UNIVERSITI PUTRA MALAYSIA

DESIGN AND DEVELOPMENT OF SELF- BALANCING CLIMBING MACHINE FOR OIL PALM HARVESTING

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By

HAMED SHOKRIPOUR

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

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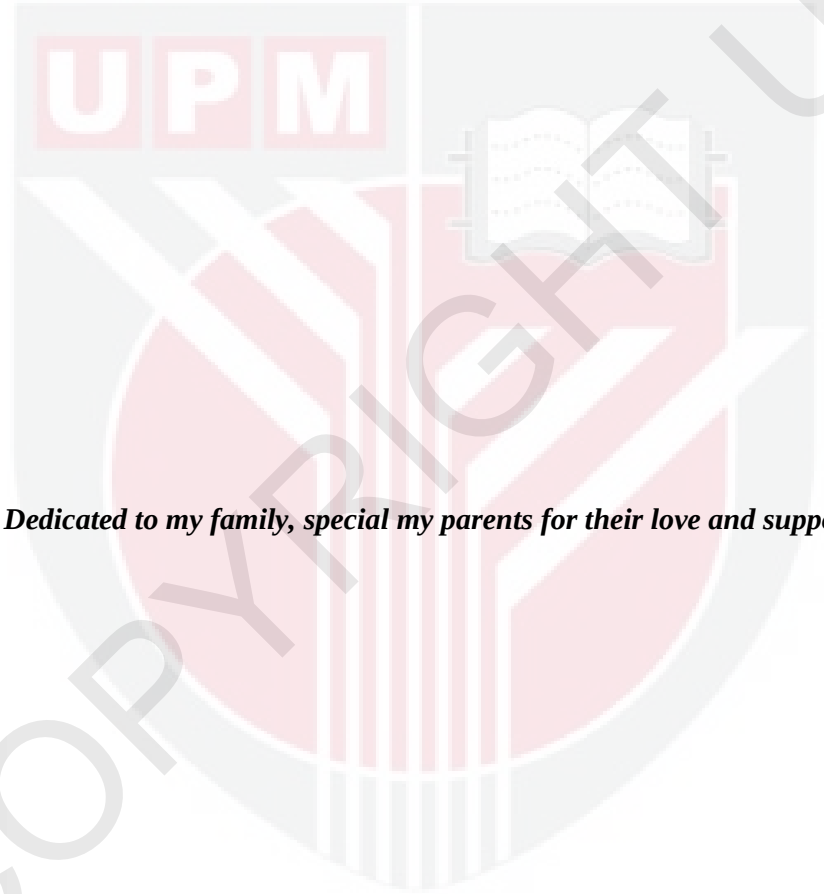

Dedicated to my family, special my parents for their love and support

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

DESIGN AND DEVELOPMENT OF SELF-BALANCING CLIMBING MACHINE FOR OIL PALM HARVESTING

By

HAMED SHOKRIPOUR

September 2010

Chairman: Professor Wan Ishak Wan Ismail, PhD

Faculty: Engineering

Oil palm is a major plantation crop in Malaysia. The country successfully developed the oil palm plantation industry during the past three decades and it is now one of the largest palm oil producers in the world. However, due to the lack of specific machinery for harvesting oil palm fruits, the harvesting operation is still done using the traditional method of a sharp knife that is attached to the head of a long pole. This traditional method of harvesting requires strong workers with special experience and skills. In the face of a decreasing number of these skilled workers, their salaries have increased, which has added to the cost of harvesting. Furthermore, using the traditional method, workers cannot harvest fruits from trees which are too tall.

The project *was* to design, fabricate and test a new self-balancing and remote-controlled four wheeled climbing robot for oil palm trees and a special cutting system for cleaning the fronds. A control system was designed and fabricated for the climbing robot to keep the robot's balance during the climbing process by individually controlling the speed of each wheel. A dual axis tilt sensor was used to simultaneously measure the angle of tilt for both X and Y axes. In addition, a carrier machine was designed and fabricated to bear different equipment – such as the cutting system, digital camera and sprayer – and carry these around the tree trunk to enable them to undertake different processes. The operator controls the climbing robot and carrier machine via a specific remote control. The speeds of the DC motors are controlled by a Pulse-width modulation (PWM). A specific program was written with Bascome software in Basic language for an ATmega64 microcontroller as the Arithmetic and Logic Unit of the robot.

