A Hybrid of Round Robin and Shortest Job First CPU Scheduling Algorithm for Minimizing Average Waiting Time

[1]Tanuja Jha, [2]Tanupriya Choudhury
[1]Amity University UttarPradesh, Noida, India, [2]University of Petroleum and Energy Studies(UPES) Dehradun,India
[1]tanujatannu1@gmail.com, [2]tanupriya1986@gmail.com

Abstract— **One of the important role played by CPU is process management. The CPU scheduling algorithms are essential for the performance of the system. The CPU utilization is maximized by the CPU scheduling algorithms. The algorithms used for scheduling CPU help in reducing the context-switching, turnaround time, response time ,average waiting time. First Come First Serve, Round Robin, Shortest Job First and Priority Scheduling are some useful algorithms for scheduling CPU. The systems based on time sharing uses Round Robin CPU scheduling algorithm. This paper presents an algorithm which is hybrid of both Round Robin Algorithm and Shortest Job First(SJF) Algorithm in which the burst -time of shortest job is used as the time quantum. The modified algorithm is proven useful than the conventional Round Robin. The hybrid of Round Robin and SJF algorithms have minimized the turnaround time and average waiting time to enhance CPU performance.**

Keywords—SJF Scheduling; Round Robin(RR) Scheduling; Burst time; Turnaround Time

I. INTRODUCTION

Many processes are executed simultaneously by CPU in the multiprogramming systems. In order to maximize the CPU utilization, CPU keeps on executing some process all the time so that it is not idle. This improves the efficiency of the CPU. The algorithms for scheduling CPU focuses on minimizing the turnaround -time, response -time and waiting -time and improving the performance of CPU. This paper throws light on modifying the Round Robin algorithm used for CPU Scheduling.[1][2][3]

A. Performance Parameters

When a process is fetched from disk to memory then it is in new state. In the ready queue, new state processes wait for the processor to be allocated. The interval for which process waits for the processor to be allocated in ready queue is called as waiting-time. Interval between process submission to process completion is called turnaround time. The time required to complete a process or a task is called burst time.[6][7]

B. CPU Scheduling Algorithms

The process gets the processor on the basis of CPU Scheduling Algorithms. The processor is allocated to the process on the basis of time on which they arrive in the First Come First Serve algorithm. The process which arrives first is given processor first. The understanding and implementation of this is easy. But, the average waiting time is high. In Shortest Job First (SJF) algorithm, CPU is available for the processes having less burst time. The average waiting time is less. In priority scheduling algorithm, the processes are assigned some priority. The process with maximum priority is allocated CPU first. In Round Robin (RR) Algorithm, every process is executed for a constant time interval called as quantum. The process executes for a constant time interval and then the execution of other process takes place for a constant time interval and so on. In this paper, the Round Robin Algorithm for scheduling CPU is modified and a hybrid of Round Robin and SJF algorithms is proposed so that the average waiting time is reduced.[4]

II. HYBRID OF RR AND SJF CPU SCHEDULING ALGORITHM

Hybrid of RR and SJF algorithm is combination of both of these algorithms. The arrangement of the processes which arrive to the ready queue is done in increasing order of their bust time. Then the minimum burst time i.e. the execution time of the primary method in the ready queue is selected as the time quantum to further perform RR Scheduling. All the processes are allocated CPU on the foundation of Round Robin Algorithm for the selected time period and are processed. After each cycle, every process gets already queued in cumulative order of their remaining burst time in the ready queue. In this way, every process is processed for fixed time slice i.e. minimum burst time.[5]

Proposed Algorithm for CPU Scheduling:

- Create a ready queue RQ where the processes get submitted.

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- Set up the processes in RQ in the increasing order of burst -time of each process.
- Fix the time slice as execution time of the primary procedure lying in the Ready Queue RQ.
- DO steps 5 to 6 UNTIL ready queue RQ gets vacant.
- Select the primary process in RQ and allocate CPU to it for unit time quantum.
- The process in ready queue RQ is to be removed IF running process' remaining burst time becomes zero. ELSE move the method which is executing to the termination of the Ready Queue RQ.

