



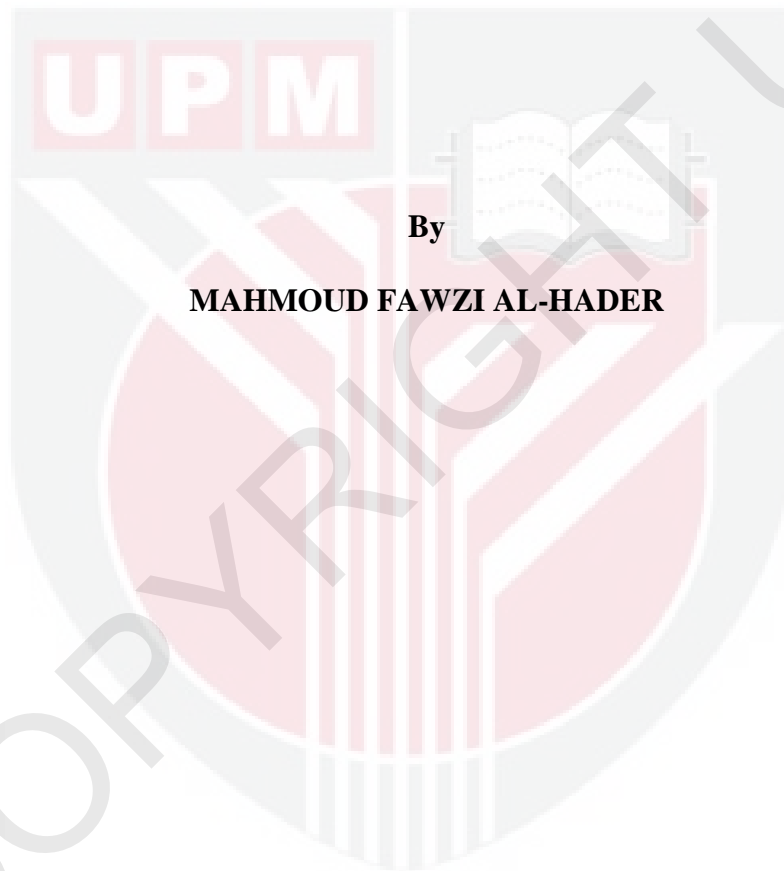
UNIVERSITI PUTRA MALAYSIA

**DEVELOPMENT OF OPTIMISED MODEL FOR POLYETHYLENE
INFRASTRUCTURE MONITORING USING MOBILE LASER SCANNING
TECHNIQUE**

MAHMOUD FAWZI AL-HADER

ITMA 2011 22

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TECHNIQUE**



By

MAHMOUD FAWZI AL-HADER

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

September 2011

Abstract of thesis presented to the Senate of University Putra Malaysia in Fulfilment
of the requirement for the degree of Doctor of Philosophy

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MAHMOUD FAWZI AL-HADER

September 2011

Chairman: Associate Professor Ahmad Rodzi Mahmud, PhD

Faculty : Institute of Advanced Technology

The daily infrastructure networks' updates are very huge due to frequent new installations, replacements and enforcements which are subject to maintenance and operation on a frequent basis. The efficiency of the maintenance and operation workflow is strongly related to the geographical location of these infrastructure networks. Due to the huge daily updates of the infrastructure networks, the ability of collecting the updated locations using the current geospatial monitoring techniques is very difficult. This research brought forward a more efficient geospatial data updating technique for the infrastructure networks. The monitoring is needed to geospatially locate and update the physical infrastructure development which significantly enhances the performance of managing and maintaining the infrastructure assets.

