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Development of an Intelligent Traffic Management System Based on Modified Round-Robin Algorithm

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Abstract

Now a days, each and everything in our life demands the characteristic of being real time. Traffic control is a challenging issue in our daily life and it always requires to be modified to cope with real time demand. Ongoing systems have limitation because these have fixed time interval for providing signal as well as non-systematic way of signal time manipulation which does not provide the flexibility to readjust the system according to the changing situation. More over choice of an appropriate algorithm is not suitable always to control the system with variety of time. Considering these facts we have proposed a traffic management system with a modified process scheduling algorithm. For the betterment of traffic management, we actually proposed a modified round-robin algorithm in this paper. To verify it's appropriateness virtually, a simulation environment is developed in JAVA. We considered variety of input and calculated average waiting time, variance and standard deviation of waiting time as performance metric for selecting the most suitable scheduling algorithm. The performance of existing process scheduling algorithms and modified round-robin are evaluated and compared. Finally, the simulation results show that the proposed modified round-robin algorithm is better adaptable to design an intelligent traffic control system.

Keywords: *Scheduling Algorithm, Intelligent Traffic Signal Control*

1. Introduction

The populace and the quantity of autos or cars in metro-urban communities are expanding quickly. Subsequently, the metro activity is getting packed which prompts the congested driving conditions. To control such immense activity, improvement of a cutting edge insightful transportation framework is imperative. The intelligent traffic signal control (ITSC) is one of the significant segments of ITS. ITSC alludes to all innovations which could be utilized to produce activity signal mix to minimize the wastage of time (aggregate holding up time and normal holding up time). It is a hard issue in the setting of over populated nation to deal with the activity blockage at different convergence purposes of urban regions because of blunder and absence of legitimate methodical way. As an issue it makes overwhelming congested driving conditions and kills a lot of significant time. Besides, a typical stage for activity signal era is important to understand a clever transportation framework supporting safe driving, element course planning, crisis transporting, less wastage of time *etc.*, under common conditions, activity signs control principally has two deformities:

1). At the point when the traffic lane holds up until the green light, time setting is practically same and altered. The vehicles are continually moving in untidy. As a result the vehicles can't pass through in the time allowed.

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2). Emergency cars are not considered. Fire motors and ambulances have need over other movement. On account of the settled movement light control framework and absence of crisis measures, the junction or cross roads dependably meets an automobile overload.

The ITSC is aimed to make a system with the following characteristics:

- **Real-time Communication Platform**: The vehicles can be efficiently moved with small delay and high safety.
- **Road Utilization**: Conceptually, we want to ensure proper use of transportation system and maximum utilization of the resources.
- **Reduced Waiting Time:** The system affects to reduce the amount of time that a vehicle spends in the traffic queue.
- **Organized Transport System Platform:** The system can be enabled to control the whole transportation system at organized way.

In this paper, we present the implementation of a widely discussed the traffic signal combination control system by manipulating the traffic volume using sensor-network. The implementation based on traffic volumes that are manipulated using some process scheduling algorithms and proposed a modified process scheduling algorithm. This paper is organized in a way first it introduces the problem and present requirements. Then it described some related works and their limitations. Then we focused on methodology which introduces the system architecture and portrayed the whole system in a sequential manner. Experimental results were given for various environments to detect any flaws or to perceive the consistency of the system. Finally conclusions and possible future improvements are mentioned.

