UNIVERSITI PUTRA MALAYSIA

IMPROVING UTILITY AND RECOVERY ALGORITHMS FOR ADAPTIVE REAL TIME SYSTEM IN MULTIPROCESSOR ENVIRONMENT

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By

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IMPROVING UTILITY AND RECOVERY ALGORITHMS FOR ADAPTIVE REAL TIME SYSTEM IN MULTIPROCESSOR ENVIRONMENT

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Among the issues in adaptive real time system is the efficiency of the scheduling algorithm to satisfy the predefined deadline and utility requirements. The design of real time scheduler to achieve an efficient utility and fault recovery algorithm in multiprocessor environment is the main problem focused in this research. This thesis considers the independent tasks that are subject to deadline constraints specified in the TUF/UA scheduling environment. The algorithms for uniprocessor environment are known as Priority Inversion Utility Accrual Scheduling (PUAS) and Negation Oriented Utility Accrual Scheduling (NUAS). These algorithms solved the abortion problem in the existing General Utility Scheduling (GUS). PUAS implements a preemption strategy while NUAS negates the scheduling decision to abort by resuming the owner task. Simulation results reveal that the proposed algorithms outperforms the existing algorithm for the entire load range.

The algorithm for multiprocessor environment is known as Global PUAS (GPUAS). GPUAS is adapted from the existing Greedy-Global Utility Accrual (G-GUA) and Non-Greedy Global Utility Accrual (NG-GUA) algorithms that considered task migration attribute for load sharing purposes. GPUAS enhanced the task placement mechanism in G-GUA and NG-GUA algorithms. From the simulation results, GPUAS outperforms the existing G-GUA

algorithm. The placement of task into a queue according to the value of utility in GPUAS has efficiently accrued at most 4.98% higher utility as compared to the existing G-GUA in dual core platform during overloaded condition in the system. GPUAS also tremendously outperforms NG-GUA in all platforms at most 12.44% higher utility accrued to the system.

The scheduling algorithms with fault recovery are implemented in the uniprocessor and multiprocessor environment. The Backward Recovery (BR) mechanism is adapted from the Responsive Algorithm (RA) and works by re-executing of the erroneous request after its transient error period is over. The *Backward Recovery PUAS* (BRPUAS) and *Backward Recovery NUAS* (BRNUAS) algorithms are implemented for the uniprocessor scheduling environment. The *Backward Recovery GPUAS* (BR_GPUAS) algorithm is implemented in the multiprocessor environment. This thesis has proven that the BR mechanism is efficient to be used in the uniprocessor as BRPUAS saved at most 8.94% higher utility as compared to the abortion recovery. In multiprocessor environment, the BR_GPUAS saved at most 31.98% utility and thus enhanced the system performance in transient erroneous environment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENAMAMBAHBAIKAN ALGORITMA UTILITI DAN PEMULIHAN UNTUK SISTEM MASA NYATA YANG ADAPTIF DALAM PERSEKITARAN PEMPROSES BERBILANG

Oleh

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Diantara permasalahan dalam sistem masa nyata yang adaptif adalah kecekapan perlaksanaan algoritma penskedulan untuk memenuhi keperluan had masa. Rekabentuk penskedulan masa nyata untuk mencapai kecekapan algoritma utility dan pemulihan ralat dalam persekitaran pemproses berbilang adalah masalah utama yang menjadi fokus dalam kajian ini. Tesis ini mempertimbangkan tugas yang bersifat bebas dan mempunyai kekangan had masa dinyatakan dalam persekitaran fungsi masa/utiliti dan pengumpulan utiliti (TUF/UA). Algoritma untuk pemprosesan tunggal adalah *Priority Inversion Utility Accrual Scheduling* (PUAS) dan *Negation-oriented Utility Accrual Scheduling* (NUAS). Algoritma ini menyelesaikan masalah penguguran pada algoritma sedia ada iaitu *General Utility Scheduling* (GUS). PUAS menggunakan strategi celahan manakala NUAS meniadakan keputusan penskedulan untuk mengugurkan dengan meneruskan tugas pemilik. Keputusan simulasi menunjukkan algoritma yang dicadangkan mengatasi algoritma sedia ada bagi keseluruhan beban.

Algoritma untuk pemprosesan berbilang adalah *Global PUAS* (GPUAS). GPUAS adalah adaptasi dari algoritma *Greedy-Global Utility Accrual* (G-GUA) dam *Non-Greedy Global*

Utility Accrual (NG-GUA) yang mempertimbangkan atribut migrasi untuk tujuan berkongsi beban. GPUAS mempertingkatkan mekanisma penempatan tugas dalam G-GUA dan NG-GUA. Keputusan simulasi menunjukkan GPUAS mengatasi algoritma sedia ada G-GUA. Penempatan tugas ke dalam baris giliran berdasarkan pada nilai utility dalam GPUAS telah secara efisen mengumpulkan paling banyak 4.98% lebihan utiliti dibandingkan dengan G-GUA sedia ada pada pelantar dua teras semasa keadaan lebihhan beban dalam sistem. GPUAS juga dengan ketara ia mengatasi prestasi NG-GUA untuk semua bilangan pelantar paling banyak 12.44% lebihan pengumpulan utiliti pada sistem.

Algoritma penskedulan dengan pembetulan ralat dilaksanakan dalam persekitaran pemprosesan tunggal dan berbilang. Mekanisma *Backward Recovery* (BR) adalah adaptasi dari *Responsive Algorithm* (RA) yang berkerja dengan cara melaksanakan semula permintaan tugas yang terjejas sejurus tamatnya tempoh ralat. Algoritma yang dilaksanakan untuk persekitaran pemprosesan tunggal adalah *Backward Recovery PUAS* (BRPUAS) dan *Backward Recovery NUAS* (BRNUAS). Algoritma yang dilaksanakan untuk pemprosesan berbilang adalah *Backward Recovery GPUAS* (BR_GPUAS). Tesis ini membuktikan bahawa mekanisma BR adalah efisien untuk digunakan dalam pemprosesan tunggal kerana BRPUAS telah menyelamatkan paling banyak 8.94% lebihan utiliti dibandingkan dengan pemulihan secara pengguguran. Pada pemprosesan berbilang, BR_GPUAS the menyelamatkan paling tinggi 31.98% utiliti dan meningkatkan prestasi sistem dalam persekitran ralat sementara.

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Approval Sheet 1

I certify that an Examination Committee has met on [date of viva] code to conduct the final examination of Idawaty binti Ahmad on her doctorate degree thesis entitled "Utility Accrual Scheduling Algorithms for Adaptive Real Time System" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the student be awarded the (Name of relevant degree).

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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 University Putra Malaysia or at any other institutions.

_____

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Date: 31 July 2012

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