The research concentrates on the polyethylene infrastructure materials, where power, water and communication networks are either covered or protected by polyethylene materials. The research conducted a technical comparison between the current geospatial data collection techniques and developed an overall performance evaluation in the sense of coverage capacity, objects extraction, data formats, time initialization of the systems and post processing time consumption. The use of mobile laser scanning technology had achieved the best evaluation performance. The evaluations were based on conducting a detailed data analysis, data collection, modelling and interpretation. Prior conducting the performance evaluation, the research investigates the mobile laser behaviour and recognition capabilities with respect to polyethylene infrastructure materials. Each material has different characteristics and accordingly has a different response (reflections and absorptions) to laser pulses, where this response is constant and only material dependent. The mobile laser pulses response constant for the polyethylene infrastructure materials has been concluded after analysing the pulses behaviour and its correlations with the mission ground speed and exposed scanned surface. The obtained mobile laser scanning constant for the polyethylene infrastructure material is 726 pulses/cm when the system ground speed is 16.49 km/h. The concluded mobile laser pulses constant were used to develop a mathematical method for re-planning the mobile laser scanning missions to obtain the best model for updating the polyethylene infrastructure networks. Mobile laser scanning using the improved planning missions can detect 97% of the polyethylene infrastructure networks in a very good performance.

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

**PEMBANGUNAN SEBUAH MODEL DIOPTIMIS UNTUK PEMANTAUAN
INFRASTRUKTUR POLITENA MENGGUNAKAN KAEDAH
PEINGIMBASAN LASER MUDAH ALIH**

Oleh

MAHMOUD FAWZI AL-HADER

September 2011

Pengerusi : Profesor Madya Ahmad Rodzi Mahmud, PhD

Fakulti : Institut Teknologi Maju

Pengemaskinian harian jaringan infrastruktur adalah amat sukar disebabkan pemasangan, penggantian dan pengukuhan yang tertakluk kepada proses penyelenggaraan dan operasi yang kerap. Kecekapan aliran kerja penyelenggaraan dan operasi adalah berkait dengan lokasi geografik jaringan infrastruktur tersebut. Disebabkan pengemaskinian harian yang amat besar terhadap jaringan infrastruktur tersebut, pengumpulan maklumat lokasi pengemaskinian menggunakan kaedah pemantauan geospasial yang sedia ada adalah amat rumit. Penyelidikan ini mengemukakan suatu kaedah pengemaskinian data geospasial yang lebih cekap untuk jaringan sistem infrastruktur. Pemantauan ini adalah diperlukan untuk mencari lokasi geospasial dan mengemaskini pembangunan infrastruktur fizikal, lantas meningkatkan prestasi pengurusan dan penyelenggaraan asset-aset infrastruktur.

Kajian ini ditumpukan terhadap bahan infrastruktur polyethylene, di mana saluran kuasa elektrik, air dan jaringan komunikasi ditutup atau dilindungi bahan polyethylene. Kajian ini menjalankan perbandingan teknikal di antara teknik-teknik pengumpulan data geospasial yang sedia ada dan membangunkan suatu penilaian prestasi menyeluruh dari segi kapasiti liputan, pengekstrakan objek, format-format data, pengawalan masa sistem-sistem, dan penggunaan waktu pasca-proses. Penilaian-penilaian itu adalah berdasarkan analisis data secara terperinci, pengumpulan data, pemodelan dan pentafsiran. Sebelum menjalankan penilaian prestasi, kajian ini menyiasat ciri-ciri laser mudah alih serta kebolehan pengesananannya terhadap bahan-bahan infrastruktur polyethylene. Setiap bahan mempunyai ciri-ciri tertentu dan mempunyai respons yang berbeza (pantulan dan serapan) terhadap denyutan laser, di mana respons ini konstan dan hanya bergantung pada bahan tersebut. Konstan respons denyutan laser mudah alih bagi bahan-bahan infrastruktur polyethylene telah ditentukan setelah menganalisis ciri-ciri denyutan laser mudah alih itu serta korelasinya dengan kelajuan bumi misi dan permukaan terdedah yang diimbas. Konstan imbasan laser mudah alih bagi bahan infrastruktur polyethylene ialah 726 denyutan/cm bila halaju bumi sistem tersebut ialah 16.49 km/j. Konstan denyutan laser mudah alih ini digunakan untuk membangunkan suatu kaedah matematik untuk merancang semula misi imbasan laser mudah alih untuk mendapatkan model yang paling bagus untuk mengemaskinikan jaringan infrastruktur polyethylene. Pengimbasan laser mudah alih yang menggunakan perancangan misi

yang diperbaiki mampu mengesan 97% daripada jaringan infrastruktur polyethylene, prestasi yang agak memuaskan.



