Assessment of Disk scheduling policies with fuzzy Rotational delay in Real world Environment

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ABSTRACT-Various disk scheduling policies such as FCFS,SSTF,CSCAN,SCAN,C-LOOK etc are already available in the literature with objective to minimize the seek time of the disk. In this paper we have made an attempt to make performance analysis & efficiency to these scheduling policies along with the our new proposed algorithm in context of the criteria such as average seek time, Transfer time, Rotational delay, Disk access time,Average Disk access time etc. The rotational delay has been considered under fuzzy environment. The fuzzy surface view for rotational delay v/s Disk access time have been presented through Bar diagram. The paper covers a wide range of study. Hence it is more relevant ,significant & applicable.

KEYWORDS- Seektime, Rotational Delay, Transfer time,Disk access time, Fuzzy inference rules, Average Disk access time.

1) INTRODUCTION-Disk scheduling algorithms have been studied for the past 30 years in order to improve the efficiency & performance of disk access time. These algorithms utilize a stream of operational requests as input& arrange them as output. Many algorithms propose to achieve better performance & efficiency to utilize disk interval state information which we briefly presented in our paper. Most real time systems control unpredictable environments & may need operating systems that can handle unknown & changing task population.

In this light, not only dynamic task scheduling is required but also systems Hardware& Software must adopt to enforcing configuration. In a multiprogramming environment with many processes to provide control & uniform memory access to each process, the concept of disk scheduling is used. A disk drive consists of a number of platters. Each platter has two surfaces. Each surface of a platter is made up of concentric circles called tracks. Even a single surface contains thousands of tracks. Given a queue of disk access requests to service a request, first the disk arm head is moved to the desired track called seek distance then the disk rotates to the desired sector until it isunder read or write head. Disk time taken the location in the rotation is called rotational delay. In this paper, we are extending the research in the field of disk scheduling using fuzzy logic. Fuzzy logic deals with uncertainty with impreciseness and ambiguity associated with the information in a better way. We have considered rotational delay in fuzzy environment.

Following the introductory part the rest of the paper is organised as: Section 2 throws light on literature survey of related work. Section 3describes problem formulation and disk scheduling algorithm using fuzzy logic. Research methodology and formulae used are discussed in section-4.Section-5 contain proposed framework and calculation thereof. Results are evaluated and compared with Disk scheduling algorithm based on fuzzy logic in section-6. Finally section-7 includes conclusion of the research done.

2) LITERATURE SURVEY- A lots of research work has been performed in disk scheduling and its applications based in fuzzy logic. The earlier work was based on command selection strategies such as

FCFS, SSTF, SCAN. Edward goffman &Hofri(1982),Denning (1967),Gotliez&macewen (1972) &MichaHofri (1980), Grey (1975) etc.

The SSTF Approach reduces the average response time compared to FCFS over a wide range of work load. The SCAN policies including LOOK & C-SCAN lower the variance in the response time. Recently Worthingun et.al combined LOOK & C-SCAN and obtained excellent performance for current disk drive. Burkhard and palmer [2002] presented simulation results & obtained rotation position optimization Disk scheduling algorithms.

Mohd.Talib [2009] gave a new way to disk scheduling using concept of fuzzy logic & fuzzy inference system. He applied the fuzzy logic into two categories. The servo controller that controls the arm head or movable disk & disk scheduling policy. Rituaggarwal et.al[2013] described a vague set based controller power system stablizer. PriyaHooda&Supriya designed a different approach by developing an FIS based on two inputs seek distance & Rotational delay. Again Priya&supriya[2014],proposed a new disk scheduling algorithm based on vague logic.

Recently sachin , silky & Singh T.P [2014] made a performance analysis of C-LOOK, disk scheduling algorithm considering Rotational Delay in fuzzy environment. In this paper we have extended the work of Sachin et.al [2014] &Priya et.al [2013].

3. PROBLEM FORMULATION- Considering 8 track request on a disk generated randomly through a program in C. Our objective is to apply different scheduling policies in to calculate disk access time while the rotational delay has been assume fuzzy nature due to variation in distance per no. of tracks. The Revolutions per minute of our **WDC WD5000LPVX-75 V0TT0 ATA Device** is 5400 RPM. Here Rotational delay can be calculated from two ways.

A) Fuzzy Triangular Arithmetic:- If Fuzzy set Ă=(a,b,c) then Yager's New defuzzification Formula is approximated as**(a+2b+c) / 4**

5400 RPM (REVOLUTIONS PER MINUTE)		
5400rpm / 30sec=180 rotations **1sec=180 rotations** **1/180=0.005555sec/per rotation** **5.5 m sec**	**5400rpm / 45sec=120 rotations** **1sec=120 rotations** **1/120=0.00833sec/per rotation** **8.33 m sec**	**5400rpm / 60sec=90 rotations** **1sec=90 rotations** **1/90=0.01111sec/per rotation** **11.11 m sec**

Rotational Delay of our disk in Triangular arithmetic formis calculated in fuzzy numbers**(5.5 msec,8.3 msec,11.11 msec)**. These fuzzy values can also be expressed in Linguistic form as **LOW, AVG,HIGH**.

B) FuzzyTrapezoidal Arithmetic:- If Fuzzy set Ă=(a,b,c,d) then Chen's defuzzification Formula on the basis of functional principle is approximated as **(a+2b+2c+d) / 6**

5400 RPM (REVOLUTIONS PER MINUTE)			
5400rpm / 15sec=360 rotations **1sec=360 rotations** **1/360=0.0027777sec/per rotation** **2.7 m sec**	**5400rpm / 30sec=180 rotations** **1sec=180 rotations** **1/180=0.005555sec/per rotation** **5.5 m sec**	**5400rpm / 45sec=120 rotations** **1sec=120 rotations** **1/120=0.00833sec/per rotation** **8.33 m sec**	**5400rpm / 60sec=90 rotations** **1sec=90 rotations** **1/90=0.01111sec/per rotation** **11.11 m sec**

Rotational Delay of our disk in trapezoidal arithmetic form is calculated in fuzzy numbers**(2.7 msec, 5.5 msec, 8.3 msec, 11.11 msec)**. These fuzzy values can be expressed in Linguistic form as **LOW, AVG, MORE THAN AVG,HIGH**.

