



UNIVERSITI PUTRA MALAYSIA

***THYROID VOLUME ESTIMATION FROM ULTRASOUND EXTEND FIELD OF
VIEW IMAGES USING STAR ALGORITHM WITH GREENS' THEOREM***

MAHER FAIK ESMAILE

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FIELD OF VIEW IMAGES USING STAR ALGORITHM WITH GREENS'
THEOREM**



By

MAHER FAIK ESMAILE

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

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DEDICATION

THIS PIECE OF WORK IS SPECIALY DEDICATED TO THE SOUL OF MY
SISTERS WESSAM, MY PARENTS, MY SISTER, MY WIFE AND MY LOVELY
CHILDREN.



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

**THYROID VOLUME ESTIMATION FROM EXTEND FIELD OF VIEW
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By

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January 2013

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Area calculation is regarded as an important step in many applications (e.g. industry, medicine, biology). Greens' theorem is one of the methods that can be applied to calculate the area with the advantages: it evaluates a double integral over the region of an object by a simple integration along the boundary of the object, and it can result in high accuracy for the area calculations by increasing the edge's point of the object. In this work a modified Star algorithm is incorporated with Greens' theorem (SAGT) to calculate the area of an arbitrary shape. As an application to this modification, it has been applied in medical field to calculate the actual area of thyroid gland from ultrasound extend field of view (EFOV) images and for several slices along the neck. Then area summation technique will be used to estimate the volume of thyroid gland. Diagnosis of thyroid gland diseases and correct radioiodine dosage depend on the correct thyroid gland volume estimation. Different approaches used to determine thyroid size including ultrasound, scintigraphy, SPECT, CT scan, and MRI. Recently, ultrasonography is the preferred aid in clinical diagnosis.

The use of ultrasound to estimate thyroid volume involves several disadvantages. First; the application of ellipsoid formula with thyroid gland ultrasound images to evaluate thyroid volume which is applied to irregular shape is reported to be inaccurate and may result in underestimation or overestimation. Second; the thyroid lobe length is sometimes difficult to be measured, because most modern transducers are available with a footpad of 4 cm or less which is less than the adult's thyroid lobe length. Third; the accuracy of ultrasound thyroid gland volume estimation depends on operator skill.

A new methodology is proposed to estimate the volume of thyroid gland using SAGT and ultrasound (EFOV) images through four steps: first; modifying Star algorithm with Green's theorem (SAGT) to calculate the actual thyroid area instead of measuring the thyroid dimensions manually that avoids using the ellipsoid

formula. Second; the neck scanning is systemised in order to minimize the operator experience effect and to create the EFOV image during the registration process. third; a new edge detection filter suitable to this application is designed that's based on the extraction and registration of the ultrasound image features to be used with SAGT to calculate the thyroid actual area from US EFOV images. Fourth: applying the summation of area technique to calculate the volume of thyroid gland. The experimental results conducted for the phantom neck showed that the proposed method could perform the volume estimation with accuracy between (96-98) % as compared to the ellipsoid formula that has accuracy between (83-92) %.

It's concluded that, the area calculation of thyroid gland using SAGT, with systemising the neck scanning has shown an improving accuracy for the thyroid gland volume estimation.