2. Background and Related Works

With expanding number of vehicles on street, overwhelming activity clogging has generously expanded in significant urban areas. This happened typically at the fundamental intersections regularly in the morning, before office hour and at night, after available time. The primary impact of this matter is expanded time squandering of the individuals out and about. The answer for this issue is by creating the system which distinctive setting postponements for diverse intersections. The deferral for intersections that have high volume of activity ought to be setting longer than the postponement for the intersection that has low of movement. This operation is called Normal Mode [1]. At specific junctions, frequently regardless of the possibility that there is no movement, individuals need to hold up. Since the activity or traffic light stays red for the preset time period, the street clients ought to hold up until the light turn to green. In the event that they run the red light, they need to pay fine. The arrangement of this issue is by creating a framework which discovers movement stream on every street and set timings of signs appropriately. Moreover, synchronization of traffic signals in adjacent junctions is also necessary [2]. The existing methods for traffic management and control are not efficient in the performance, cost, and the effort needed for maintenance and support. For example, The 2007 Urban Mobility Report estimates total annual cost of congestion for the 75 U.S. urban areas at 89.6 billion dollars, the value of 4.5 billion hours of delay and 6.9 billion gallons of excess fuel consumed. And the traffic engineering department in Jordan estimates that the total cost due to congestion in the year 2007 was around 150 million USDs [3]. So there is a need for efficient solutions to this critical and important problem. The main role of ITSCs is adjusting traffic signal durations according to traffic flows. ITSCs have been widely studied and several ITSCs have been proposed base on different technologies such as wireless sensor networks [4], fuzzy-neural techniques [5], agents [6], fuzzy-genetic algorithm [7], dynamic programming [8] and Petri-nets [9]. In the intelligent traffic light flow control system, the controllers on embodies traffic signal time manipulation on based of round-robin scheduling algorithm [10]. The intelligent traffic signal control (ITSC) system manipulate traffic signal time on based of some process scheduling algorithms as shortest-job first(SJF), priority scheduling and round-robin(RR). But the process scheduling algorithms have some limitations. SJF is used for long term scheduling. It can't be implemented at the level of short term CPU scheduling. There is no way to know the length next CPU burst. We just predict its value. Priority scheduling algorithm is indefinite blocking, or starvation. A priority scheduling algorithm can leave some low-priority processes waiting indefinitely. In a heavily loaded computer system, a steady stream of higher-priority processes can prevent a low-priority process from ever getting the CPU. The performance of round-robin (RR) algorithm depends on the size of the time quantum. If the time quantum is extremely large, the RR policy is the same as the FCFS (first-come-first-served) policy.

3. Motivation and Goals

Creating a genuine and time shearing traffic control framework is a yelling need. It ought to be such that it can deal with the movement/traffic stream adequately and in a methodical manner. Count of the traffic volume and giving movement sign as indicated by the activity/traffic volume must be incorporated. So, we proposed a modified round-robin scheduling algorithm to develop a better ITSC system. Our goal is to reduce the average waiting time of vehicles at traffic congestion point. We focused on managing the traffic control system minimizing the total and average waiting time. A simulation tool was used to analyze cross road traffic.

4. Methodology

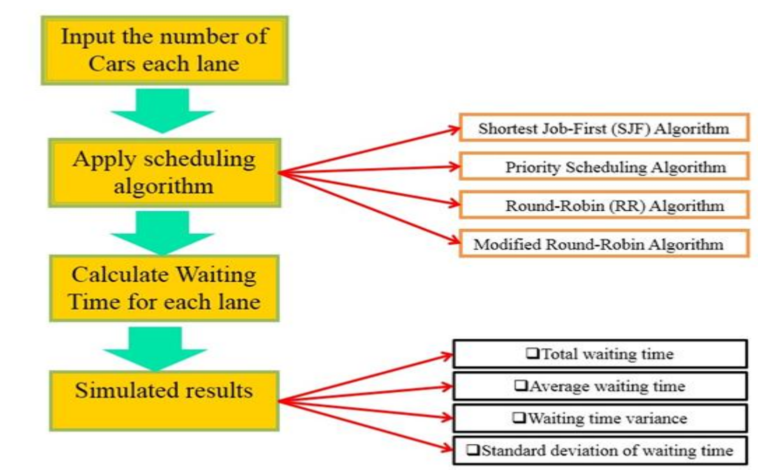

Figure 1. System Architecture of ITSCS

Our system is divided into several steps of processing. The whole architecture of the developed system is given in Figure 1.