4. METHODOLOGY ADOPTED -The specification of our disk are as follows.

PARAMETERS	SPECIFICATIONS
Model	**WDC WD 5000 LPVX-75V0TT0 -ATA DEVICE**
Size of Disk	**465.76GB (500,105,249,280 bytes)**
Rotations Per minute	**5400**
Sectors Per Track	**63**
Bytes Per Sector	**512**
Total Cylinders	**60801**
Total Sectors	**976768065**
Total Tracks	**15504255**
Track/cylinder	**255**
Number of Track Request	**8**
List of Requests	**{16, 75, 24, 21, 30, 80, 116, 63 }**
Initial Head Position	**66**
Data Transfer Rate	**147MB/s**
Data to be transferred	**20 MB**

FORMULAE USED-

1) TOTAL SEEK TIME= $\sum_{i=1}^{n}$ **Seek Time(i)**

2) DATA TRANSFER RATE= $\frac{((RPM/60) \times Sectors\ Per\ Track \times Bytes\ Per\ Sector) \times 8}{10^6}$

3) TRANSFER TIME= $\frac{Total\ amount\ of\ data\ to\ be\ transferred}{Data\ Transfer\ Rate}$

4) DISK ACCESS TIME= Seek Time+ Rotational Delay+ Transfer Time

5) AVERAGE SEEK TIME= $\frac{Seek\ Time}{No.\ of\ Track\ Request}$

6) AVERAGE DISK ACCESS TIME=Average Seek Time + Average Rotational Delay +Transfer Time+ Controller Overhead + Queuing Delay

7) DISK LATENCY= Seek Time+ Rotation Time+ Transfer Time+ Controller Overhead

8) NUMBER OF SECTOR PER TRACK=Number of Sector /Number of Tracks per cylinder per cylinder

9) HEAD=Tracks/ Cylinder

10) TOTAL TRACKS=Head/ Cylinder

4.1 CALCULATION OF NUMBER OF SECTOR PER TRACK, HEAD TOTAL TRACKS-

1) NUMBER OF SECTOR PER TRACK= (976768065/60801) / (15504255/60801)
16065 / 255=63

2) TRACKS/CYLINDER (HEAD)=15504255 / 60801=255

3) TOTAL TRACKS=255×60801=15504255

In this Paper, we are applying all the above said formulae to various algorithms considering Rotational Delay in fuzzy. After calculating these we get different results and Seek Time is calculated in our previous Research Paper. So here we are taking the same Track Requests & Seek Time to calculate the Disk access Time. So below we are showing that how it could be calculated and how the results are different in each algorithm.

5. **CALCULATION OF TRANSFER TIME, ROTATIONAL DELAY IN FUZZY-**

5.1 TRANSFER TIME=$\frac{20 \times 10^6 \times 8}{147 \times 10^6 \times 8} = \frac{20}{147}$ = 0.136 sec = 136.05 msec

After calculating the seek time and transfer time according to the above mentioned mechanisms, rotational delay is then defuzzified using triangular & trapezoidal membership function.

5.2 ROTATIONAL DELAY IN TRIANGULAR FUNCTION

ROTATIONAL DELAY			DEFUZZIFIED VALUE OF ROTATIONAL DELAY (msec)
<a	b	c>	
5.5	8.3	11.11	**8.3025 msec**

Yager's New Formula

(a+2b+c) / 4 = (5.5+2×8.3+11.11) / 4 = 33.21 / 4 = 8.3025 m sec

5.3 ROTATIONAL DELAY IN TRAPEZOIDAL FUNCTION

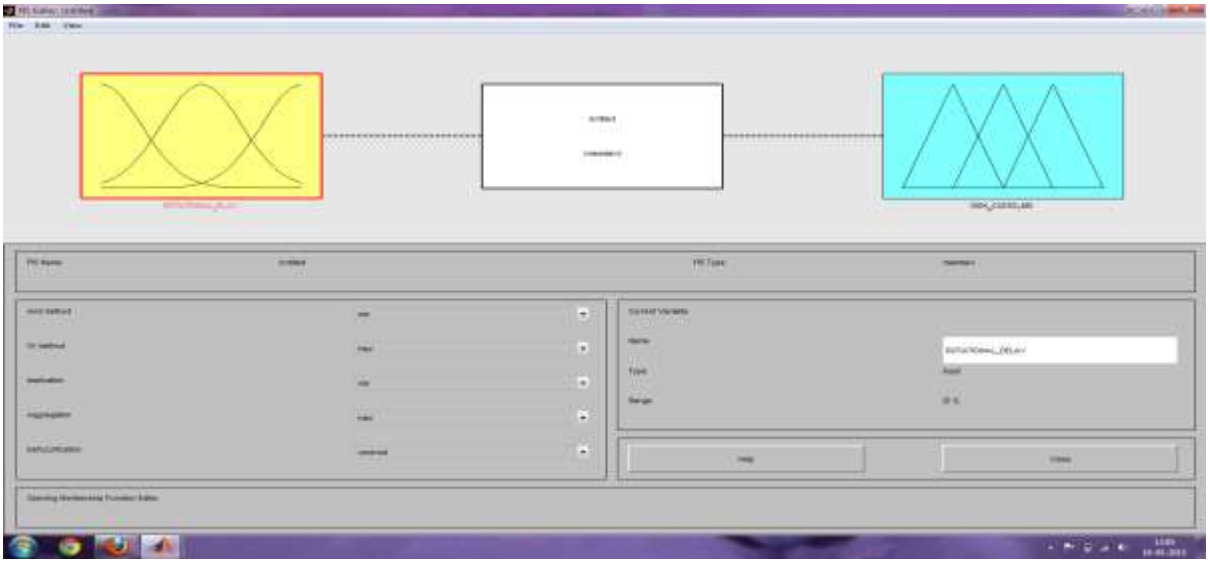
ROTATIONAL DELAY			DEFUZZIFIED VALUE OF ROTATIONAL DELAY (m sec)
<a	b	cd>	
2.7 5.58.311.11			**6.90 m sec**