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

**ANGGARAN ISI PADU KELENJAR TIROID DARI PANDANGAN
LANJUTAN MENGGUNAKAN ALGORITMA STAR DARI TEOREM
GREEN**

Oleh

MAHER FAIK ESMAILE

Januari 2013

Pengarsui: Prof. Madya Mohammad Hamiruce b. Marhaban, PhD

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Pengiraan kawasan adalah satu langkah yang dianggap penting dalam banyak aplikasi (contohnya, industri, perubatan dan biologi). Teorem Green adalah salah satu kaedah yang boleh digunakan untuk mengira kawasan dengan beberapa kebaikan: ia menilai integral double di seluruh kawasan objek melalui satu integrasi mudah di sepanjang sempadan objek, dan ia boleh membawa kepada ketepatan aras tinggi untuk pengiraan kawasan dengan meningkatkan lagi mata sisipan objek. Dalam kajian ini, satu algoritma Star yang telah diubahsuai digabung dengan teorem Green (SAGT) untuk mengira kawasan berbentuk rawak. Sebagai satu aplikasi kepada pengubahsuaian ini, ia telah diaplikasikan kepada bidang perubatan untuk mengira kawasan sebenar kelenjar tiroid dari imej-imej lapangan pandangan ultra-bunyi (EFOV) dan beberapa keratan di sepanjang leher. Kemudian, teknik penjumlahan kawasan akan digunakan untuk menganggarkan isi padu kelenjar tiroid. Diagnosis penyakit kelenjar tiroid dan dos radioiodine yang tepat bergantung kepada anggaran isi padu kelenjar tiroid yang betul. Penggunaan berbeza-beza yang digunakan untuk menentukan saiz tiroid termasuk ultra-bunyi, *scintigraphy*, SPECT, imbasan CT, dan MRI. Baru-baru ini, ultrasonografi menjadi alat-bantu pilihan dalam diagnosis klinikal.

Penggunaan ultra-bunyi dalam menganggarkan isi padu tiroid mempunyai beberapa kelemahan: Pertama sekali, aplikasi formula ellipsoid dengan imej-imej ultra-bunyi kelenjar tiroid untuk menilai isi padu tiroid yang diaplikasikan kepada bentuk tidak sekata dilaporkan tidak tepat dan boleh membawa kepada keadaan bawah-anggaran atau lebih-anggaran. Yang kedua panjang lubang tiroid kadangkala sukar untuk diukur, kerana kebanyakan transduser moden boleh diperolehi dengan pad kaki berukuran 4 cm atau kurang daripada itu yang mana ia kurang dari panjang lubang tiroid orang dewasa. Yang ketiga ketepatan anggaran isi padu kelenjar tiroid ultra-bunyi bergantung kepada kemahiran pengoperasinya.

Satu metodologi baru dicadangkan untuk menganggarkan isi padu kelenjar tiroid menggunakan SAGT dan imej-imej ultra-bunyi (EFOV) melalui empat langkah: pertama; mengubahsuai algoritma Star dengan teorem Green (SAGT) untuk mengira kawasan tiroid sebenar dan bukan mengukur dimensi tiroid secara manual yang tidak menggunakan formula ellipsoid. Yang kedua imbasan leher menjalani kaedah sistematik untuk mengurangkan kesan pengalaman pengoperasi dan untuk mencipta imej EFOV sewaktu proses operasi. Yang ketiga penyaring pengesan mata yang baru, yang sesuai untuk aplikasi ini direkacipta berdasarkan pengestrakan dan pendaftaran ciri-ciri imej ultra-bunyi yang digunakan dengan SAGT untuk mengira kawasan sebenar tiroid dari imej-imej EFOV US. Yang keempat mengaplikasikan penjumlahan teknik kawasan untuk mengira isi padu kelenjar tiroid. Keputusan-keputusan eksperimen yang dijalankan untuk leher bayangan menunjukkan bahawa kaedah yang disarankan boleh melaksanakan anggaran isi padu dengan ketepatan di antara (96-98) % berbanding dengan formula ellipsoid yang mempunyai ketepatan (83-92) %.

Kesimpulannya, pengiraan kawasan kelenjar tiroid menggunakan SAGT, dengan kaedah imbasan leher yang sistematik telah mempamerkan ketepatan yang lebih baik untuk proses menganggarkan isi padu kelenjar tiroid.

