



UNIVERSITI PUTRA MALAYSIA

***DESIGN OF OPTIMAL WIRE MESH COLLIMATOR FOR GAMMA CAMERA IN
MAPPING OF CANCER IMAGES***

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**DESIGN OF OPTIMAL WIRE MESH COLLIMATOR FOR GAMMA
CAMERA IN MAPPING OF CANCER IMAGES**



By

WIRA HIDAYAT BIN MOHD SAAD

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the
Degree of Doctor of Philosophy**

November 2012

to my late mother...♡



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy.

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Chair: Associate Professor M. Iqbal Saripan, PhD

Faculty: Engineering

One of the factors leading to a high mortality rate for breast cancer patient is the late detection of the cancer cells. An early detection of breast cancer is vital as it increases the rate of survival among patients with breast cancer. Thus, that has become the main motivation of this project.

Several types of modalities have been identified for use in breast cancer detection such as scintimammography, mammography, ultrasound and magnetic resonance imaging. Scintimammography is a functional type of imaging that is capable of reducing false detection per cancer ratio in other types of imaging. Gamma camera is one of the nuclear imaging devices used for scintimammography. One of the important structures in gamma camera is a collimator.

The aim of this study was to propose an optimal configuration of a wire mesh collimator as a replacement for the conventional multihole collimator, specifically for breast cancer detection. Monte Carlo N-Particle code version 5 is used to simulate a semi-compressed breast phantom imaging with gamma camera where the energy of the

radio-tracer used is 140 keV and the acceptance window of the detector is between 126 and 154 keV. Our evaluation was based on several parameters that give impact on the output image which indicates by the sensitivity, tumor contrast, spatial resolution and signal-to-noise ratio. These parameters were compared with a conventional multihole collimator, which is our benchmark. The results were further processed by using an optimal parameter selection of Metz filter.

At the end of this study, we managed to propose an optimal configuration of a wire mesh collimator for breast cancer imaging. Its percentage of weight was reduced to 44.09% from the weight of multihole collimator. At the same time, the sensitivity had also increased, while the tumor contrast, spatial resolution and signal-to-noise ratio were preserved.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah.

**REKABENTUK JARINGAN WAYAR PENGKOLIMAT YANG OPTIMAL
BAGI KAMERA GAMA
DALAM PEMETAAN GAMBAR BARAH**

Oleh

WIRA HIDAYAT BIN MOHD SAAD

November 2012

Pengerusi: Profesor Madya M. Iqbal Saripan, PhD

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Salah satu daripada faktor yang membawa kepada kadar kematian yang tinggi bagi pesakit barah payudara adalah kerana kelewatan untuk mengesan kehadiran penyakit tersebut pada peringkat awal. Oleh itu, pengesanan awal barah payudara sangat mustahak kerana ianya dapat menyelamatkan nyawa pesakit. Hal ini menjadi motivasi utama kepada keberhasilan projek ini.

Beberapa jenis cara pengimejan telah dikenalpasti untuk mengesan penyakit barah payudara, diantaranya ialah sintimamografi, mamografi, ultrabunyi, dan pengimejan resonans magnetik. Sintimamografi adalah pengimejan nuklear jenis fungsional yang dapat membantu mengurangkan kadar kesilapan biopsi, yang biasanya terhasil apabila menggunakan teknik pengimejan yang lain. Kamera sinar gama adalah salah satu daripada alatan pengimejan berteknologi nuclear bagi tujuan pengimejan jenis ini. Salah satu daripada struktur komponen utama bagi kamera sinar gama ialah pengkolimat.

Tujuan utama kajian ini dijalankan adalah untuk memperkenalkan satu konfigurasi pengkolimat jaringan wayar yang optimum bagi menggantikan pengkolimat berlubang selari yang sedia ada yang khusus untuk pengesanan barah payudara. Kod Monte Carlo N-Particle versi ke-5 digunakan untuk simulasi pengimejan fantom payudara separa termampat dengan kamera sinar gama. Tenaga radiopengesan yang digunakan ialah 140 keV dan tetingskap penerimaan tenaga bagi pengesan sinar gama dilaraskan kepada 126 keV hingga 154 keV. Penilaian dibuat berasaskan beberapa pengukursuai matematik yang digunakan untuk mengira kualiti gambar seperti sensitiviti, kontras ketumbuhan, resolusi ruang, dan nisbah hingar kepada isyarat dengan membandingkannya dengan keputusan pengkolimat berlubang selari sebagai petanda aras. Imej yang didapati seterusnya diproses menggunakan penapis Metz dengan pemilihan pengukursuai yang optimum.

Di penghujung pengajian, satu konfigurasi pengkolimat jaringan wayar yang optimum untuk pengimejan barah payudara telah dihasilkan. Beratnya dapat diturunkan kepada 44.09% daripada berat pengkolimat berlubang selari sedia ada. Dalam masa yang sama, sensitiviti juga turut meningkat dan resolusi ruang serta nisbah hingar kepada isyarat dapat dikekalkan.

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I hope that this thesis can be a useful reference in the future in order to improve the cancer detection imaging system. Cancer has caused so many people to suffer throughout the world. Let us fight cancer together to save lives.

I certify that a Thesis Examination Committee has met on 27 November 2012 to conduct the final examination of Wira Hidayat bin Mohd Saad on his thesis entitled “Design of Optimal Wire Mesh Collimator for Gamma Camera in Mapping of Cancer Images” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.



WIRA HIDAYAT BIN MOHD SAAD

Date: 27 NOVEMBER 2012



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