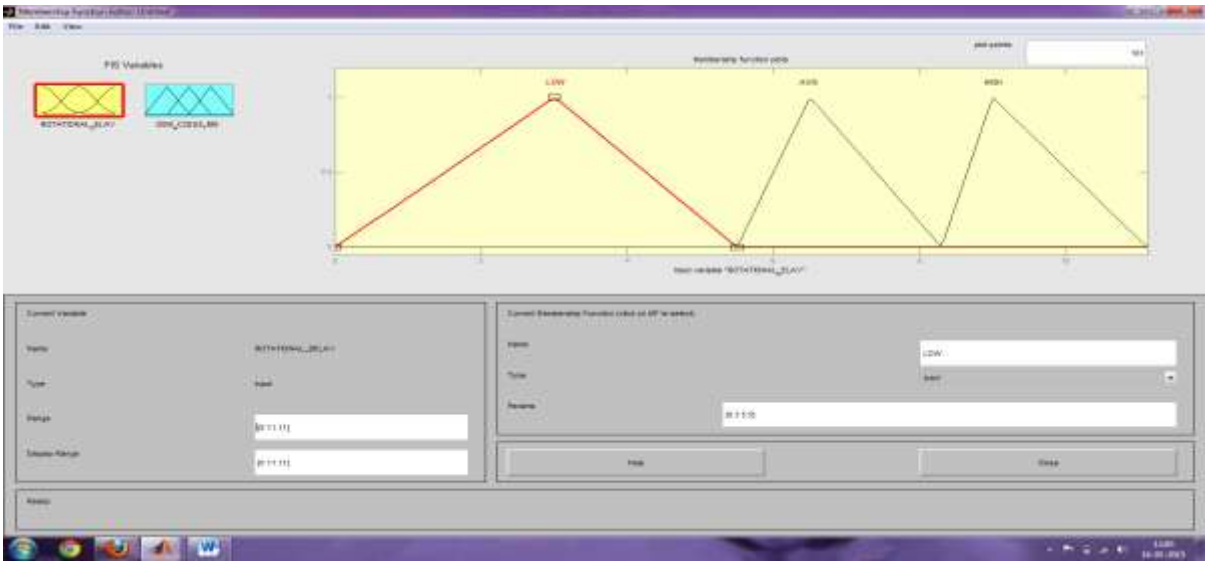
Yager's New Formula

(a+2b+2c+d) / 6= (2.7+2×5.5+2×8.3+11.11) / 6= 41.41 / 6 =6.90 m sec

In our work we have designed the Mamdani type fuzzy inference system named “Disk Scheduling” using the Matlab Fuzzy Tool Box as shown in following diagram.Following figures depict the fuzzy design between Rotational Delay and Disk Access Time whereas Rotational Delay is an Input parameter while Disk Access Time is output parameter. The Fuzzy Inference Rules have been designed to show the direct relationship between these two parameters. These diagrams are common in all algorithms.

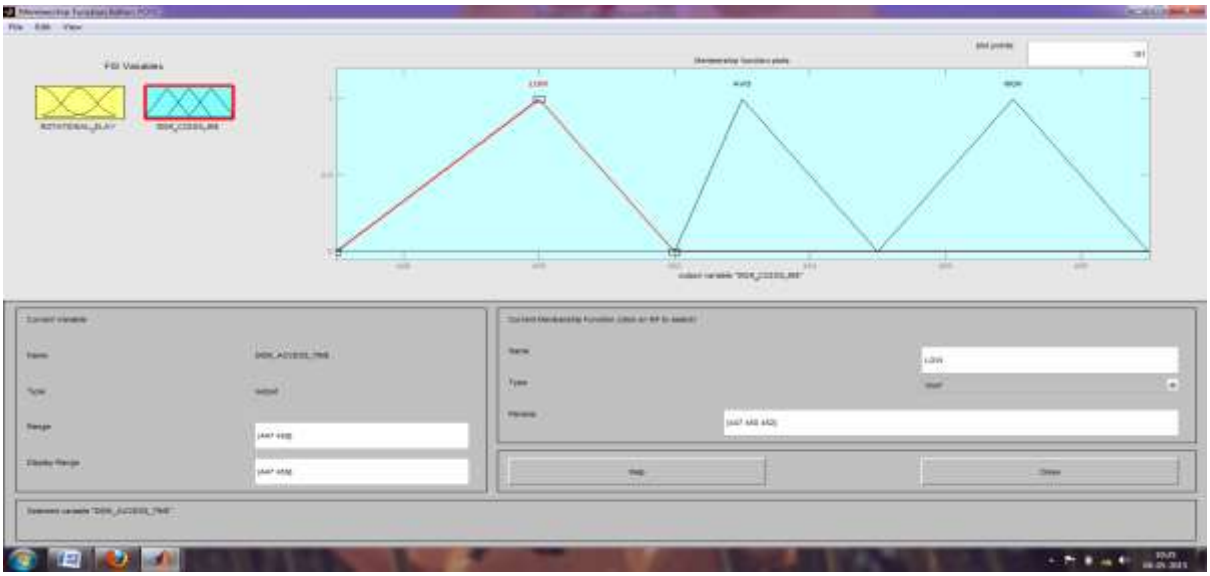
TRIANGULAR FUZZY: -



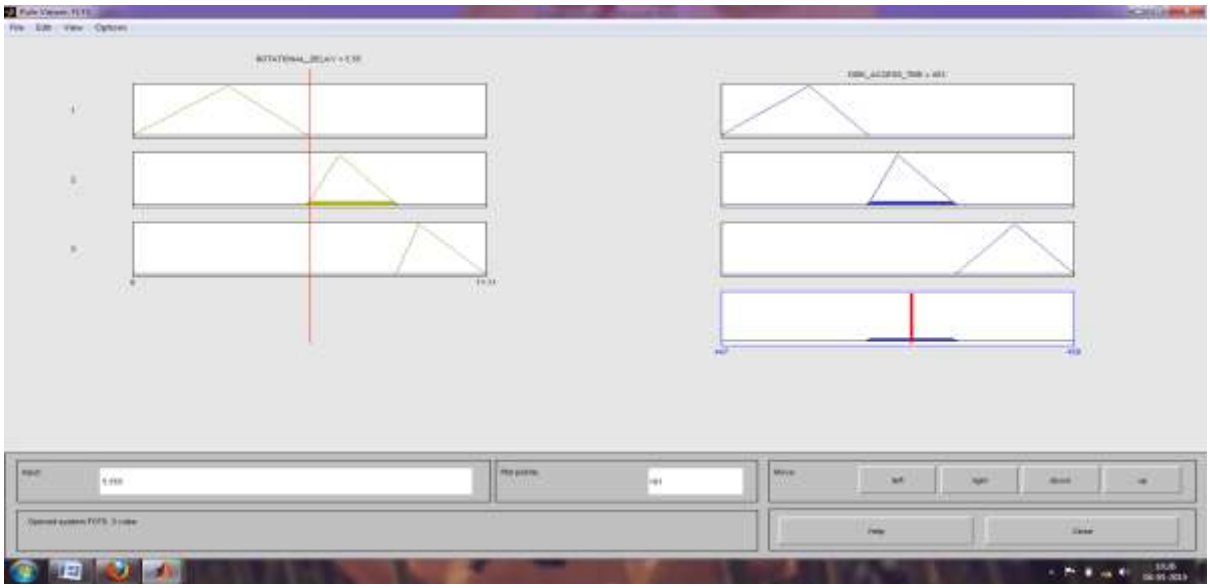


Fuzzy design for Rotational Delay V/s Disk Access Time (Triangular Fuzzy)