4.1 Inputs from Sensor Networks

The sensor system innovations are utilized to locate the quantity of autos in the each one line of the movement convergence point. Sensors focused around video image processing, microwave radar, laser radar, detached infrared, ultrasound, passive acoustic, magnetometer, and inductive-circle are utilized to this reasons. But in respect of country, a sensor for counting traffic is not available. The traffic system is controlling here in manually. So, there is no sensor network to collect the traffic information. In this project we have given the number of cars as input for simulating in manually. For example, the input numbers of cars are given for simulating the process scheduling algorithm shown in Figure 2:

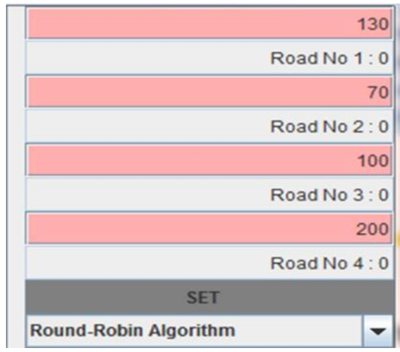

Figure 2. Input of Cars number

In Figure 2, the numbers of cars are given as input. The road number 1, 2, 3 and 4 contain the number of cars 462, 123, 754 and 90 as input. Then the input cars are loaded into the queues and the traffic signal duration are calculated by process scheduling algorithms. We used mainly three process scheduling algorithms as the shortest job-first (SJF), Priority scheduling and round-robin (RR) and we also proposed the modified round-robin algorithm that is better to develop an intelligent traffic control (ITSC) system.

4.2 Initialize the Cars into the Queues

After taking input, the framework introduces the autos through the lines for recreation. It is unrealistic to see all autos immediately through the lines in the created framework. Along these lines, at most the quantities of twenty-seven autos/cars are indicated in lines at once and whatever is left of the autos are out of lines. The numbers of remaining cars are also showing in the roads. The cars initialization is shown in Figure 3. Some cars are initialized through the queues and the remaining numbers of cars are shown at the text fields.

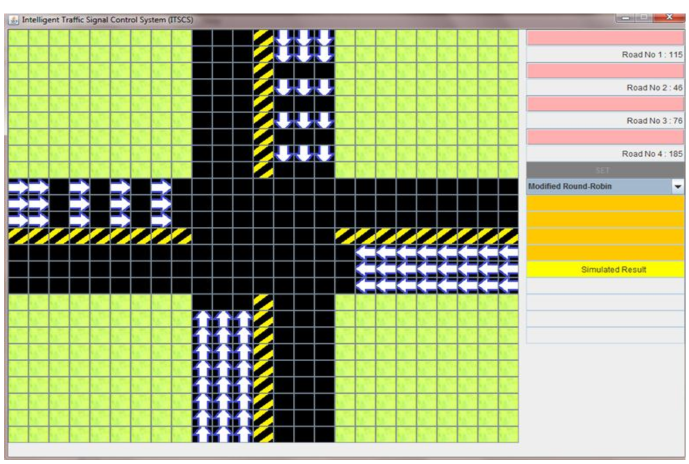

Figure 3. Initialization of Cars in Queues

4.3 Algorithms Selection:

The next step of the developed system is algorithm selection. We use the process scheduling algorithms to manipulate traffic signal duration for the cars of queues. Actually, the process scheduling algorithms are used for CPU scheduling. But in this ITSC system, we use basic three scheduling algorithm like as the shortest job-first (SJF), priority scheduling and round-robin (RR). The SJF and priority scheduling algorithm are non-time shearing process scheduling algorithm. But the round-robin and modified round-robin algorithm are time shearing process scheduling algorithm. The algorithms are detailed in below and we will also made discussion with pseudo code between Round Robin and the proposed modified Round Robin algorithm.

4.3.1 Shortest Job-First (SJF) Algorithm

The SJF scheduling algorithm is provably optimal, in that it gives the minimum average waiting time for a given set of processes. Moving a short process before long one decrease the waiting time of the short process more than it increases the waiting time of the long process. Consequently, the average waiting time decreases. We know that the traffic control system is a real life time shearing system. Although, we have used the SJF algorithm to design and simulate the traffic control system. But the SJF is a non-time shearing algorithm. So, it is not suitable to implement a real life time shearing traffic control system. Actually, we compared the performance of SJF algorithm with others algorithms.