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I certify that a Thesis Examination Committee has met on 27 January 2014 to conduct the final examination of Maher Faik Esmail on his thesis entitled “Thyroid Volume Estimation from Ultrasound Extended Field of View Images using Star Algorithm with Greens’ Theorem” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the University 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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TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	vii
APPROVAL	viii
DECLARATION	x
LIST OF TABLES	xv
LIST OF FIGURES	xvii
LIST OF ABBREVIATIONS	xxi
CHAPTER	
1 INTRODUCTION	
1.1 Thyroid Gland Background	1-1
1.2 Ultrasound	1-1
1.3 Problem Statement	1-2
1.4 Aims and Objectives	1-4
1.5 Scope of the Work	1-4
1.6 Thesis Organization	1-7
2 LITERATUR REVIEW	
2.1 Introduction	2-1
2.2 The Importance of Thyroid Gland volume Estimation	2-1
2.3 Computed Tomography (CT)	2-2
2.3.1 Manual Thyroid Gland Volume Estimation Using Spiral CT Scan	2-3
2.3.2 Automatic Thyroid Volume Estimation using CT image	2-5
2.4 Magnetic resonance imaging (MRI)	2-6
2.4.1 Thyroid Gland Volume Estimation Using MRI	2-6
2.5 Scintigraphy	2-7
2.5.1 Automatic Thyroid Gland Volume Estimation with Scintigraphy	2-8
2.6 Single Photon Emission Computer Tomography (SPECT)	2-9
2.6.1 Thyroid Gland Volume Estimation with SPECT	2-9
2.7 Ultrasound	2-11
2.7.1 Manual Thyroid Gland Volume Estimation with Ultrasound	2-11
2.7.2 Automatic Thyroid Gland Volume Estimation with Ultrasound	2-13
2.8 Comparison between Ultrasound Device and Other Medical Devices	2-15

2.9	Extend Field Of View (EFOV) Background	2-19
2.10	Star Algorithm Background	2-20
2.11	Segmentation of Thyroid Gland Algorithms	2-21
2.12	Summary	2-24

3 CROSS SECTIONAL AREA CALCULATION FOR ARBITRARY SHAPE IN THE IMAGE USING STAR ALGORITHM WITH GREENS' THEOREM

3.1	Introduction	3-1
3.2	Green's Theorem Fundamentals	3-2
3.3	Curvature Points Arrangement (CPA)	3-3
3.3.1	Active Contour	3-4
3.3.2	Radii- Based Approach	3-5
3.3.3	Incorporation of Star algorithm with Greens' theorem	3-7
3.5	Experiment Results and Discussion	3-10
3.5.1	Application to Regular Shapes	3-12
3.5.2	Application with Ultrasound Images	2-16
3.6	Summary	3-20

4 SYSTEMATIC ULTRASOUND SCANNING TO GENERATE B-MODE ULTRASOUND EXTEND FIELD-OF-VIEW FOR THYROID GLAND

4.1	Introduction	4-1
4.2	Materials and Methods	4-2
4.2.1	Equipment and Phantom	4-2
4.2.2	Scanning Method	4-2
4.2.3	Image Registration Algorithm	4-3
4.2.4	Magnitude of Gradient	4-4
4.2.5	Local Entropy	4-5
4.2.6	Features Extraction for Image	4-6
4.2.7	Valid Blocks Selection Process	4-6
4.2.8	Local Motion and Local Registration of Valid Blocks	4-8
4.2.9	Global Motion and Global Registration	4-9
4.3	Experiment Results	4-10
4.4	Experiments Discussion and Verification	4-18
4.5	Summary	4-26

5 AUTOMATIC THYROID VOLUME ESTIMATION

5.1	Introduction	5-1
5.2	The Proposed Algorithm	5-1
5.3	Gabor Filter	5-4
5.3.1	Orientation Calculation for the Image	5-5
5.3.2	Frequency Determination for Gabor Filter	5-8
5.3.3	Calculation of Standard Deviation for Gabor Filter	5-8
5.5	Local Standard Deviation	5-12

5.6	Experiment Results	5-13
5.6.1	The Combination of Image Features	5-13
5.6.2	Gabor Filter Results Based on Parameters Tuning	5-16
5.6.3	Thyroid Gland Volume Results Discussion and Verification	5-17
5.7	Summary	5-28

6 CONCLUSION AND RECOMMENDATION FOR FUTURE WORK

6.1	Conclusions	6-1
6.2	Thesis Contribution	6-3
6.3	Recommendation for Future Work	6-3

REFERENCES

R-1

APPENDICES

	Thyroid Ultrasound Training Phantom Model 074.	A-1
A.	The Derivative of Orientation for Gabor Filter.	B-1
B.	The Effect of Block Selection Size on the Registration Process.	C-1
C.	The EFOV for the Right and Left Thyroid Lobe.	D-3
D.	The Ultrasound Scanning for the Right and Left Thyroid gland lobe According to the Proposed Systemisation Procedure (Illustrated in Chapter 3).	E-1

BIODATA OF STUDENT LIST OF PUBLICATIONS