A. *Illustration*

For illustration, four processes P1, P2, P3, and P4 are considered. The processes come to the Ready Queue at zero time interval. The burst time for the processes P1, P2, P3, P4 are 10, 12, 8 and 5 respectively. The methods are set up in Ready Queue in increasing order of their respective burst time as P4, P3, P1 and P2. The quantum of time for scheduling is fixed as the burst time of the primary process in the Ready Queue as 5 milliseconds. The processor is allocated to every processes for a time period of 5 milliseconds.

In the first cycle, the CPU is allocated to the processes and for the processes P4, P3, P1 and P2, the outstanding burst times are 0, 3, 5 and 7 respectively. The process P4 is eliminated from Ready Queue as its lasting burst time is zero. Since the processes are already in increasing order of their respective outstanding burst times, they will be allocated CPU in the same order. The time quantum remains always constant i.e. 5 ms. Hence, after the second cycle, the remaining burst time for remaining processes in ready queue i.e. P3, P1 and P2 are 0, 0 and 2 respectively. The processes P3, P1 and P2 have zero outstanding burst time so these processes are eliminated from Ready Queue. In the third cycle, the process P2 is only left in the Ready Queue. After the third cycle, the outstanding burst time of each process becomes zero and Ready Queue becomes empty. The waiting time for the process P4, P3, P1 and P2 are 0, 15, 18 and 23 respectively. The processes have 14 ms as their average waiting time. Whereas by Round Robin CPU Scheduling, the average waiting time for these processes with time quantum of 5 ms and same arrival time is 19.50 ms. The average turnaround time for the processes is 22.75 ms in Hybrid of RR and SJF while average turnaround time is 28.25 ms in RR algorithm.

III. EXPERIMENTAL ANALYSIS

A. *Assumptions*

All the processes are considered to have zero arrival time. The burst time for each process are already given. The number of processes are already known. Milliseconds is used to estimate the time quantum.

B. *Experiments performed*

Five sets of data have been taken for the evaluation of performance of the scheduled algorithm. For all sets of data, different burst time have been given and the time slice used in both the algorithms are considered same.

1) *CASE 1*

TABLE 1.1. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR ROUND ROBIN

Process (Pn)	Burst -Time (bt)	Waiting -Time (wt)	Turnaround-Time (tt)
Process1 (P1)	20	72	92
Process2 (P2)	25	74	99
Process3 (P3)	21	81	102
Process4 (P4)	18	54	72
Process5 (P5)	19	84	103

Time slice= 18 ms
Avg (wt) = 73.00
Avg (tt) =93.59

TABLE 1.2. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR HYBRID OF ROUND ROBIN AND SJF

Process	Burst -Time	Waiting -Time	Turnaround-Time
Process1 (P1)	20	73	93
Process2 (P2)	25	78	103
Process3 (P3)	21	75	96
Process4 (P4)	18	0	18
Process5 (P5)	19	72	91

Avg (wt) = 59.59
Aveg (tt) = 80.19

2) CASE 2

TABLE 1.3. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR ALGO OF RR

Process	Burst -Time	Waiting - Time	Turnaround- Time
Process1 (P1)	10	28	38
Process2 (P2)	8	31	39
Process3 (P3)	16	38	54
Process4 (P4)	13	39	52
Process5 (P5)	7	28	35

Time slice = 7 ms
Avg (wt) = 32.79
Avg (tt) = 43.59

TABLE 1.4. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR HYBRID OF RR AND SJF

Process	Burst -Time	Waiting - Time	Turnaround- Time
Process1 (P1)	10	29	39
Process2 (P2)	8	28	36
Process3 (P3)	16	38	54
Process4 (P4)	13	32	45
Process5 (P5)	7	0	7

Avg (wt) = 25.4
Avg (tt) = 36.200001

3) CASE 3

TABLE 1.5. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR RR

Process	Burst -Time	Waiting -Time	Turnaround- Time
Process1 (P1)	13	36	49
Process2 (P2)	16	40	56
Process3 (P3)	12	47	59
Process4 (P4)	10	50	60
Process5 (P5)	9	36	45

Time slice= 9 ms
Avg (wt) = 41.79
Avg (tt) = 53.79

TABLE 1.6. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR HYBRID OF RR AND SJF

