Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 4, October 2024
DOI : https://doi.org/10.33395/sinkron.v8i4.13563
e-ISSN : 2541-2019
p-ISSN : 2541-044X

A Review on AMRR and Improved Round Robin Algorithms: Comparative Study

Tri Dharma Putra[1], Rakhmat Purnomo[2*]
[1,2]Department of Informatics, Faculty of Computer Science, Universitas Bhayangkara Jakarta Raya
tri.dharma.putra@dsn.ubharajaya.ac.id, rakhmat.purnomo@dsn.ubharajaya.ac.id*

Submitted : March 6, 2024 | **Accepted** : March 24, 2024 | **Publish** : Oct 7, 2024

Abstract: The Round-Robin algorithm is a dominant algorithm in real-time systems. Improved round robin and average max round robin, which is also called AMRR are two types with a breakthrough. Improved round robin is an algorithm where if the remaining burst time of the process is less than the quantum, then the running process will continue to be executed. Afterward, the next iteration will be executed as its turn. So, each iteration will have a variety of quantums. It is called a dynamic time quantum. Different from the improved round robin, in AMRR, in every iteration, the quantum will be calculated. So, for every iteration, the quantum might be different, depending upon the quantum calculation of the rest burst time. The first stage of this algorithm is to calculate the average of the existing burst times. Then this average is added to the maximum existing burst time. This addition then will be divided, then we get the quantum. This calculation will be executed again after the iteration finishes. Based on our analysis, with quantum 10 in these two algorithms. It is can be shown that the improved round-robin is less efficient than AMRR because its average turnaround time and average waiting time are lower. The average turnaround time is 17.25 ms for AMRR compared to 23.25 ms in improved round robin. And the average turnaround time is 9 ms for AMRR compared to 15 ms in improved round robin.

Keywords: Average Max Round Robin, Burst Time, Improved Round Robin, Quantum, Turnaround Time, Waiting Time

INTRODUCTION

Process scheduling is a crucial concept in operating systems. The operating system acts as an interface between software and hardware in the system. The operating system helps the user to use the computer more easily. All the application installed in the operating system, is installed in the operating system's API. In modern operating systems, the systems are more complex and sophisticated. The operating system can handle multitasking by scheduling the processes. An operating system performs many functions like process scheduling, memory management, and resource management (Putra & Purnomo, 2022b)(Purnomo & Putra, 2022b)(Putra, 2020).

Scheduling is an important task in the operating system. The method of scheduling process makes an important contribution to the system's performance. There are several scheduling algorithms in the operating system, shortest job first (SJF), first come first serve (FCFS), priority scheduling, round robin scheduling and all its variants (Putra, 2022)(Putra & Purnomo, 2021)(Tri Dharma Putra, 2021).

Round robin algorithm is one of the most commonly used scheduling algorithms (Freire et al., 2022). It is also a traditional algorithm. In round robin, the execution of the process is given with quantum. Time quantum is an important concept in round-robin algorithms. If one iteration is finished, then the next process in the ready queue will be executed again. These iterations continue until all the processes are finished (Alhaidari & Balharith, 2021)ed (Ali et al., 2021).

Then experts came out with the idea to use a dynamic time quantum. Which is in every iteration, the time quantum might be different. Several proposed algorithms in round-robin use dynamic time quantum. And also this average max round robin (AMRR), On the contrary, the improved round robin algorithm uses a different method. This algorithm uses also different time quantum. But if in the last iteration, the time quantum is bigger than the remaining burst time, then the running processes will be kept to be executed.

The main contribution of this journal is the comparison of types of round robin algorithms. The comparison between the two, give the comparison of efficiency between the two. The comparisons are between the average turnaround time and average waiting time. A thorough comparisons are given in the discussion sections of this journal, with table to present the comparison clearly.

