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In Vivo Tissue Diagnosis for Myocardial Infarction Using Optical Spectroscopy with Novel Spectral Interpretation Algorithms

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

IN VIVO TISSUE DIAGNOSIS FOR MYOCARDIAL INFARCTION USING
OPTICAL SPECTROSCOPY WITH NOVEL SPECTRAL INTERPRETATION
ALGORITHMS

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

BIOMEDICAL ENGINEERING

by

Po-Ching Chen

2011

To: Dean Amir Mirmiran
College of Engineering and Computing

This dissertation, written by Po-Ching Chen, and entitled In Vivo Tissue Diagnosis for Myocardial Infarction using Optical Spectroscopy with Novel Spectral Interpretation Algorithms, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Armando Barreto

Anthony McGoron

Richard Bone

Yen-Chih Huang

Wei-Chiang Lin, Major Professor

Date of Defense: March 31, 2011

The dissertation of Po-Ching Chen is approved.

Dean Amir Mirmiran
College of Engineering and Computing

Dean Kevin O'Shea
University Graduate School

Florida International University, 2011

ABSTRACT OF THE DISSERTATION
IN VIVO TISSUE DIAGNOSIS FOR MYOCARDIAL INFARCTION USING
OPTICAL SPECTROSCOPY WITH NOVEL SPECTRAL INTERPRETATION

by

Po-Ching Chen

Florida International University, 2011

Miami, Florida

Professor Wei-Chiang Lin, Major Professor

In recent decades, the rapid development of optical spectroscopy for tissue diagnosis has been indicative of its high clinical value. The goal of this research is to prove the feasibility of using diffuse reflectance spectroscopy and fluorescence spectroscopy to assess myocardial infarction (MI) in vivo. The proposed optical technique was designed to be an intra-operative guidance tool that can provide useful information about the condition of an infarct for surgeons and researchers.

In order to gain insight into the pathophysiological characteristics of an infarct, two novel spectral analysis algorithms were developed to interpret diffuse reflectance spectra. The algorithms were developed based on the unique absorption properties of hemoglobin for the purpose of retrieving regional hemoglobin oxygenation saturation and concentration data in tissue from diffuse reflectance spectra. The algorithms were evaluated and validated using simulated data and actual experimental data.

Finally, the hypothesis of the study was validated using a rabbit model of MI. The mechanism by which the MI was induced was the ligation of a major coronary artery of the left ventricle. Three to four weeks after the MI was induced, the extent of myocardial

