



UNIVERSITI PUTRA MALAYSIA

***DEVELOPMENT OF A LOW COST MICROWAVE-TYPE RICE YIELD
MONITOR WITH WIRELESS DATA COMMUNICATION FOR RICE
COMBINE HARVESTER***

OH YUN JU

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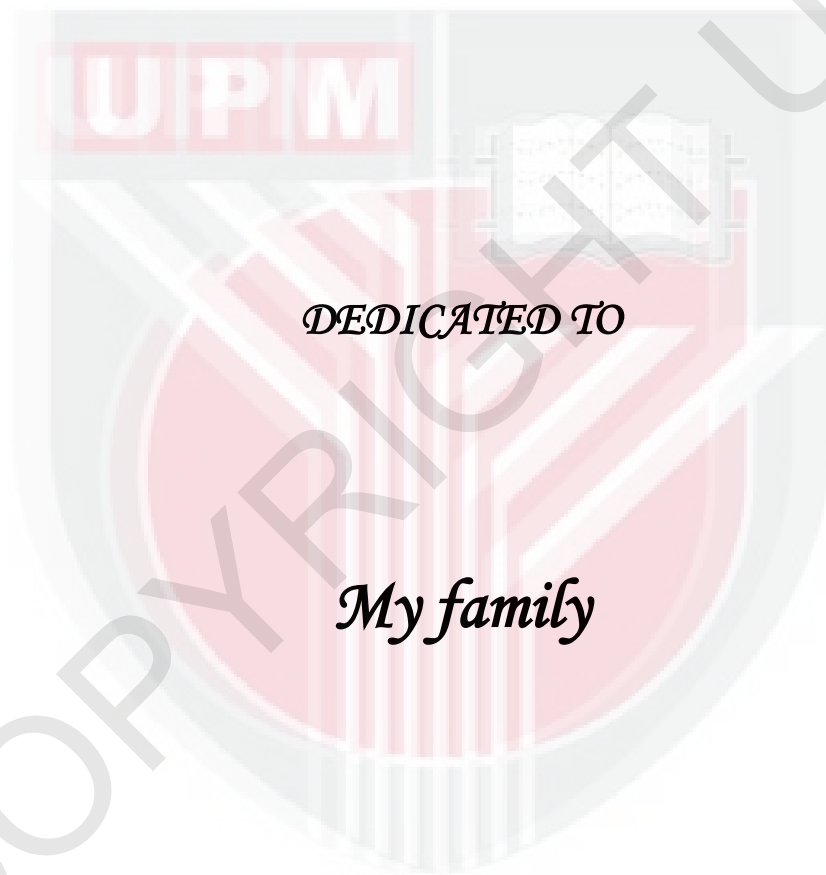
**DEVELOPMENT OF A LOW COST MICROWAVE-TYPE RICE YIELD
MONITOR WITH WIRELESS DATA COMMUNICATION FOR RICE
COMBINE HARVESTER**

By

OH YUN JU

**This thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in fulfillment of the requirements for the Degree of Master of Science**

August 2011



DEDICATED TO

My family

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

DEVELOPMENT OF A LOW COST MICROWAVE-TYPE RICE YIELD MONITOR WITH WIRELESS DATA COMMUNICATION FOR RICE COMBINE HARVESTER

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August 2011

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Faculty : Engineering

This study was carried out to develop a simple, portable, and rugged microwave-type yield monitoring system that could be directly used onto a conventional grain type combine harvester to monitor and record in real-time harvested rice yield. Crop yield monitor and grain moisture content by the impact-type flow sensor and capacitance-type sensor on the combine harvesters had been widely reported to be low in accuracies by previous researchers. This newly developed instrumentation system consists of a National Instrument CompactRio 9004 embedded system with NI 9221 I/O module, a National Instrument 2016 touch panel component (TPC), a Trimble AgGPS 132 DGPS, a D-link 655 with 3 D-link ANT24-0700 antennas, and a Panasonic CF-19 toughbook with D-link DWA-140 USB adapter, and related measurement sensors. Ultrasonic displacement sensors, electromagnetic rotation detector, microwave solid flow sensor and microwave moisture sensor were respectively used for measuring the combine cutting width, combine rotational elevator speed grain flow and grain moisture content going into the combine tank during the harvesting operation. Laboratory Virtual Instrument Engineering Workbench (LabVIEW) 8.6 software was programmed to process and display the