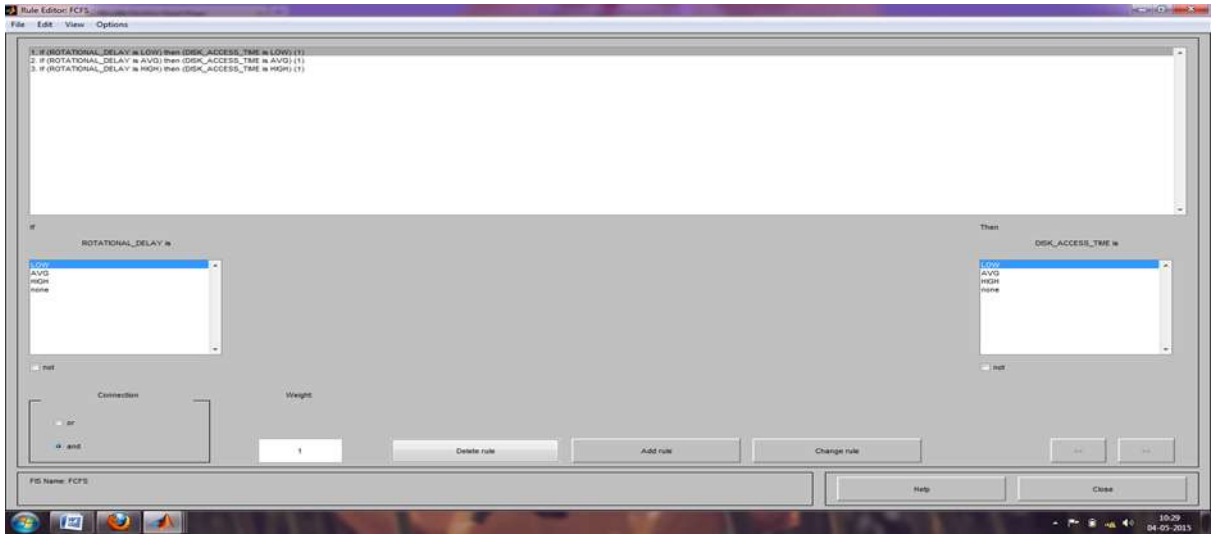
Fuzzy input parameters for Rotational Delay



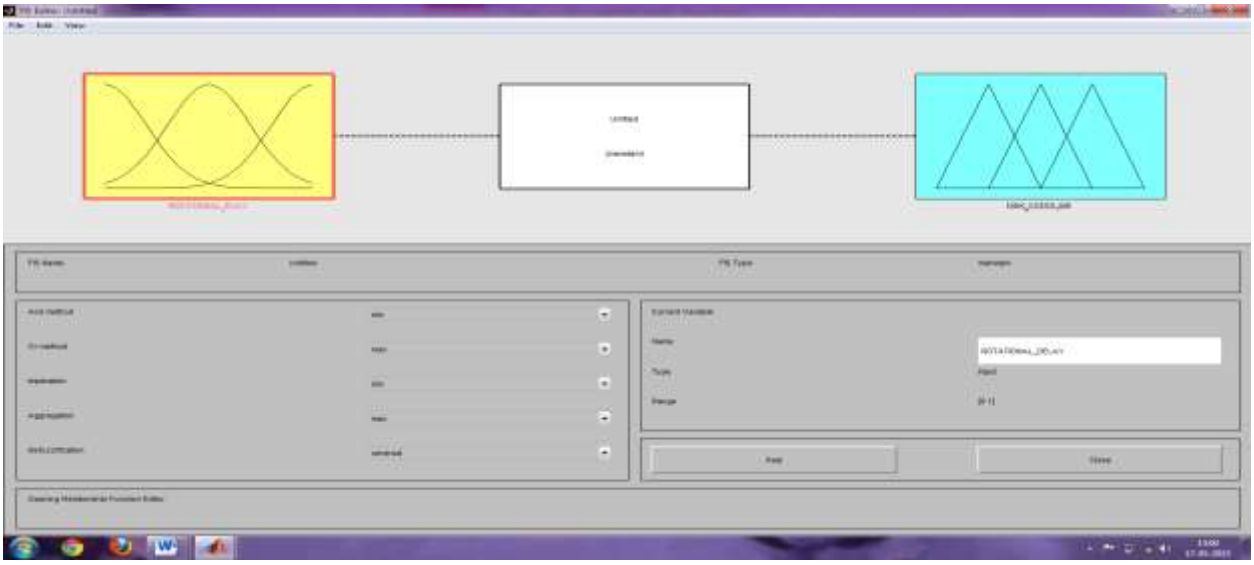
Fuzzy output parameters for Disk Access Time