The structure of this journal is as follow: First chapter is introduction, Then the second chapter is literature review. In this chapter other relevant works of experts are presented. The third is method. Here discussion about AMRR and improved round robin are discussed. The fourth chapter is Result. The fifth chapter is discussion about the analysis. And the last chapter is conclusion and future works.

*name of corresponding author

LITERATURE REVIEW

Ali gave proposal to improve CPU optimization criteria with different algorithms to improve waiting time, response time, turnaround time (Ali et al., 2021). The conclusion was there was no algorithm which is better in all criteria.

Abdelkader Ghazy, Zaki, and ElDahshan gave proposal of an algorithm by using dynamic time quantum. The quantum is generated for its iteration depending on the remaining burst time. In their research, the system's performance is enhanced in terms of turnaround time, waiting time, and time quantum. It is concluded that this algorithm outperform other known algorithms (Abdelkader et al., 2022).

Shafi, Shah, Wahid, Abbasi, Javaid, Asghar, Haider, gave proposal of an improved conventional scheduling round robin algorithm which is named amended dynamic round robin (ADRR). They then evaluate and compare the proposed algorithm with the result in analysis numerical and simulation by using MATLAB. This research revealed that this algorithm outperform other existing round robin algorithms (Shafi et al., 2020).

Mostafa and Amano proposed a new modified version of round robin algorithm. This algorithm combines the advantageous of favor short process and low scheduling overhead of round robin to minimize average turnaround time, average waiting time, and the number of time quantums. Their experiments based on K-Mens clustering technique revealed that the proposed algorithm gave better results (Mostafa & Amano, 2020).

Simarmata, Lumbantoruan, Nainggolan, and Napitupulu introduced round robin algorithm with average dynamic time quantum in multicore processors. In their study, they improvised round robin algorithm on system with multicore to execute processes contained in a single queue, so that it gives a quantum time based on the average burst time of the whole processes in the queue. The proposed research is with the aim to minimize turnaround time and waiting time (Simarmata et al., 2019).

Sakshi, Sharma, Kautish, Alsallami, Khalil, and Mohamed introduced a new median-average round robin scheduling algorithm. Their study suggests using MARR, median-average round robin, using the median and average of the burst time from each process. This algorithm uses a dynamic time quantum algorithm. These authors compared the proposed model with the existing well-known round-robin algorithm (Sakshi et al., 2022).

Fiad, Maaza, and Bendoukha introduced an algorithm to make the average waiting time and turnaround time lower. The use of different analytical models takes into consideration different parameters to use variable quantum. With five different approaches have been implemented. The proposed algorithm uses burst time as a parameters in the model to ensure more suitable quantum time. The proposed algorithm not only can be applied in any operating system, but also can be used in cloud computing environments (Fiad et al., 2020)

Ghazy, Abdelkader, Zaki, and ElDahshan proposed a median mean round-robin algorithm. This algorithm finds an optimal dynamic quantum of (median+mean)/2 and generated for each cluster depending on the remaining burst time of the processes. Their experiments showed that the proposed algorithm running well compared to other types of round robin algorithms.

METHODS

In this chapter discussion will be given about the method behind these two algorithms, the AMRR, average max round robin and improved round robin algorithm.

Improved Round Robin Algorithm

Neha and Ankita Jiyani introduced an algorithm to utilize an improved round robin algorithm in real real-time system. The first process is executed as its burst time. Afterward, the system will check the remaining burst time of this running process. If the quantum of the remaining burst time is bigger than the running process, then the running process will continue executing these processes until it is finish (Putra & Purnomo, 2022a). Afterwards, then the subsequent process will be executed (Neha, 2018)(Purnomo & Putra, 2022a). Then the next process will be executed as its turn.