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I certify that an Examination Committee has met on to conduct the final examination of Mahmoud Fawzi Abdallah Alhader on his Doctor of Philosophy thesis entitled “Development of Optimized Model for Polyethylene Infrastructure Monitoring Using Mobile Laser Scanning Technique” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the degree of Doctor of Philosophy.

Members of the examination committee were as follows:

Mohd Nizar Bin Hamidon, PhD

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Helmi Zulhaidi Bin Mohd Shafri, PhD

Associate Professor
Institute of Advanced Technology
Universiti Putra Malaysia
(Internal Examiner)

Biswajeet Pradhan, PhD

Research Fellow
Institute of Advanced Technology
Universiti Putra Malaysia
(Internal Examiner)

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as partial fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the supervisory committee were as follows:

Ahmad Rodzi Mahmud, PhD

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Abdul Rashid Mohamed Shariff, PhD

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Noordin Ahmad, PhD

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

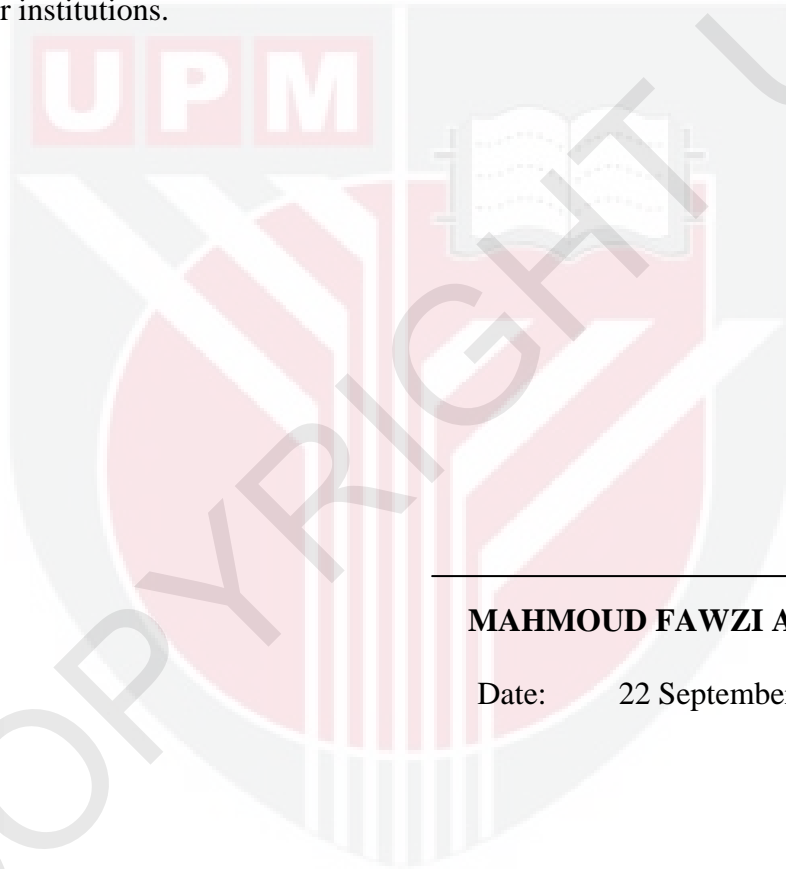
BUJANG KIM HUAT, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except that 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 other institutions.



MAHMOUD FAWZI AL-HADER

Date: 22 September 2011

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