Fuzzy Inference rules for Rotational Delay V/s Disk Access Time

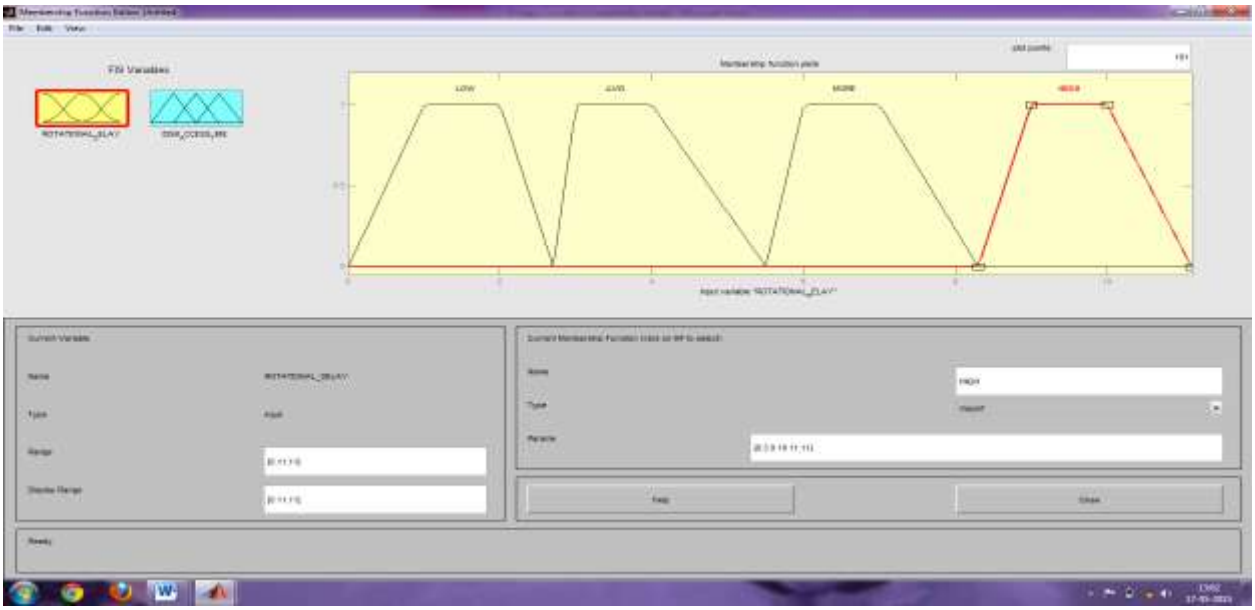


Fuzzy Inference rules for Rotational Delay V/s Disk Access Time

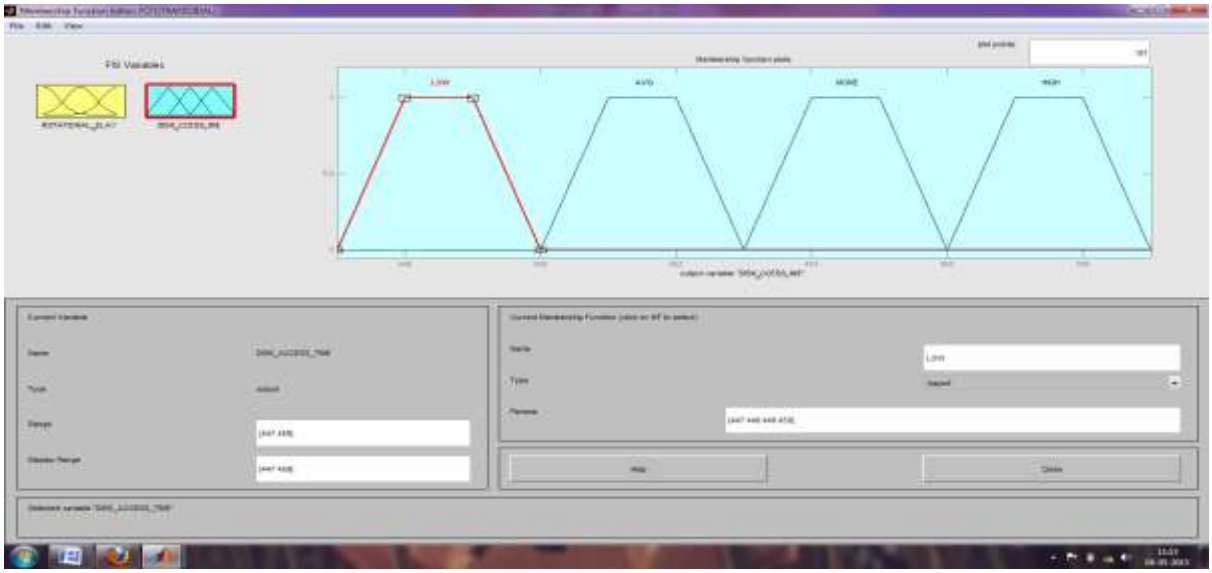


TRAPEZOIDAL FUZZY:

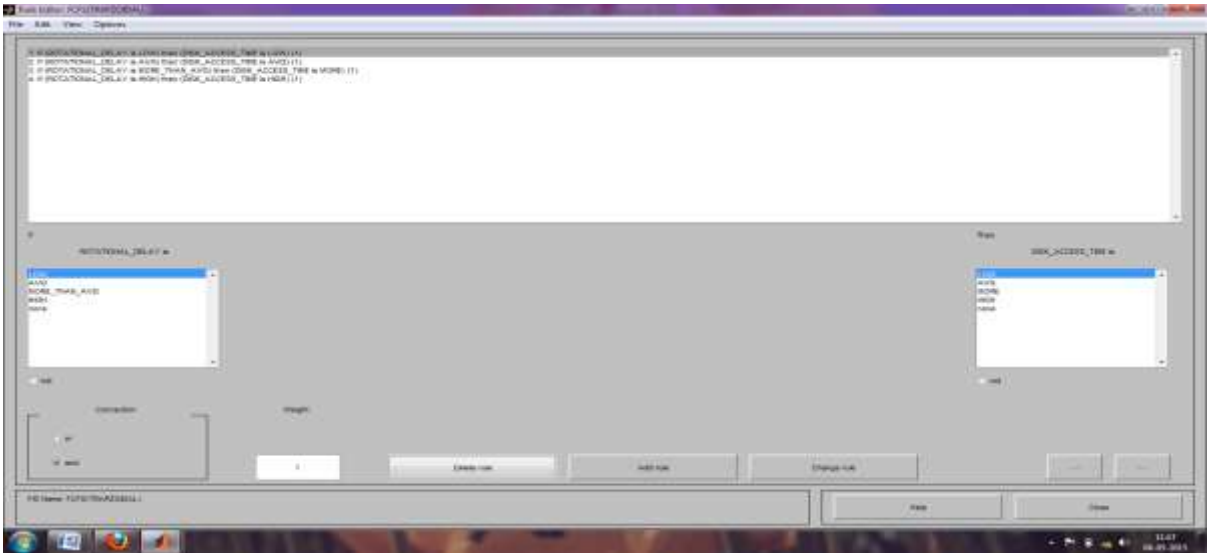
Fuzzy design for Rotational Delay V/s Disk Access Time (Trapezoidal Fuzzy)



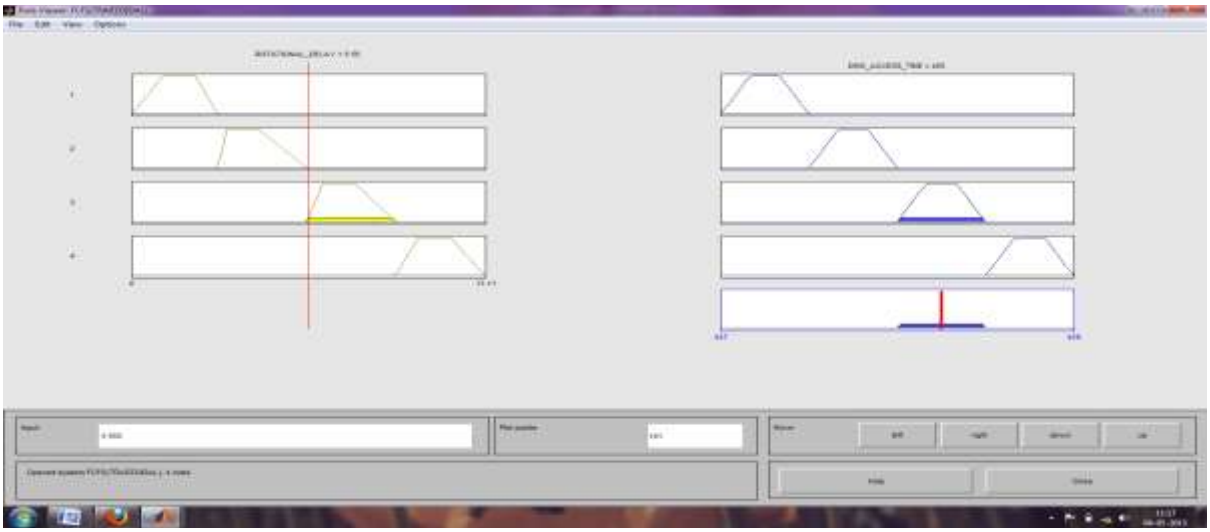
Fuzzy input parameters for Rotational Delay