Let us discuss the theorem of this improved algorithm. Let's say we have four processes as the table below:

Table 1. Process and Burst Time

Process	Burst Time
A1	1
A2	3
A3	5
A4	4

In the table 1 above, we have four processes with its burst time each. Let say its quantum is 3. Then A1 will be executed until finish since its only 1 ms. The second process A2, will be executed also until finish since its burst time only 3. Then in the third process, A3, we have 5 ms of burst time. Then since the remaining of the 5 is 2, then this process will be executed until finish, namely 5 ms. Then this also happen in the fourth process. It will be

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 4, October 2024
DOI : https://doi.org/10.33395/sinkron.v8i4.13563
e-ISSN : 2541-2019
p-ISSN : 2541-044X

executed until finish, since its burst time is 4. More than the quantum which is 3, and less then the next quantum which its burst time only 1 ms.

1	2	3	4	5	6	7	8	9	10	11	12	13
A1	A2	A2	A2	A3	A3	A3	A3	A3	A4	A4	A4	A4

Fig 1. Processes Gantt Chart

a) Average Max Round Robin (AMRR) Algorithm

First we arrange it in ascending order. Four processes that is the same as before. But A3 and A4 are swabbed to be in ascending order.

Tabel 2. Process with ascending order

Process	Burst Time
A1	1
A2	3
A4	4
A3	5

We do not know yet how big the time quantum, because the quantum should be calculated first. The total of burst time is 13. Then we get its average which is 3.25. Then we calculated the quantum based on this formula (Ali et al., 2021) (Sakshi et al., 2022):

Quantum = (Average + Maximum Burst Time)/2

So the quantum for the first iteration is (3.25+5)/2, which is 4.125. It is rounded down to be 4. This is the the first iteration. For the second iteration, the process of A3 is left alone. So there is no calculation. It is executed afterwards. Here is the Gantt Chart of this processes, below.

1	2	3	4	5	6	7	8	9	10	11	12	13
A1	A2	A2	A2	A4	A4	A4	A4	A3	A3	A3	A3	A3

Fig 2. Process Gantt Chart of AMRR

RESULTS

Below are several reviews of these algorithms in case 1 and case 2 to analyze average max round robin (AMRR) and improved round robin algorithms. Each with a comparative study.

Case 1

Please take a look on table 3. Below: We have four processes with arrival times and burst times.

Table 3. Process burst time with arrival time

Process	Arrival Time	Burst Time
A1	0	12
A2	0	7
A3	0	10
A4	0	4

a) Analysis of Improved Round Robin Algorithm
Let say we use a quantum equal to 10

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	A2	A2	A3

21	22	23	24	25	26	27	28	29	30	31	32	33
A3	A3	A3	A3	A3	A3	A3	A3	A3	A4	A4	A4	A4

Fig 3. Gantt Chart of first comparative study

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 4, October 2024
DOI : https://doi.org/10.33395/sinkron.v8i4.13563
e-ISSN : 2541-2019
p-ISSN : 2541-044X

To calculate turnaround time, please take a look at the Table 3. below. The table must be populated first.

Table 4. Calculation of Turnaround Time and Waiting Time

Process	Arrival Time	Burst time	Start Time	Finish Time	Turn Around Time	Waiting Time
A1	0	12	0	12	12	0
A2	0	7	12	19	19	12
A3	0	10	19	29	29	19
44	0	4	29	33	33	29
Total		33			93	60

So that, it is concluded that we get average turn around time: 93/4=23.25 ms and the average waiting time is 60/4=15 ms.

Analysis of Average Max Round Robin (AMRR) Algorithm

First we arrange it in ascending order. Again, here, we must calculate the quantum because in AMRR the quantum is dynamic depends on the situation of the process for each iteration.

Table 5. Calculation of Turnaround Time and Waiting Time

Process	Arrival Time	Burst Time
A4	0	4
A2	0	7
A3	0	10
A1	0	12

First we calculate the average of all burst time. Which is 33/4=8.25 ms. Then we added the maximum burst time which is 12 to be (8.25+12)/2 = 10.125. Then we rounded it down to be 10. It is concluded that the quantum is 10 for the first iteration. In the second iteration, it is only left in the process A1, which is 2 ms of burst time. Then, there is no calculation of quantum for the second iteration.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A4	A4	A4	A4	A2	A2	A2	A2	A2	A2	A2	A3	A3	A3	A3	A3	A3	A3	A3	A3

21	22	23	24	25	26	27	28	29	30	31	32	33
A3	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1

Fig 4. Gantt Chart

So, it is concluded for average turnaround time is 69/4= 17.25 ms and average waiting time is 36/4=9 ms.

