the optimization of the useful signals.

Furthermore, simulations are used to study the requirements of the application accompanied by chemometric analysis. Then, experimental studies are performed on humans to measure blood glucose concentration. Finally, to push the performance of the MEMS FTIR spectrometer, parallel interferometers operating on the same MEMS chip are used. This concept is implemented and characterized for enhancing the spectral range and the SNR.

Keywords: Near-Infrared, Mid-Infrared, Micro-Electro-Mechanical-System, **Silicon, FTIR Spectroscopy, Non-invasive glucose, Non-invasive alcohol, Monte Carlo, Parallel Spectrometer, Skin-safe MEMS spectrometer.**