Process	Burst -Time	Waiting - Time	Turnaround- Time
Process1 (P1)	13	40	53
Process2 (P2)	16	44	60
Process3 (P3)	12	37	49
Process4 (P4)	10	36	46
Process5 (P5)	9	0	9

Avg (wt) = 31.40
Avg (tt) = 43.40

4) CASE 4

TABLE 1.7. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR RR

Process	Burst -Time	Waiting - Time	Turnaround- Time
Process1 (P1)	45	156	201
Process2 (P2)	39	39	78
Process3 (P3)	42	162	204
Process4 (P4)	47	165	212
Process5 (P5)	43	173	216

Time slice =39 ms
Avg (wt) = 139.00
Avg (tt) = 182.19

TABLE 1.8. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR HYBRID OF RR AND SJF

Process	Burst -Time	Waiting - Time	Turnaround- Time
Process1 (P1)	45	163	208
Process2 (P2)	39	0	39
Process3 (P3)	42	156	198
Process4 (P4)	47	169	216
Process5 (P5)	43	159	202

Avg (wt) = 129.39
Avg (tt) = 172.60

5) CASE 5

TABLE 1.9. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR RR

Process	Burst -Time	Waiting - Time	Turnaround- Time
Process1 (P1)	25	0	25
Process2 (P2)	30	100	130
Process3 (P3)	33	105	138
Process4 (P4)	29	113	142
Process5 (P5)	26	117	143

Time slice =25 ms
Avg (wt) = 87.00
Avg (tt) = 115.59~

TABLE 1.10. PROCESSES: BURST, WAITING AND TURN AROUND TIMES FOR HYBRID OF RR AND SJF

Process	Burst - Time	Waiting - Time	Turnaround- Time
Process1 (P1)	25	0	25
Process2 (P2)	30	105	135
Process3 (P3)	33	110	143
Process4 (P4)	29	101	130
Process5 (P5)	26	100	126

Avg (wt) = 83.19
Avg (tt) = 111.80

IV. COMPARISONS

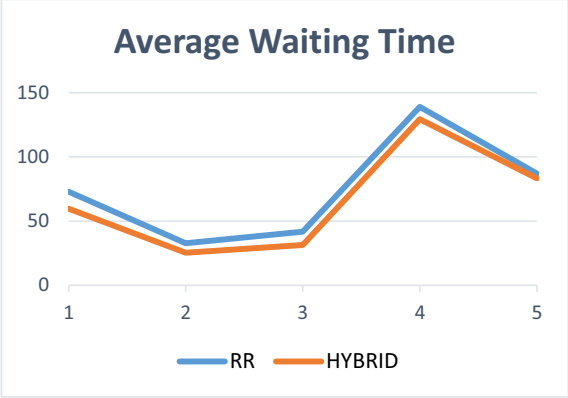

Fig. 1. Evaluation of Average Waiting Time in RR and Hybrid of RR and SJF Algorithms

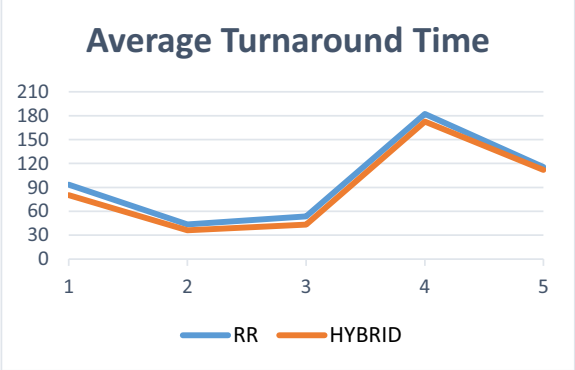

Fig. 2. Comparison of Turnaround Time in RR and Hybrid of RR and SJF Algorithms

V. CONCLUSION

The operating system allocates processor to different processes available in ready queue which are in waiting state. For this, various algorithms are proposed. All the algorithms

have their own merits and demerits. The algorithm projected in this paper i.e. the Hybrid of RR and SJF shows significant improvement in processing if compared to the conventional Round Robin Algorithm. This hybrid of both the algorithms has helped to improve the CPU performance by reducing the average turnaround and waiting times. Thus, this algorithm can improve the system's performance.

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