Table 6. Calculation of Turnaround Time and Waiting Time

Process	Arrival Time	Burst Time	Start Time	Finish Time	Turnaround Time	Waiting Time
A4	0	4	0	4	4	0
A2	0	7	4	11	11	4
A3	0	10	11	21	21	11
A1	0	12	21	33	33	21
Total		33			69	36

Case 2

Please take a look to table 7 below: Again, we have four processes, each with arrival times and burst times.

Table 7. Process burst time and arrival time

Process	Arrival Time	Burst Time
A1	0	3
A2	0	3
A3	0	4
A4	0	6

*name of corresponding author

SinkrOn
JURNAL & PENELITIAN TEKNIK INFORMATIKA
Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 4, October 2024
DOI : https://doi.org/10.33395/sinkron.v8i4.13563
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Analysis of Improved Round Robin Algorithm
Let say we use quantum equal to 5

Please take a look at figure 5 below. Since the quantum is 5 and the burst time of A1 is 3, then A1 is executed until finish. The same thing happens with A2 and A4. Since for A2 the burst time is only 3, and for A4 the burst time is 4. For the last process, A4, It is executed until finish in two iterations. First until 15 ms, and left 1, it is continue tobe executed until 16.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A1	A1	A1	A2	A2	A2	A3	A3	A3	A3	A4	A4	A4	A4	A4	A4

Fig 5. Gantt chart of case 2

To calculate the turnaround time and waiting time, please take a look at table 8 below: We have the total turnaround time is 35 and the total waiting time is 19. Since we have four processes, it is divided by 4 each. So that, we get average turnaround time is 35/4=8.75 and average waiting time is 19/4=4.75 ms. As per the table 8 below.

Table 8. Calculation of Turnaround Time and Waiting Time

Process	Arrival Time	Burst Time	Start Time	Finish Time	Turnaround Time	Waiting Time
A1	0	3	0	3	3	0
A2	0	3	3	6	6	3
A3	0	4	6	10	10	6
A4	0	6	10	16	16	10
Total		16			35	19

Analysis of Average Max Round Robin (AMRR) Algorithm

First, we have arrange the process in ascending order. Since it is already in ascending order we do not have to do it. Please take a look at figure 6 below. For the first iteration, we have to calculate the quantum for the processes. We have four processes with burst time 3, 3, 4, and 6. Then the total of processes's burst time is 16. Then the average is 16/4=4. Then the result of this calculation 4 is added to the biggest process 6. Then we have to divide (4+6)/2=5. Then it is concluded that the quantum is 5.

Please take a look at the gantt chart below, at figure 6. Since the quantum is 5, then A1, A2 and A3 will be executed in a row until it is finish. Then the last burst time, A4 which have burst time 6 will the executed the last time. It is executed until 15. Then since A4 left only 1, there is no calculation of quantum the the second iteration. A4 is executed until 16.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A1	A1	A1	A2	A2	A2	A3	A3	A3	A3	A4	A4	A4	A4	A4	A4

Fig 6. Gantt chart of case 2

For the calculation of average turnaround time and average waiting time, since the Gantt chart of this AMRR algorithm is the same with an improved round-robin algorithm, then the same calculation exists, as per the table below. It is concluded that the average waiting time and the average turnaround time of this case 2 analysis give the same result. Please take a look at Table 9 below:

Table 9. Calculation of Turnaround Time and Waiting Time

Process	Arrival Time	Burst Time	Start Time	Finish Time	Turnaround Time	Waiting Time
A1	0	3	0	3	3	0
A2	0	3	3	6	6	3
A3	0	4	6	10	10	6
A4	0	6	10	16	16	10
Total		16			35	19

To calculate the turnaround time and waiting time, please take a look at table 9 above. This table is the same as the previous table in improved round robin algorithm. We have the total turnaround time is 35 and the total

*name of corresponding author

waiting time is 19. Since we have four processes, it is divided by 4 each. So that, we get average turnaround time is 35/4=8.75 and average waiting time is 19/4=4.75 ms. As per the table 9 above.

