DESIGN AND DEVELOPMENT OF REAL TIME MONITORING AND CONTROL SYSTEM FOR WATER QUALITY IN RECIRCULATING AQUACULTURE SYSTEM

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DEDICATION

This thesis is dedicated to my wife Rosmawati Yusof, my son Adzraf Syaifullah and my daughter Amni Syahirah who have supported me since the beginning of my studies.

This thesis is also dedicated to my mother who has always been a great source of motivation and inspiration.

Finally, this thesis is dedicated to all those who believe in the richness of learning.

Abstract of thesis presented to Senate of University Malaysia Terengganu in fulfillment of requirement for the degree of Master of Science

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This thesis presents the implementation of process control system technique into the monitoring and control for the recirculating aquaculture system (RAS). This study focuses on the development of the real time monitoring and control system for water quality in RAS. The design and development process consists of four stages. The first stage is the design and development of the pilot scale RAS. The second stage is the development of the data acquisition module. The third stage is the software development for monitoring and control of water quality. The final stage is the development of the water quality database system using MySQL database. It is intended that database system provides the platform to record water quality data, so that users will be able to study and analyses the water quality related data for optimizing the RAS production system.

In this project, three water quality parameters sensors i.e., Temperature, pH and Dissolved Oxygen (DO), were installed in RAS tank. The computer acquires the water quality parameters using these sensors. These sensors were connected to the Remote Terminal Unit (RTU) which acts as an interfacing device between these sensors and a host computer. Then four outputs device i.e., blower, heater and outlet valve 1 and 2 were controlled using the host computer. The developed automated monitoring and control system prototype was programmed to be able to send short message system (SMS) to the particular mobile phone for reporting of the system status. In additional, the RAS operator also may request the status of water quality at any time when required using the SMS. The automated monitoring and control system developed was able to generate an alarm to alert the operator when certain critical conditions are reached.

The operational capability of the automated monitoring and control system prototype was tested by two (2) major experiments. Firstly, the developed prototype was conducted to operate without fish in the culture. The purpose of this test is to investigate the workability of the control system. Secondly, the developed prototype was tested on actual operational condition where catfish at different stoking density were growth into the RAS culture tank. During the experiments, water quality parameters i.e., temperature, pH and DO were recorded to ensure the validity of the measured data. The results of the comparison show that the developed prototype produced has no significant difference with the data acquired using the benchmark equipment such as the YSI multi probe.

Abstrak tesis dikemukakan kepada Senat University Malaysia Terengganu sebagai memenuhi keperluan untuk ijazah Master Science

REKABENTUK DAN PEMBANGUNAN SISTEM PENGAWASAN DAN KAWALAN KUALITI AIR UNTUK SISTEM AKUAKULTUR EDARAN SEMULA (RAS)

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Tesis ini membentangkan perlaksanaan teknik kawalan proses untuk mengawal dan mengawas dalam Sistem Akuakultur Edaran Semula (RAS). Kajian ini mengkhususkan kepada pembangunan sistem pengawasan dan kawalan masa sebenar untuk kualiti air bagi RAS. Rekabentuk dan proses pembangunan melibatkan empat peringkat. Peringkat pertama adalah rekabentuk dan pembangunan prototaip RAS. Peringkat kedua adalah pembangunan modul pensampelan data. Peringkat ketiga pula adalah pembangunan perisian bagi sistem pengawasan dan kawalan. Akhir sekali adalah pembangunan sistem pengkalan data menggunakan perisian MySQL. Sistem pengkalan data dapat menyediakan tempat simpanan untuk rekod kualiti air sepanjang masa. Dengan itu pengguna dapat mengkaji dan analisis kualiti air bagi tujuan meningkatkan produktiviti RAS untuk masa hadapan.

Dalam projek ini, terdapat tiga penderia kualiti air digunakan iaitu suhu, pH dan Oksigen Terlarut (DO), di mana ia dipasang di dalam tangki RAS. Komputer akan bertindak membaca kualiti air menggunakan tiga penderia ini. Ketiga-kita penderia ini akan di sambungkan kepada Unit Terminal Jauh (RTU) di mana ia bertugas sebagai perantaramuka antara penderia dan sistem komputer. Manakala terdapat empat

perkakasan luaran digunakan iaitu penyembur oksigen, pemanas, injab keluaran 1 dan 2 yang di kawal menggunakan komputer utama. Prototaip yang dibangunkan ini juga dilengkapi dengan sistem khidmat pesanan ringkas berkemampuan untuk menghantar khidmat pesanan ringkas (SMS) kepada telefon bimbit pengguna. Di samping itu, operator RAS juga boleh menghantar khidmat pesanan ringkas (SMS) untuk mengetahui keadaan terkini kualiti air disesebuah tangki. Sebagai tambahan sistem yang dibangunkan ini juga mampu untuk mengaktifkan sistem amaran untuk memaklumkan kepada operator bertugas apabila kualiti air melebihi had-had tertentu.

Kemampuan prototaip yang dibangunkan diuji melalui dua ujian utama. Ujian pertama dikenali ujian kering, di mana prototaip yang dibangunkan ini diuji tanpa ikan dalam tangki utama. Tujuan ujian ini adalah untuk menyiasat kebolehkerja sistem kawalan yang dibangunkan. Ujian kedua adalah di mana prototaip sistem diuji pada operasi sebenar di mana ikan keli dimasukkan pada kepadatan berbeza yang dimasukkan di dalam tangki RAS. Sepanjang ujikaji dijalankan kualiti air iaitu suhu, pH dan DO direkodkan. Untuk memastikan ketepatan data yang diukur, perbandingan data dilakukan di mana data yang direkod oleh sistem yang dibangunkan dan data direkod oleh multi deria sistem jenama YSI. Keputusan perbandingan menunjukkan sistem prototaip yang dibangunkan tidak menunjukan sebarang perbezaan yang ketara antara data yang diperolehi daripada peralatan yang digunakan sebagai penanda aras seperti multi deria sistem.