All parts of the robot were successfully tested in laboratory and field conditions. The time and motion study was carried out on several trees. The average time required to place the robot around the tree, then have it climb up, cut a frond, and descend, was about eight (8) minutes for each tree. The maximum angle of tilt around X and Y axes were eight (8) and six (6) degrees respectively. The robot successfully negotiated the irregularities of the tree trunk's surface and automatically set its size relative to changes in the diameter of the tree trunk. The carrier machine carried the cutting machine and moved smoothly around the tree trunk. Both the climbing robot and carrier machine responded successfully to the commands sent from the remote control by the operator.

Key words: Climbing Robot, Cutting System, Oil Palm, Self Balancing, PWM.

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

MEREKAKABENTUK DAN MEMBORGUNKAN MESIN MEMANJAT SWA-IMBANG UNTUK PENUAIAN KELAPA SAWIT

Oleh

HAMED SHOKRIPOUR

September 2010

Pengerusi: Professor Wan Ishak Wan Ismail, PhD

Faculty: Kejuruteraan

Kelapa sawit merupakan perladangan utama di jalankan di Malaysia. Untuk selama tiga dekad, Malaysia telah menjalani pembangunan dalam industri ini dan sekarang ia merupakan pengeluar terbesar untuk industri minyak kelapa sawit. Walaubagaimanapun, kekurangan dalam penggunaan mesin yang sesuai mengakibatkan pemetikan buah secara tradisional menggunakan mata pisau bersama-sama batang galah masih lagi digunakan.Pelaksanaan pemetikan buah secara tradisional ini memerlukan kepakaran buruh kasar.Masalah kekurangan pekerja mahir yang dihadapi kini mengakibatkan pembayaran upah yang meningkat dan mengakibatkan kos pemetikan yang tinggi.Begitujuga, buah kelapa sawit pada pokok yang tinggi tidak dapat di petik melalui kaedah tradisional ini**.**Dalam projek

ini, rekabentuk dan pembuatan serta pengujian telah dijalankan untuk robot pemanjat empat roda dan berupaya dalam penimbangan sendiri serta dikawal secara jauh. Ia juga mempunyai system pemotongan canggih untuk pembersihan pelepah pokok kelapa sawit secara automatik. Sistem kawalan telah di rekabentuk dalam pembuatan robot pemanjat bagi membolehkan penimbangan robot dapat dikawal melalui pengawalan secara individu untuk setiap roda pemanjatan sewaktu pengoperasian dijalankan. Penderian pedua paksi keserongan telah digunakan secara serentak bagi mengukur sudut kedua-dua paksi X dan Y robot.Sebagai tambahan, mesin pengangkut telah direkabentuk dan dibangunkan bagi penggunan peralatan yang berbeza seperti sistem pemotongan, kamera digital serta penyembur dan peralatan ini diangkut bersama-sama sewaktu pengoperasian yang pelbagai ketika pemanjatan pokok.Operator akan mengawal robot pemanjat serta mesin pengangkut ini menggunakan sistem kawalan jauh. Kelajuan motor DC dikawal secara Pulse-width modulation (PWM).Perisian Bascome telah digunakan sebagai Arithmetic dan Logic Unit untuk robot bagi membangunkan program komputer untuk ATmega64 microcontroller .Robot telah diuji didalam makmal dan dilapangan. Kajian masa dan pergerakan robot telah diambil untuk beberapa pokok. Masa purata selama 8 minit adalah diperlukan bagi robot mengelilingi pokok, memanjat, memotong pelepah dan turun dari pokok tersebut.Sudut maksimum untuk kecondongan diantara paksi X dan Y adalah sebanyak 8 dan 6 darjah.Mesin pengangkut telah membawa alat pemotong serta didapati bergerak secara lancar mengelilingi batang pokok. Kedua-dua robot pemanjat dan mesin pengangkut telah berjaya beroperasi dan di kawal selia dari jauh oleh operator.

Kata Kunci: Pemanjat Robot, Sistem Pemotongan, Oil palm, Keseimbangan Diri, PWM

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I certify that a thesis Examination Committee has met on……. to conduct the final examination of **Hamed Shokripour** on his **Master of science** thesis entitled "**Design And Development of Self- Balancing Climbing Machine for Oil Palm Harvesting Operation"** in accordance of 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 Master of Science.

Members of the Thesis Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of **Master of Science**. The members of the Supervisory Committee were as follows:

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Date: December 2010

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 University Putra Malaysia or at any other institutions.

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HAMED SHOKRIPOUR

Date: September 2010

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