DISCUSSION

For AMRR algorithm, there is no second iteration to find the new quantum in both case 1 and case 2, which is should be dynamic, because its already finish, so there is no calculation for the second iteration. For the first iteration, the quantum is 10. The total burst time is 33. However, the turnaround time is 17.25 ms which is lower than the improved round robin. Also, for the average waiting time, it is 9 ms, which is also lower than the improved round robin algorithm.

The table comparison between these algorithms is below, in Table 10. Please take a look on table 10 below. For improved round robin, there is no calculation for the second iteration. For the quantum, it is already stated before which is 10, this is not based on the calculation since the quantum is predetermined. This quantum which is 10, is predetermined to be the same with the AMRR, so that the comparison will be balanced. The total burst time is 33. The average turnaround time is 23.25 and average waiting time is 15.

However in the case 2, we get exactly the same analysis for AMRR and improved round robin algorithm, and we get the same average turnaround time and average waiting time. The analysis table is exactly the same. The total burst time is 16. The average turnaround time is 8.75 and the average waiting time is 4.75. Also in this case 2, there is no second calculation for quantum in AMRR. For this case 2 we use quantum 5 for both algorithms.

Table 10. Comparison between AMRR and Improved Round Robin

Algorithm	Quantum Calculation for Second Iteration	Quantum (first iteration)	Total Burst Time	Average Turn Round Time	Average Waiting Time
Improved Round Robin	No	10	33	23.25	15
AMRR	No	10	33	17.25	9
Imrpoved Round Robin	No	5	16	8.75	4.75
AMRR	No	5	16	8.75	4.75

CONCLUSION

It is concluded that the average turnaround time and average waiting time of AMRR is better compared to improved round robin only in the case 1. In the case 1, the average turnaround time is 17.25 for AMRR compared to 23.25 ms. And the average turnaround time is 9 ms for AMRR compared to 15 in improved round robin. However, in the case 2, we get the same average turn around time and average waiting time 8.75 and 4.75. The analysis table is actually the same. Actually, the AMRR is an algorithm with dynamic quantum. Each iteration can have different quantum. But in these comparative study the calculation is only once, since all process is already finish by one iteration. In improved round robin, we use quantum 10 to make the comparison balance between the two in case 1. And in case 2 we use quantum 5.

For future works, may be comparison analysis with other variants of round robin algorithms can be done and analyze. Also, a new proposed novelty of the new variant round robin algorithm can be discussed.

REFERENCES

Abdelkader, A., Ghazy, N., Zaki, M. S., & ElDahshan, K. A. (2022). MMMRR: a Modified Median Mean Round Robin Algorithm for Task Scheduling. *International Journal of Intelligent Engineering and Systems*, *15*(6), 599–608. https://doi.org/10.22266/ijies2022.1231.53

Alhaidari, F., & Balharith, T. Z. (2021). Enhanced round-robin algorithm in the cloud computing environment for optimal task scheduling. *Computers*, *10*(5). https://doi.org/10.3390/computers10050063

Ali, S. M., Alshahrani, R. F., Hadadi, A. H., Alghamdi, T. A., Almuhsin, F. H., & El-Sharawy, E. E. (2021). A Review on the CPU Scheduling Algorithms: Comparative Study. *International Journal of Computer Science & Network Security*, *21*(1), 19–26. https://doi.org/10.22937/IJCSNS.2021.21.1.4