4.3.2 Priority Scheduling Algorithm

The SJF calculation is a unique instance of the general priority scheduling calculation. A priority is connected with each one methodology/process, and the CPU is allocated to the process with the highest priority. Really the priority scheduling algorithm is the reverse order of SJF calculation. In our work, the most astounding need means the path which contains more number of autos/cars.We know that the traffic control system is a real life time shearing system. Although,We have also used the priority algorithm to design and simulate the traffic control system. But the priority is also a non-time shearing algorithm. So, it is not suitable to implement a real life time shearing traffic control system. Actually, we compared the performance of this algorithm with others algorithms.

4.3.3 Round-Robin (RR) Algorithm

The round-robin (RR) scheduling algorithm is designed especially for timesharing systems. It is similar to FCFS scheduling, but preemption is added to enable the system to switch between processes. A small unit of time, called a time quantum or time slice, is defined. A time quantum is generally from 10 to 100 milliseconds in length. But in this paper, we set the time quantum as the average value of the total number of cars.

Pseudo Code of Round-Robin Scheduling Algorithm:

1. Input the number of cars and initialize the queues.
2. Select the round-robin algorithm.
3. Calculate the time quantum as k.
4. Select any lane from the inputs randomly.
    - i. Allocate one quantum k if the number of lane cars >=k.
    - ii. Else allocate the number of lane cars.
    - iii. Calculate the lane waiting time

5. Continue the step 4 until finish the inputs.
6. Calculate the total waiting time, average waiting time, variance waiting time and standard deviation.
7. We know that the traffic control system is a real life time shearing system. Although,

We have used the round-robin algorithm to design and simulate the traffic control system. Because of the round-robin is a time shearing algorithm. So, it is suitable to design and implement a real life time shearing traffic control system. Actually, we compared the performance of this algorithm and also proposed the modified round-robin algorithm for better performance.

4.3.4 Modified Round-Robin (MRR) Algorithm

The Modified round-robin (MRR) scheduling algorithm is same as Round-Robin algorithm to design especially for timesharing systems. But this algorithm differs from simple round-robin algorithm within contains extra some features.

- ❑ The time quantum is allocating in ascending order of processes time.
- ❑ After completing the first cycle, double the initial time quantum.

<u>Pseudo Code of Modified Round-Robin Algorithm:</u>

Phase 1:

i. Input the number of cars and initialize the queues.
ii. Select the round-robin algorithm.
iii. Calculate the time quantum as k.

Phase 2: Allocate every process in ascending order, a single time by applying RR scheduling with an initial time quantum k.

Phase 3: After completing first cycle perform the following steps:

i. Double the initial time quantum (K=2*k).
ii. Select every remaining process in ascending order for new time quantum K and calculate the waiting time.

Phase 4: Repeat the phase 3 cycles until complete execution of all processes.

Phase 5: Calculate the total waiting time, average waiting time, variance waiting time and standard deviation.

As the modified round-robin algorithm is a time shearing algorithm, so it is more suitable for designing and implementing the traffic control system. Actually, the performance of modified round-robin algorithm is better than the simple round-robin.

5. Experimental Results

The system was tested in a lots of sample input sets. The algorithms manipulated the sample data and provided output as the total waiting value, average waiting value, waiting value variance and the standard derivation of waiting value. In table 1 waiting time output for four algorithms are shown.

Table 1. Number of Cars and Total Waiting Time Value for Four Algorithms

Road No	Number of Cars	Shortest Job-First minute	Priority Scheduling minute	Round-Robin minute	Modified Round-Robin minute
1	130	7.68	8.4	16.44	13.08
2	70	0	18.48	10.8	0
3	100	3.24	14.04	14.04	3.24
4	200	13.32	0	13.08	13.68

The Figure 4 shows the number of cars vs. average waiting time for round-robin and modified RR algorithm in below.

