DEVELOPMENT OF A RICE COMBINE HARVESTER INSTRUMENTATION SYSTEM FOR MAPPING OF CROP YIELD AND FIELD PERFORMANCE

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

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DEDICATED TO

My parents, husband, brothers and sisters

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

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Chairman : Professor Sudhanshu Shekhar Jamuar, PhD

Faculty : Engineering

Yield variations within a paddy field indicate the loss of potential of valuable cultivated land in Malaysia. By integrating the location in the field of a combine harvester with accurate yield measurement, it is possible to produce a map with detailed, site-specific variations. When this yield map is used in conjunction with soil maps, topographic maps and weed maps, it is possible to understand the reasons for yield variations. From these maps, treatment plans can be made to control inputs specific to a desired location, using variable rate controllers to optimize the use of land in order to achieve maximum yield. Thus, this research was initiated to develop a dedicated and complete instrumentation system on-board a New Holland TC-56 rice combine harvester to monitor the grain losses, harvested crop yield and combine operating parameters during harvesting operation with the ultimate goal of generating grain loss map, crop yield map and combine field performance parameter maps. The developed instrumentation system has been installed with ultrasonic displacement sensor for measurement of combine actual cutting width and the header position sensor for measurement of header cutting height position. Grain flow, grain moisture and grain loss sensors have been installed and calibrated for measurements

of grain flow in kg/m^2, percentage of grain moisture contents and grain losses in grams during harvesting, respectively. Radar velocity sensor and theoretical ground speed sensor have been used to measure the actual ground speed, theoretical ground speed of the combine in the field during operation, respectively. The tilt sensor has been used to measure the pitch and roll angles of the combine in the field during operation. In order to measure the combine engine fuel consumption, fuel flow sensor has been used. Resistance strain gauge and a slip ring have been used to measure the combine drive axle shaft torque during operation. The data acquisition system is used for conditioning, amplifying, collecting, processing, displaying and storing all the measured parameters from the sensors and differential global positioning system receiver. The differential global positioning system is used for identifying the geo-position of combine in the field. Laboratory Virtual Instrument Engineering Workbench (LabVIEW) software is used to control and process the outputs from different sensors in the data acquisition system. The LabVIEW has also been used for data logging, monitoring, processing and storing of the performance signals from sensors and collected differential global positioning system signal. The functionality and reliability of the developed instrumentation system has been tested in a harvesting operation with the combine harvester at a paddy field plot located in Sawah Sempadan Block C, Kuala Selangor under the North West Selangor Agricultural Development Project authority. Point data with specific location collected continuously with an interval of one second over the field area were down loaded into computer and presented into a spatial map using ArcGis 8.3 software.

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

MEMBINA SISTEM INSTRUMENTASI PADA JENTERA PENUAI PADI UNTUK PEMETAAN HASIL PENGELUARAN DAN PRESTASI JENTERA PENUAI

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Variasi hasil pengeluaran tanaman sawah padi menunujukkan berkemampuan hilang dari pelbagai tanah penanaman di Malaysia. Sistem bersepadu pemetaan hasil pengeluaran padi yang sedang dibangun untuk jentera penuai dengan ukuran hasil yang tetap ini berkemampuan menghasilkan peta hasil padi yang terkumpul, peta kehilangan hasil padi semasa kerja penuaian dan peta prestasi jentera penuai. Sebab-sebab untuk variasi hasil dapat diketahui apabila peta ini digunakan bersama dengan peta tanah, peta topografi dan peta rumpai. Daripada peta ini, perancangan rawatan dapat dilaksanakan untuk mengawal spesifik input untuk sesuatu kawasan dan menggunakan pelbagai kawalan supaya mencapai hasil maksima dengan penggunaan kawasan penanaman yang optima. Kajian ini melibatkan kerja-kerja merekabentuk dan membina sistem instrumentasi pemetaan hasil pengeluaran padi untuk jentera penuai New Holland TC56. Ia telah dilengkapkan dengan penderia lebar pemotongan untuk mengukur kelebaran pemotongan padi oleh pengepala jentera penuai dan penderia pengepala untuk mengukur ketinggian pemotongan padi oleh pengepala jentera penuai. Penderia aliran bijirin, penderia lembapan bijirin dan penderia kehilangan bijirin telah dipasang dan diujitentu untuk mengukur kadar alir

bijirin bersih ke tangki, peratus kelembapan bijirin ke tangki dan kadar alir bijirin yang terkeluar dari belakang pengayak pembersih dan pelantar jerami jentuai masing-masing semasa kerja dilakukan. Penderia radar kelajuan dan pengekod laju digunakan untuk mengukur laju sebenar jentera penuai dan laju teori jentera penuai. Penderia miring telah digunakan untuk mengukur darjah miring sisi dan darjah miring membujur jentera penuai ketika beroperasi di kawasan sawah padi. Penderia aliran bahan api digunakan untuk mengukur kadar penggunaan bahan api diesel enjin jentera penuai manakala penderia daya kilas digunakan untuk mengukur daya kilas pada aci pemacu bagi gegancu trek jentera penuai. Sistem global penentu dudukan memberi kedudukan geografi jentera penuai ketika beroperasi di kawasan sawah padi melalui satelit. Sistem perolehan data digunakan untuk mengawal dan merekod isyarat dari penderia-penderia dan isyarat sistem global penentu dudukan yang terdapat pada jentera penuai. Perisian LabVIEW digunakan untuk mengawal dan memproses data keluaran daripada isyarat penderia-penderia dan isyarat sistem global penentu dudukan. Kajian perladangan telah dilaksanakan di Sawah Sempadan Blok C, Kuala Selangor untuk menguji fungsi fungsi penderia yang telah dilengkapkan pada jentera penuai. Hasil padi direkodkan dalam sela masa 1 saat dan semua data kemudian dianalisa dan peta ruang dihasilkan dengan menggunakan ArcGis 8.3.

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I certify that an Examination Committee met on …… 2006 to conduct the final examination of Yap Yoke Kin on her Master Degree thesis entitled "Rice Combine Harvester Instrumentation System for Crop Yield and Field Performance Mapping" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Member of the Examination Committee are 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 acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

YAP YOKE KIN

Date: 25 JANUARY 2007

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