Fiad, A., Maaza, Z. M., & Bendoukha, H. (2020). Improved version of round robin scheduling algorithm based on analytic model. *International Journal of Networked and Distributed Computing*, *8*(4), 195–202. https://doi.org/10.2991/IJNDC.K.200804.001

Freire, D. L., Frantz, R. Z., Frantz, F. R., & Fernandes, V. B. (2022). New developments in round robin algorithms and their applications: a systematic mapping study. *International Journal of Business Process Integration and Management*, *11*(2), 90. https://doi.org/10.1504/ijbpim.2022.128704

Mostafa, S. M., & Amano, H. (2020). Dynamic round robin CPU scheduling algorithm based on K-means clustering technique. *Applied Sciences (Switzerland)*, *10*(15). https://doi.org/10.3390/app10155134

Neha, A. J. (2018). An Improved Round Robin CPU Scheduling Algorithm. *Iconic Research and Engineering*

Journal, *1*(9), 82–86.

Purnomo, R., & Putra, T. D. (2022a). Comparison Between Simple Round Robin and Improved Round Robin Algorithms. *JATISI (Jurnal Teknik Informatika Dan Sistem Informasi)*, *9*(3), 2205–2221. https://doi.org/10.35957/jatisi.v9i3.2547

Purnomo, R., & Putra, T. D. (2022b). *Simulation of Preemptive Shortest Job First Algorithm*. *11*(5), 1–11. https://doi.org/10.17148/IJARCCE.2022.11501

Putra, T. D. (2020). Analysis of Preemptive Shortest Job First (SJF) Algorithm in CPU Scheduling. *IJARCCE*, *9*(4), 41–45. https://doi.org/10.17148/ijarcce.2020.9408

Putra, T. D. (2022). Analysis of Priority Preemptive Scheduling Algorithm: Case Study. *Ijarcce*, *11*(1), 27–30. https://doi.org/10.17148/ijarcce.2022.11105

Putra, T. D., & Purnomo, R. (2021). Analisis Algoritma Round Robin pada Penjadwalan CPU. *Jurnal Ilmiah Teknologi Informasi Asia*, *15*(2), 85. https://doi.org/10.32815/jitika.v15i2.481

Putra, T. D., & Purnomo, R. (2022a). Case Study : Improved Round Robin Algorithm. *Sinkron : Jurnal Dan Penelitian Teknik Informatika*, *7*(3), 950–956.

Putra, T. D., & Purnomo, R. (2022b). Simulation of Priority Round Robin Scheduling Algorithm. *Sinkron*, *7*(4), 2170–2181. https://doi.org/10.33395/sinkron.v7i4.11665

Sakshi, Sharma, C., Sharma, S., Kautish, S., A. M. Alsallami, S., Khalil, E. M., & Wagdy Mohamed, A. (2022). A new median-average round Robin scheduling algorithm: An optimal approach for reducing turnaround and waiting time. *Alexandria Engineering Journal*, *61*(12), 10527–10538. https://doi.org/10.1016/j.aej.2022.04.006

Shafi, U., Shah, M., Wahid, A., Abbasi, K., Javaid, Q., Asghar, M., & Haider, M. (2020). A novel amended dynamic round robin scheduling algorithm for timeshared systems. *International Arab Journal of Information Technology*, *17*(1), 90–98. https://doi.org/10.34028/iajit/17/1/11

Simarmata, E. R., Lumbantoruan, G., Nainggolan, R., & Napitupulu, J. (2019). Round Robin Algorithm with Average Quantum Dynamic Time Based on Multicore Processor. *Journal of Physics: Conference Series*, *1361*(1). https://doi.org/10.1088/1742-6596/1361/1/012005

Tri Dharma Putra, A. F. (2021). Comparison Between Simple Round Robin and Intelligent Round Robin Algorithms in CPU Scheduling. *International Journal of Advanced Research in Computer and Communication Engineering*, *10*(4), 86–90.

*name of corresponding author