Fuzzy output parameters for Disk Access Time



Fuzzy Inference rules for Rotational Delay V/s Disk Access Time



Fuzzy Inference rules for Rotational Delay V/s Disk Access Time

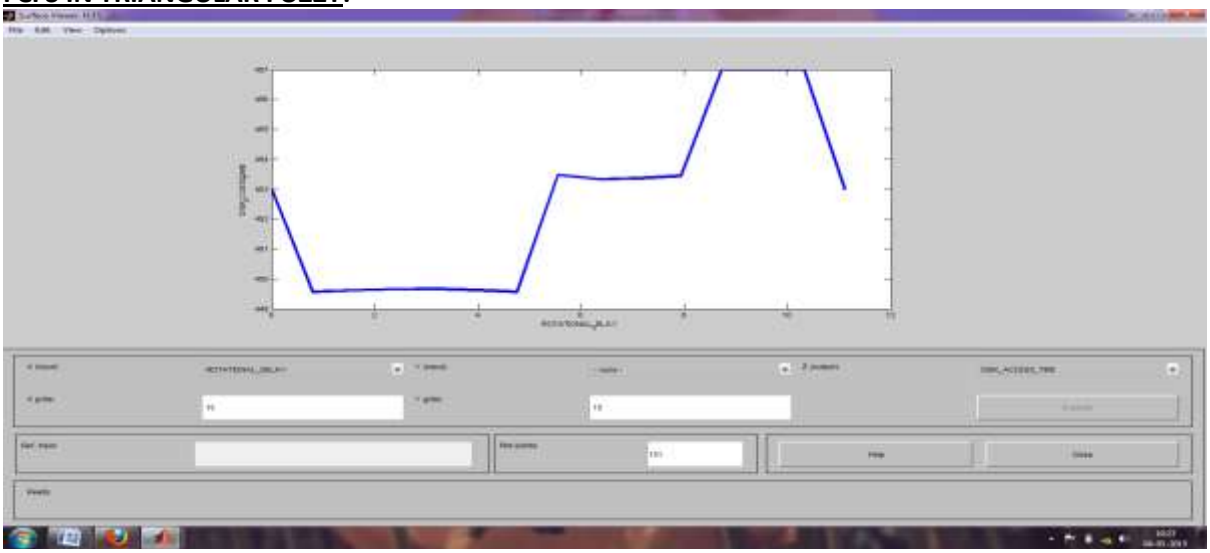
6.RESULTS AND ANALYSIS IN BRIEF- we are applying all these formulae to our disk scheduling algorithms and evaluate their comparative study.We have shown how the results are differ to each other after working in fuzzy environment.

6.1 FCFS-In this algorithm seek time can be easily find out with these track requests. By keeping the same **Seek time, Average seektime, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

Seek time=311 m sec, Average seek time = 311 / 8 = 38.87 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 38.87 + 5.5 +136.05 +0.3 = 180.72 m sec = 0.181 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) =8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME=311+136.05+11.11=458.16 m sec = 0.46 sec	**DISK ACCESS TIME= 311+136.05+8.3025=455.35 m sec = 0.455 sec**	**DISK ACCESS TIME= 311+136.05+6.90=453.95 m sec = 0.454 sec**
DISK LATENCY = 311+11.11+136.05+0.3=458.46 m sec =0.458sec	**DISK LATENCY = 311+8.3025+136.05+0.3=455.6525 m sec =0.456 sec**	**DISK LATENCY = 311+6.90+136.05+0.3=454.25 m sec =0.454 sec**

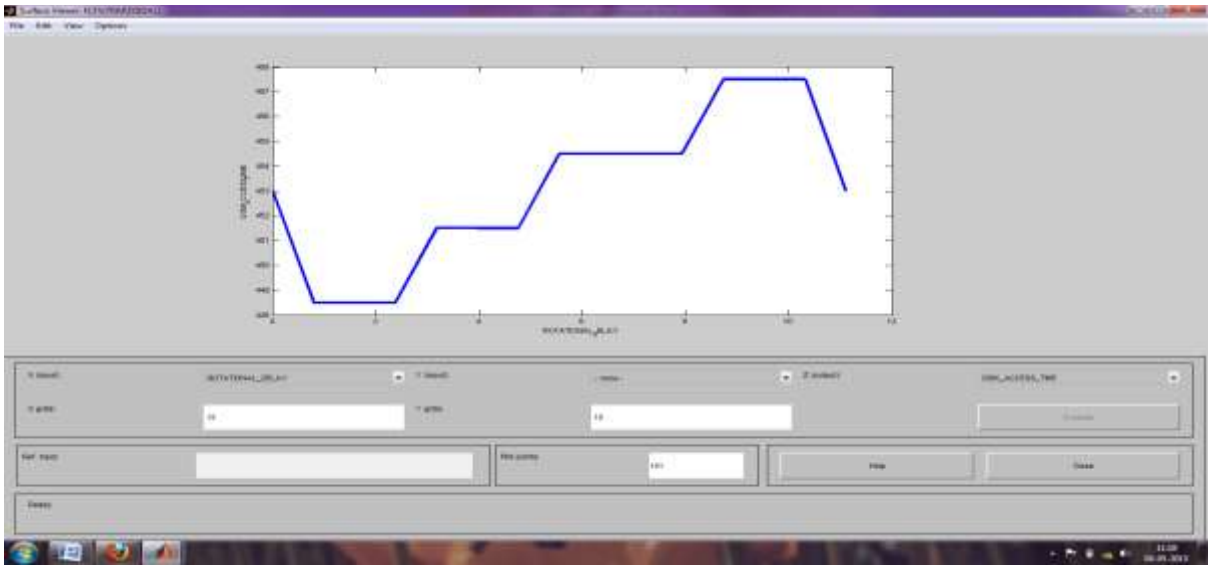
The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.