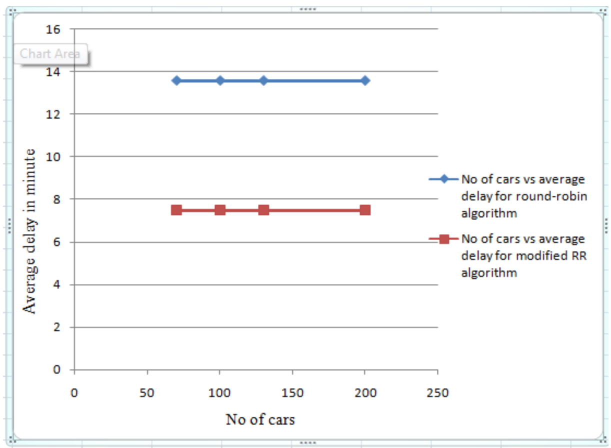

Figure 4. No. of Cars VS Average Waiting Time for Round-Robin and Modified Round Robin Algorithm

We can notice that the average waiting time of modified RR algorithm is better than the average waiting time of round-robin algorithm. Actually, the performance of modified RR is more efficient than the performance of simple round-robin algorithm.

And finally the Figure-5 shows the comparison with the number of cars vs. total waiting time among SJF, priority, round-robin and modified round-robin scheduling algorithm.

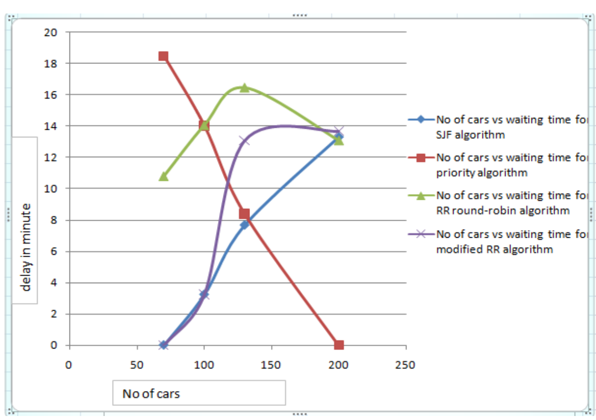

Figure 5. Comparison with the Number of Cars vs Total Waiting Value among the SJF, Priority Round-robin and Modified Round-robin Algorithm

From the Figure 5, we can notice that the increasing of total waiting time with respect to increase of the number of cars is better for modified round-robin than the simple round-robin algorithm. So the performance of modified round-robin algorithm is more efficient than the performance of simple round-robin algorithm. So we can use the modified RR algorithm to develop an intelligent traffic control (ITSC) system. Actually, the traffic control system is a time shearing system and modified RR algorithm is also a time shearing scheduling algorithm. So considering the performance and time shearing property, the modified RR algorithm is more efficient for designing the real time ITSC system. Now here is given some more simulated results manipulating by process scheduling algorithms of shortest job-first (SJF), priority scheduling, round-robin (RR) and modified round-robin (MRR) in Table 2.

Table 2. Sample Input and Simulated Results for Algorithms

Algorithm Name	Total Number of Cars	Total Waiting time (minute)	Average Waiting Time(minute)	Variance Waiting Time(minute)	Standard Deviation of Waiting Time(minute)
SJF Algorithm	50	4.8	1.2	0.89	0.94
Priority Scheduling	50	6	1.5	1.16	1.07
Round-Robin	50	9.6	2.4	.22	0.47
Modified Round-Robin	50	6	1.5	1.39	1.18
SJF Algorithm	200	8.76	2.19	4.63	2.15
Priority Scheduling	200	20.04	5.01	11.4	3.38
Round-Robin	200	19.8	4.95	2.00	1.7
Modified Round-Robin	200	11.64	2.91	6.55	2.56
SJF Algorithm	500	24.24	6.06	25.00	5.00
Priority Scheduling	500	40.92	10.23	47.65	6.9
Round-Robin	500	54.36	13.59	4.09	2.02
Modified Round-Robin	500	30.0	7.5	35.93	5.99
SJF Algorithm	700	34.44	8.61	52.12	7.22
Priority Scheduling	700	54.48	13.62	89.24	9.45
Round-Robin	700	59.88	14.97	32.74	5.72
Modified Round-Robin	700	42.36	10.59	72.78	8.53
SJF Algorithm	1000	38.88	9.72	86.02	9.27
Priority Scheduling	1000	86.04	21.51	208.75	14.45
Round-Robin	1000	91.8	22.95	61.76	7.86
Modified Round-Robin	1000	49.8	12.45	119.32	10.92

Now the Figure 6 shows the results comparison with total number of cars vs. total waiting time among the SJF, priority scheduling, round-robin and modified round-robin algorithm.