measured signals from the available sensors in the embedded system on-board the combine harvester and consequently display and store the transmitted signals from embedded system in the toughbook at the ground work station. Laboratory calibrations on the respective sensors showed good measurements linearity having correlation coefficients closed to 1.000. Field wireless transmission check-up between the embedded system and the toughbook showed excellent communications without data losses to a maximum distance of 140 m. Field demonstration tests on the developed yield monitoring system on-board the Clayson 1545 New Holland combine harvester in actual field harvesting operations on two rice plots for two crop growing seasons showed that the system could measure, display and record successfully the intended crop and combine performance parameters. Finally, these recorded data in the toughbook could download successfully at the laboratory and consequently utilised by ArcGis 9.2 software to generate maps of combine tracking, combine cutting width, combine elevator rotational speed, combine travel speed, instantaneous crop yield, combine field capacity, and grain moisture.

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

**PEMBANGUNAN SISTEM KOS MURAH PENGAWAS PADI HASIL JENIS
GELOMBANG MIKRO DENGAN KOMUNIKASI WAYARLES UNTUK
JENTUAI PADI PENUAI**

Oleh

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Pengerusi : Professor Madya. Ir. Azmi Dato' Yahya, PhD

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Kajian ini dijalankan untuk membangun satu sistem pengawasan ringkas, mudah alih, dan tahan lasak yang boleh digunakan secara langsung pada jentuai bijian lazim untuk mengawas dan merekod dalam masa nyata hasil penuaian padi. Pengawasan hasil tanaman dan kelembapan bijian daripada penderia aliran jenis hentaman dan penderia jenis kapasitan pada jentuai telah dilaporkan secara meluas mempunyai kejituan yang rendah oleh penyelidik-penyelidik sebelum ini. Sistem peralatan baru yang dibangunkan ini mengandungi satu sistem terbenam National Instrument CompactRio 9004 dengan modul NI 9221 I/O, satu komponen panel sentuh National Instrument 2016 TPC, satu Trimble AgGPS 132 DGPS, satu D-link 655 dengan 3 antenna D-link ANT24-0700, satu Panasonic CF-19 toughbook dengan penyesuai D-link DWA-140 USB, dan penderia-penderia pengukuran yang berkaitan. Penderia jarak ultrasonik, pegasan putaran elektromagnet, penderia aliran pepejal gelombang mikro, dan penderia kelembapan gelombang mikro telah digunakan untuk mengukur lebar pemotongan jentuai, laju putaran penaik jentuai, dan aliran bijian dan kandungan kelembapan bijian yang masuk ke tangki jentuai semasa operasi penuaian. Perisian Laboratory Virtual Instrument Engineering Workbench (LabVIEW) 8.6

telah diprogramkan untuk memproses dan memapar isyarat-isyarat dari penderia-penderia yang terdapat dalam sistem terbenam di atas jentuai dan seterusnya memapar and menyimpan isyarat-isyarat yang dihantar oleh sistem terbenam pada toughbook yang terletak di bumi. Penentukuran makmal ke atas penderia-penderia yang terbabit menunjukkan kekelurusan pengukuran yang baik dengan pekali-pekali sekaitan yang hampir nilai 1.000. Pemeriksaan lapangan ke atas penghantaran wayarles antara sistem terbenam dengan toughbook menunjukkan kemampuan komunikasi yang cemerlang tanpa kehilangan data sehingga ke jarak maksima 140 m. Ujian demonstrasi lapangan ke atas sistem pengawasan hasil yang telah dipasangkan pada jentuai Clayson 1545 New Holland pada operasi penuaian di ladang di dua lot padi pada dua musim penanaman padi menunjukkan sistem tersebut berjaya dapat mengukur, memapar dan merekod pembolehubah tanaman dan prestasi jentuai. Akhir sekali, data-data yang telah direkodkan di dalam toughbook itu dapat di turun-naik di makmal and seterusnya digunapakai oleh perisian ArcGis 9.2 untuk menghasilkan peta pergerakan jentuai, peta lebar pemotong jentuai, peta laju putaran penaik jentuai, peta laju pergerakan jentuai, peta hasil tanaman ketika, peta muatan ladang jentuai, dan peta kelembapan bijian.

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The author is forever indebted to her beloved family in giving support and spirit for sustaining and inspiring her all the times throughout the study.

I certify that a Thesis Examination Committee has met on 11 August 2011 to conduct the final examination of Oh Yun Ju on her thesis entitled “Development of a Low Cost, Microwave-Type Rice Yield Monitor with Wireless Data Communication for Rice Combine Harvester” in accordance with Universities and University College Act 1971 and 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.

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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 Universiti Putra Malaysia or other institutions.



OH YUN JU

Date: 11 August 2011

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