FCFS IN TRIANGULAR FUZZY: -

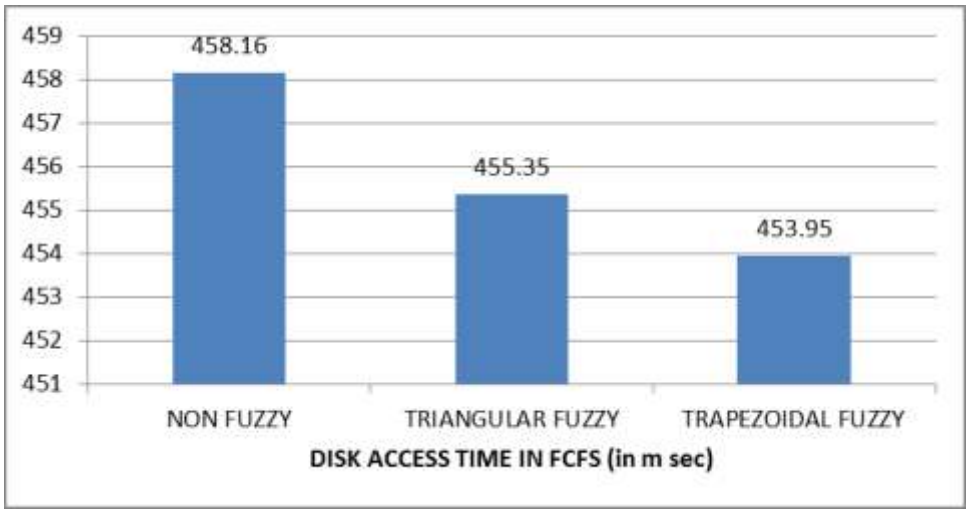


Fuzzy Surface view for Rotational Delay V/s Disk Access Time

FCFS IN TRAPEZOIDAL FUZZY: -



Fuzzy Surface view for Rotational Delay V/s Disk Access Time

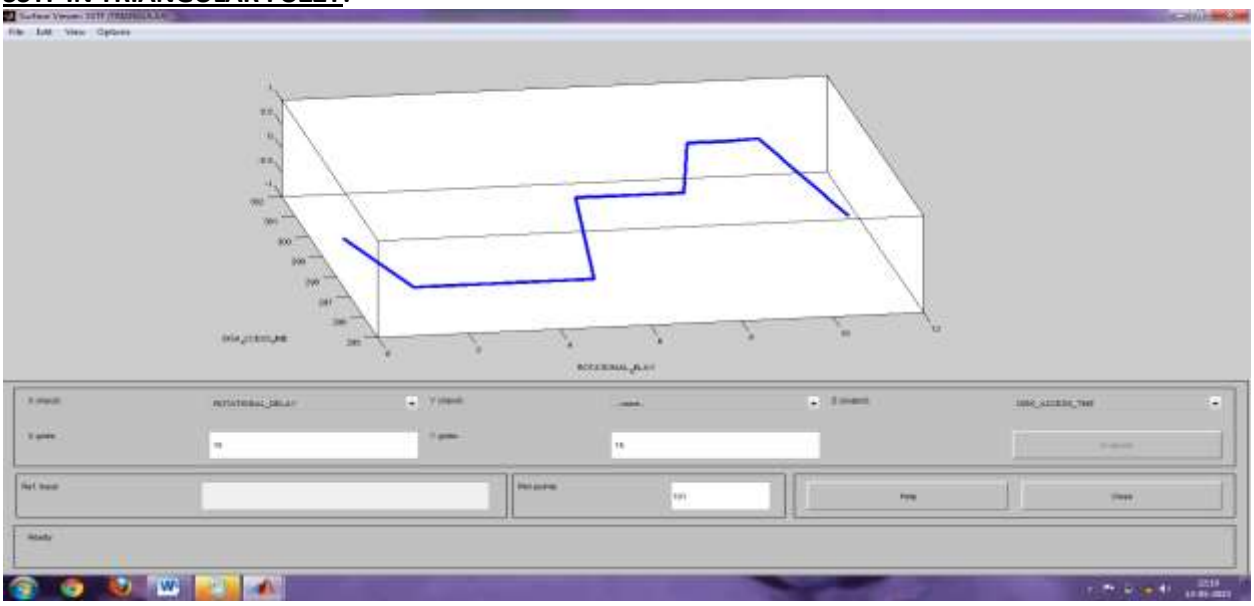


6.2 SSTF- In this algorithm seek time can be easily find out with these track requests. By keeping the same **Seek time, Average seek time, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

Seek time=156 m sec, Average seek time = 156 / 8 = 19.5 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 19.5 + 5.5 +136.05 +0.3 = 161.35 m sec = 0.161 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) = 8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME = 156+136.05+11.11=303.16m sec = 0.303sec	**DISK ACCESS TIME= 156+136.05+8.3025=300.352 m sec = 0.300 sec**	**DISK ACCESS TIME= 156+136.05+6.90=298.95 m sec = 0.299 sec**
DISK LATENCY = 156+11.11+136.05+0.3=303.46 m sec =0.303 sec	**DISK LATENCY = 156+8.3025+136.05+0.3=300.55 m sec =0.301sec**	**DISK LATENCY = 156+6.90+136.05+0.3=299.25 m sec =0.299sec**

The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.