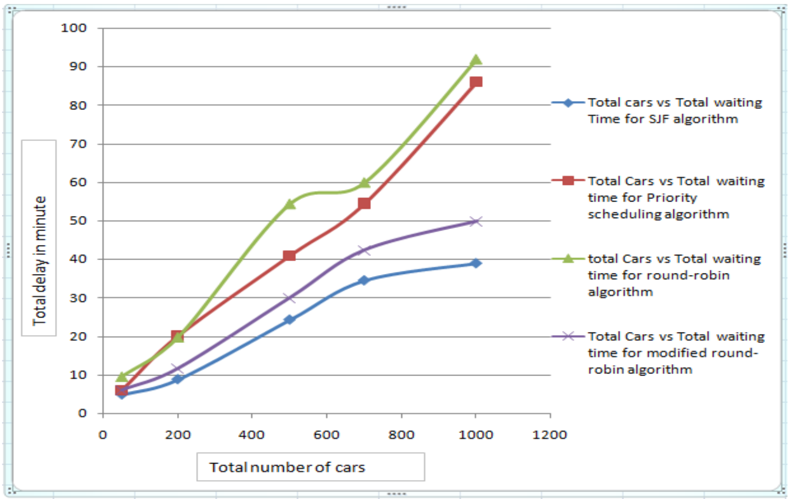

Figure 6. Results Comparison with Total Number of Cars Vs Total Waiting Time for SJF, Priority, RR and MRR Algorithm

From the Figure 6, we can say that the largest waiting time for round-robin and priority scheduling algorithm. But the waiting time of modified round-robin is relatively near to the waiting time of SJF algorithm. The Figure 7 shows the results comparison with total number of cars vs. average waiting time among the SJF, priority scheduling, round-robin and modified round-robin algorithm.

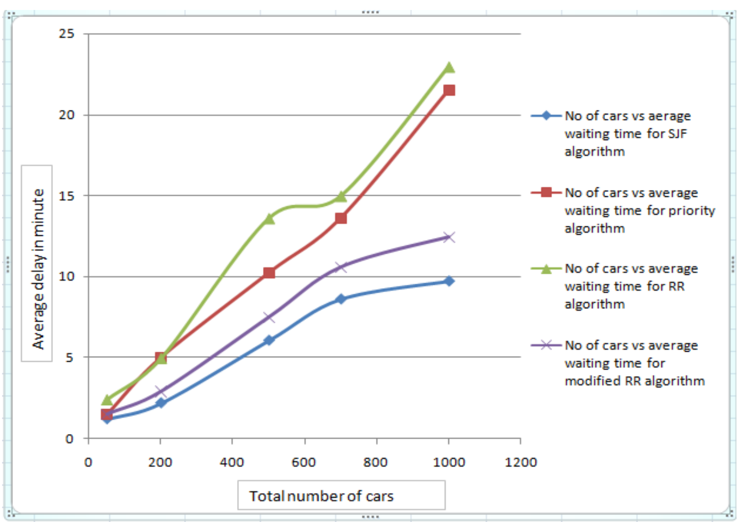

Figure-7: Results Comparison with Total Number of Cars Vs Average Waiting Value for SJF, Priority, RR and MRR Algorithm

From the Figure 7, we can say that the largest average waiting value for round-robin and priority scheduling algorithm. But the average waiting value of modified round-robin is relatively near to the average waiting value of SJF algorithm. The Figure 8 shows the results comparison with total number of cars vs. variance of waiting value among the SJF, priority scheduling, round-robin and modified round-robin algorithm.

