PRIORITY AND DYNAMIC QUANTUM TIME ALGORITHMS FOR CENTRAL PROCESSING UNIT SCHEDULING

MAYSOON A. MOHAMMED

Doctor of Philosophy
(Computer Science)

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy in Computer Systems.

_____

(Supervisor's Signature)

Full Name	:	DR. MAZLINA ABDUL MAJID
Position	:	ASSOCIATE PROFESSOR
Date	:	

STUDENT'S DECLARATION

I hereby declare that the work in this 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 Universiti Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : MAYSOON A. MOHAMMED

ID Number : PCC13004

Date : 28 April 2018

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LIST OF ABBREVIATIONS

ALU	Arithmetic Logic Unit
BCS	Buffered Crossbar Switches
BRR	Burst Round Robin
CBF	Critical internal Buffer First
CDMA	Code-Division Multiple Access
CPU	Central Processing Unit
CS	Context Switches
CTQ	Changing Time Quantum
EDA	Exploratory data analysis
FIFO	First In First Out
FRR	Fair Round-Robin
HDR	High Data Rate
HLBA	Hierarchical Load Balanced Algorithm
HRRN	Highest-Response-Ratio-Next
I/O	Input/ Output
IRR	An Improved RR
IRRSA	An Improved Round Robin Scheduling Algorithm for CPU Scheduling
IRRVQ	An Improved Round Robin CPU Scheduling Algorithm with Varying Time Quantum
ITS	Intelligent Time Slice
LA	Look Ahead
MFQS	Multilevel Feedback Queues Scheduling
MLQPTS	Multilevel Queue with Priority & Time-Sharing Scheduling
MLRRMS	Multi-level round robin multicast scheduling
NIRR	A New Improved Round Robin CPU Scheduling Algorithm
OS	Operating System
PBDRR	Priority Based Dynamic Round Robin Algorithm
PC	Personal Computer
PCB	Process Control Block
PDQT	Priority Dynamic Quantum Time
PMQDQT	Priority Multi Queue Dynamic Quantum Time
PRRDTQ	Priority based Round Robin CPU Scheduling using Dynamic Time Quantum
PS	Priority Scheduling
QT	Quantum Time
RR	Round Robin
RTOS	Real Time Operating System
SJF	Shortest Job First
TAT	Turnaround Time
V&V	Verification and Validation

