

SMART VISION SYSTEM FOR CAR TIRE CONDITION MONITORING

By

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirement for the Degree of Master of Science**

May 2006

**Dedicated to my family,
Shadni Hassan, Muhammad Nur Salam, Muhammad Nurhakim, Muhammad
Nurhazim, Rahmah Hj. Daud, Safwati Hassan, Sabrina Hassan**

**Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment
of the requirement for degree of Master of Science**

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Chairman: Associate Professor Ishak Aris, PhD

Faculty: Engineering

Car tire failure is one of the major causes of serious accident. To reduce the accidents, the US National Highway Transport Safety Administration (US NHTSA) has passed a legislation requiring all new passenger cars to be equipped with Tire Pressure Monitoring System (TPMS) starting from November 2006. However, according to automotive experts, tire failure could also originate from excessive tread wear and other several causes.

This research project is proposed to analyze tire tread conditions, and relay the information back to the user. The project is a software that is developed using Matrox Imaging Library and Visual Basic Version 6 (VB6). It consists of an inference engine, image files, selected Matrox Imaging Library modules and a graphical user interface module. The software employs an automatic threshold value selection method, that is developed during this project, to binarize a tire tread image before analyze it. The result shows that the new automatic threshold value

selection method is able to binarize an image better than the “Binarize” method that is available in Matrox Imaging Library.

The proposed system uses the “Blob Analysis” module that is available in Matrox Imaging Library to analyze a tire tread image that was binarized. The system is able to categorize an image into seven conditions i.e. worst, bad, over limit, on the limit, nearly reaches limit, beginning and good conditions, instead of only bad and good conditions. The proposed system applies If-Then rules in blob analysis stage.

Moreover, the monitoring system is able to point out the abnormal tread wear location in an image using colored rectangular lines. The system is also able to advice an action needed to be taken by the user.

Based on the test results, the proposed system is able to detect and monitor several types of tire tread wear i.e. abnormal tread wear due to chamber alignment problem, abnormal tread wear due to improper inflation, abnormal tread wear due to excessive usage and normal tread wear. The proposed system is also able to analyze all sizes of tires and various types of tread patterns produced by various manufacturers.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**SISTEM PENGLIHATAN PINTAR UNTUK PENGAWASAN KEADAAN
TAYAR KERETA**

Oleh

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Kerosakan tayar merupakan salah satu punca berlakunya kemalangan yang serius. Bagi mengurangkan kemalangan tersebut, Pentadbiran Keselamatan Kenderaan Lebuhraya Persekutuan Amerika Syarikat (US NHTSA) telah menguatkuasakan peraturan supaya semua kenderaan baru mestilah dilengkapi dengan Sistem Pengawasan Tekanan Udara Tayar (TPMS) bermula pada bulan November, 2006. Menurut pakar automotif, tayar yang tidak berfungsi boleh juga berlaku disebabkan oleh penggunaan tayar yang melebihi had menyebabkan permukaan bunga tayar tidak sekata, dan sebab-sebab yang lain.

Projek penyelidikan ini telah dicadangkan untuk menganalisis keadaan bunga tayar dan memberitahunya kepada pengguna. Projek tersebut adalah sebuah perisian yang dibina menggunakan Matrox Imaging Library (MIL) dan Visual Basic Versi ke-6 (VB6). Ianya terdiri daripada sebuah pemproses enjin, fail-fail imej, modul pilihan dari “Matrox Imaging Library” dan sebuah Antaramuka Grafik Pengguna

(GUI). Sistem tersebut menggunakan kaedah pencarian nilai ambang secara automatik yang dibina semasa projek ini dijalankan, untuk membinerisasi sesuatu imej, sebelum ianya dianalisis. Daripada keputusan ujian yang dibuat, cara baru tersebut berupaya untuk menukarkan imej yang berbagai warna kepada warna hitam dan putih dengan lebih baik berbanding kaedah “Binerisasi” yang terdapat di dalam MIL.

Sistem tersebut mengguna pakai modul “Analisis Cantuman-Piksel” yang terdapat di dalam MIL untuk menganalisis sesuatu imej yang telah. Sistem tersebut berupaya mengkategorikan sesuatu imej kepada tujuh keadaan, iaitu terburuk, buruk, melewati dari had yang dibenarkan, pada had yang dibenarkan, hampir melewati had yang dibenarkan, tahap permulaan dan bagus, berbanding dengan hanya dua keadaan; baik dan buruk sahaja. Sistem tersebut mengguna pakai peraturan ”Jika – maka” untuk menganalisis cantuman piksel-piksel di dalam sebuah imej.

Lebih dari itu, sistem tersebut berupaya menunjukkan lokasi bunga tayar yang rosak dengan kotak segiempat bewarna. Sistem tersebut juga berupaya memberi nasihat kepada pengguna tentang apa yang perlu dilakukan.

Berdasarkan keputusan-keputusan ujikaji yang dijalankan, sistem yang dicadangkan tersebut berupaya mengenal pasti dan memantau beberapa jenis kerosakan bunga tayar iaitu kehausan bunga tayar yang luar biasa disebabkan oleh

masalah camber yang tidak selari, kehausan bunga tayar yang luar biasa disebabkan tekanan udara tayar yang tidak sesuai, penggunaan yang melebihi had dan kehausan bunga tayar yang biasa. Sistem yang dicadangkan tersebut berupaya menganalisis tayar berbagai saiz dan berbagai bentuk bunga tayar yang dihasilkan oleh pelbagai pengeluar.

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I certify that an Examination Committee has met on 9th May 2006 to conduct the final examination of Mohd Razali Daud on his Master of Science thesis entitled “Smart Vision System for Car Tire Condition Monitoring” in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Putra Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

MOHD RAZALI DAUD

Date:

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LIST OF ABBREVIATIONS

b_{\min}	Minimum pixel counts
b_{\max}	Maximum pixel counts
T	Threshold value
T_a	Assumed threshold value
T_b	Random threshold value
T_h	Theoretical histogram threshold value
T_n	Theoretical new threshold value
T_{hV0}	Actual calculated threshold value
T_{hV1}	Actual calculated second threshold value