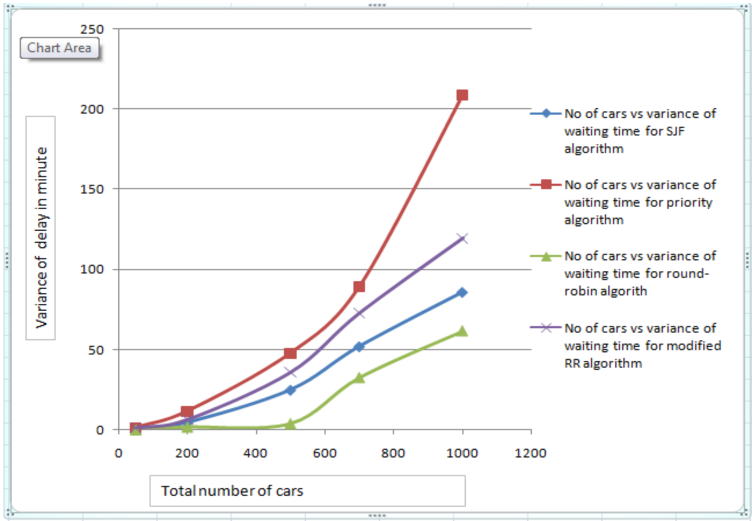

Figure 8. Results Comparison with Total Number of Cars Vs Variance of Waiting Value for SJF, Priority, RR and MRR Algorithm

The Figure 8 shows the results comparison with total number of cars vs. variance of waiting value among the SJF, priority scheduling, round-robin and modified round-robin algorithm. This graph is showing that the variance waiting time of round-robin algorithm is better than any other algorithms. The variance waiting time of priority algorithm is larger than others. And the variance waiting time of SJF algorithm is better than modified RR and priority algorithm.

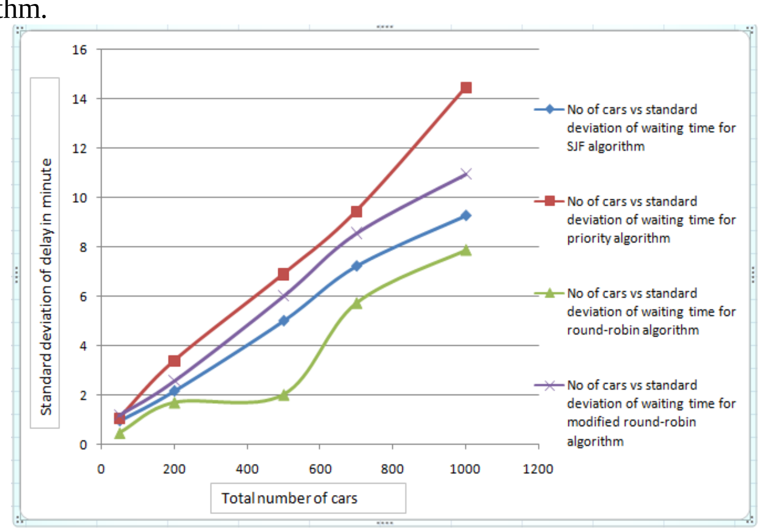

Figure 9. Results Comparison with Total Number of Cars vs Standard Deviation of Waiting Value for SJF, Priority, RR and MRR Algorithm

From the Figure 9, we can observe that the relation between average waiting value and standard deviation is inverse which the average waiting time is high; the standard derivation of waiting time is low and vice verse. Actually the total and average waiting time of round-robin algorithm is larger than any others algorithm. But the variance and standard deviation of waiting time of round-robin algorithm is smaller than others algorithm.

So, we can say that as the traffic system is a time shearing system, the SJF and priority algorithm are not suitable to implement this system. In this case, we can apply the round-robin algorithm to develop the ITSC system. But the modified round-robin algorithm is better adaptable to design the ITSC system. Because the performance of modified round-robin algorithm is better than simple round-robin algorithm.

6. Conclusion and Future Improvements

In this paper, we estimated the number of cars in lane and applied the process scheduling algorithms. However the input number of autos would be controlled from the sensor network that is not accessible in setting of our nation. So we displayed our mimicked result. At the point when one crisis auto or rescue vehicle will come then the framework might likewise not have the capacity to deal with the circumstances? The ITSC framework may be fizzled if any mischance is happened in the movement/traffic control point. In future work, we will utilize the altered round-robin calculation to outline constant movement control framework. We will also design an ITSC system in considering the emergency and road accident events. It can also be implemented more real life time-sharing systems using modified RR algorithm with improving time quantum value.

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