VOQ	Virtual Output Queues
WT	Waiting Time

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ABSTRAK

Penjadualan CPU adalah konsep utama dalam multitasking komputer, sistem operasi multiprosesor dan reka bentuk sistem operasi masa nyata. Penjadualan merujuk kepada cara proses untuk menjalankan CPU. Salah satu algoritma yang paling banyak digunakan dalam penjadualan melibatkan perkongsian dan sistem operasi batch ialah Round Robin. Algoritma Round Robin mengatur dan memilih semua unsur dalam satu kumpulan pada masa yang sama. Dalam penjadualan Round Robin, proses mendapatkan bahagian yang sama rata dari CPU disebabkan kuantum masa statik yang diberikan bagi setiap proses. Masa kuantum tetap di Round Robin berkadar songsang dengan pertukaran konteks yang membawa kepada purata masa menunggu yang tinggi dan purata masa pemulihan yang tinggi menyebabkan prestasi keseluruhan system menurun. Ramai penyelidik mencadangkan algoritma untuk menambahbaik Round Robin seperti Robin Round yang telah ditambahbaik dengan Masa Kuantum yang berbeza-beza, Algoritma Penjadualan Round Robin yang telah ditambahbaik, Round Robin Berkeutamaan dengan Masa Kuantum Dinamik dan Algoritma Penjadualan CPU Round Robin Baru yang telah ditambahbaik untuk urutan tunggal dan urutan berbilang. Pertimbangan algoritma ini telah menemukan beberapa kekangan. Robin Round yang telah ditambahbaik dengan Masa Kuantum yang berbeza-beza memberi tumpuan kepada masa kuantum yang dinamik, Algoritma Penjadualan Round Robin yang telah ditambahbaik memberi tumpuan kepada masa kuantum tetap Round Robin Berkeutamaan dengan Masa Kuantum Dinamik memberi tumpuan kepada masa kuantum yang dinamik dan faktor prioriti manual. Pertimbangan algoritma yang disebutkan ini hanya untuk urutan tunggal sahaja. Algoritma Penjadualan CPU Round Robin Baru telah ditambahbaik Meningkatkan masa kuantum yang dinamik dalam urutan berbilang. Dalam tesis ini, dua algoritma baru yang digunakan untuk menambahbaik algoritma Round Robin yang sedia ada dalam pertukaran konteks, masa pemulihan dan masa menunggu bergantung kepada keutamaan dan masa kuantum yang dinamik untuk urutan tunggal telah dicadangkan bagi meningkatkan daya tampung CPU. Algoritma yang dicadangkan (Masa Kuantum Dinamik Berkeutamaan dan Algoritma Masa Kuantum Berkeutamaan Pelbagai) dilaksanakan menggunakan bahasa pengaturcaraan JAVA dan disahkan menggunakan Persamaan Penunjuk Prestasi Utama. Perbandingan algoritma yang dicadangkan dengan algoritma Round Robin sedia ada dibentangkan untuk menekankan pentingnya algoritma yang dicadangkan untuk meningkatkan prestasi algoritma penjadualan CPU. Selepas beberapa siri eksperimen dijalankan, algoritma yang dicadangkan berjaya meningkatkan daya tampung CPU dengan mengurangkan pertukaran konteks, purata masa pemulihan dan purata masa menunggu kepada kira-kira 5%, 17% dan 20% untuk urutan tunggal dan 21%, 9% dan 13% masing-masing untuk urutan berbilang. Peningkatan ini memberi impak yang besar kepada prestasi CPU, di mana pemprosesan CPU meningkat dengan kadar yang positif, (iaitu bilangan proses yang lengkap dalam setiap pusingan meningkat, bilangan pertukaran konteks, purata pemulihan dan purata masa menunggu adalah menurun). Analisis statistik Wilcoxon untuk menguji keputusan eksperimen telah dilakukan. Hasil kajian ini membawa kepada beberapa sumbangan, Satu formula baru telah diperolehi mengandungi semua komponen yang digunakan dalam kerja ini, burst time, masa kuantum dan keutamaan. Algoritma baru juga telah dicadangkan urutan tunggal dan urutan berbilang untuk meningkatkan prestasi CPU. Gabungan masa kuantum yang dinamik dan keutamaan yang berbeza dalam urutan tunggal dan urutan berbilang Round Robin adalah sumbangan yang paling penting untuk meningkatkan daya tampung CPU.

ABSTRACT

Central Processing Unit scheduling is a key concept in computer multitasking, multiprocessing operating system and real- time operating system designs. Scheduling refers to the way processes are assigned to run on the Central Processing Unit. Central Processing Unit is scheduled using different types of scheduling algorithms. One of the most widely algorithm used in scheduling with sharing and batch operating systems is Round Robin. Round Robin algorithm arrange and choose all elements in a group equally in time. In Round Robin scheduling, processes get fair share of quantum time of the Central Processing Unit. The quantum time is fixed, so, it is inversely proportional to context switches which leads to high average waiting time and high average turnaround time which degrades the overall performance of the system. Researchers proposed different formulas and algorithms to improve the quantum time of Round Robin scheduling in different ways considering dynamic time, setting priorities and setting different number of queues. However, limitations have been found with the consideration of these algorithms. In this thesis, a new formula has been imbedded in two algorithms to improve existing Round Robin algorithms in term of context switches, turnaround time and waiting time. These formula and algorithms consider the priority, dynamic quantum time and different number of queues in order to increase the throughput of the Central Processing Unit. The proposed formula has been validated and analysed using excel software in order to access the new formula and compare with other existing formulas. In excel, a graph has been produced to show the minimum and maximum values of the new dynamic quantum time after setting the parameters of the proposed formula (priority, burst time and the current quantum time). The proposed algorithms (Priority Dynamic Quantum Time and Multi Priority Dynamic Quantum Time Algorithms) are implemented using JAVA programming language and validated using Key Performance Indicators equations. A comparison of the proposed algorithms with existing algorithms of Round Robin is presented to emphasize the importance of the proposed algorithms in order to improve the performance of the scheduling algorithm of the Central Processing Unit. After the experiments, the proposed algorithms successfully improved the throughput of the Central Processing Unit (i.e. the number of completed processes in each round is increased, number of context switches, average of turnaround and average of waiting time is decreased). For statistical analysis, a Wilcoxon non-parametric test is used to test and validate the results of the experiments. This study illustrated some contributions, 1. A new formula has been derived containing all components of the processes, burst time, quantum time and priority and 2. A new algorithms with different numbers of queues to improve the performance of the Central Processing Unit. The combination of dynamic quantum time and different priorities in single and multi-queue of Round Robin has been shown a significant contribution to increase the throughput of the Central Processing Unit.

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