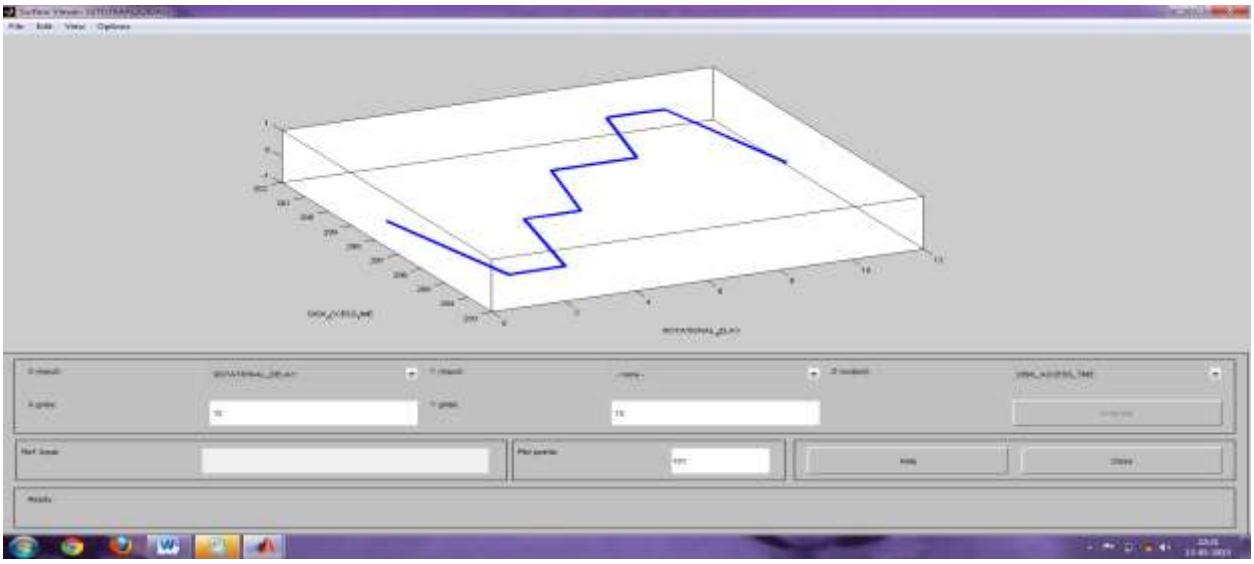
SSTF IN TRIANGULAR FUZZY: -



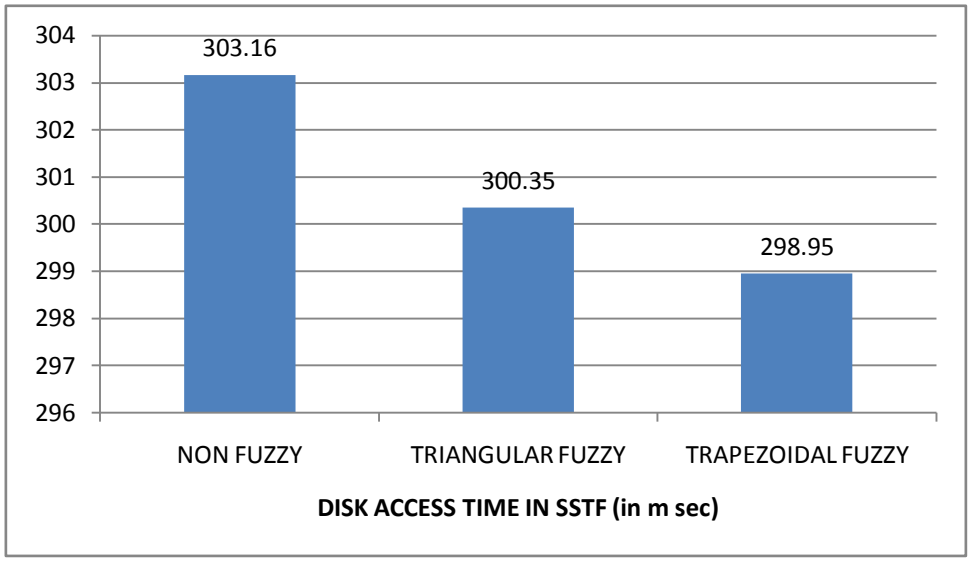
Fuzzy Surface view for Rotational Delay V/s Disk Access Time

SSTF IN TRAPEZOIDAL FUZZY: -

The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay using trapezoidal membership function over Disk access time.



Fuzzy Surface view for Rotational Delay V/s Disk Access Time

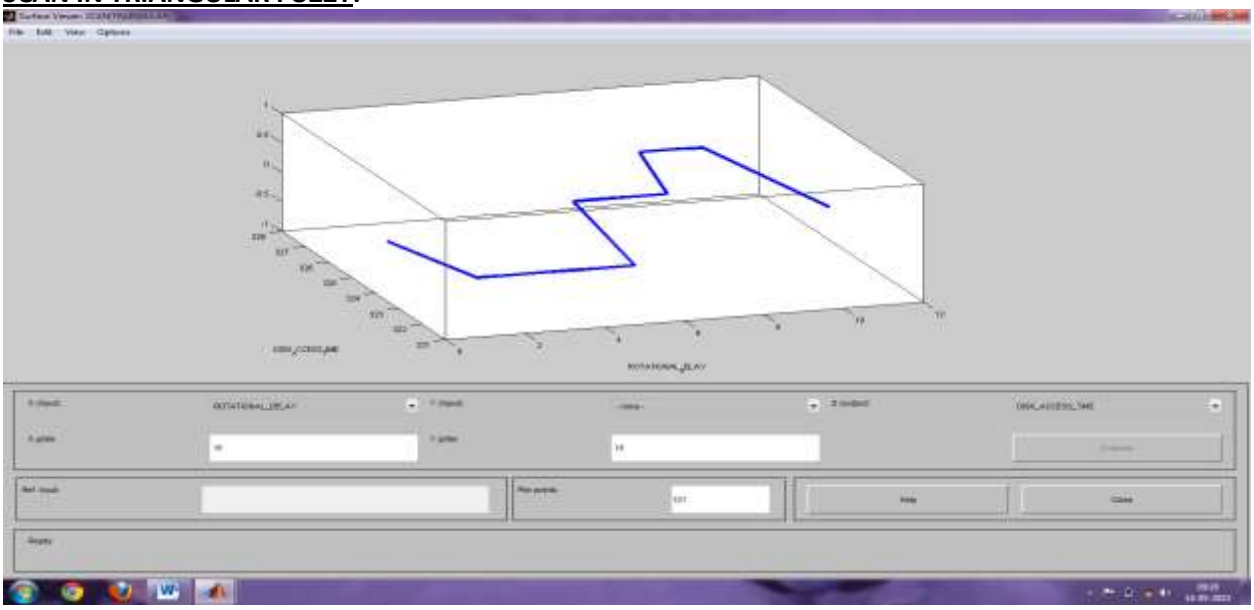


6.3 SCAN- In this algorithm seek time can be easily find out with these track requests. By keeping the same **Seek time, Average seek time, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

Seek time=182 m sec, Average seek time = 182 / 8 = 22.75 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 22.75 + 5.5 +136.05 +0.3 = 164.6 m sec = 0.165 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) = 8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME = 182+136.05+11.11=329.16m sec = 0.329sec	**DISK ACCESS TIME= 182+136.05+8.3025=326.35m sec = 0.326sec**	**DISK ACCESS TIME= 182+136.05+6.90=324.95m sec = 0.325sec**
DISK LATENCY = 182+11.11+136.05+0.3=329.46 m sec =0.329 sec	**DISK LATENCY = 182+8.3025+136.05+0.3=326.65 m sec =0.327 sec**	**DISK LATENCY = 182+6.90+136.05+0.3=325.25 m sec =0.325 sec**

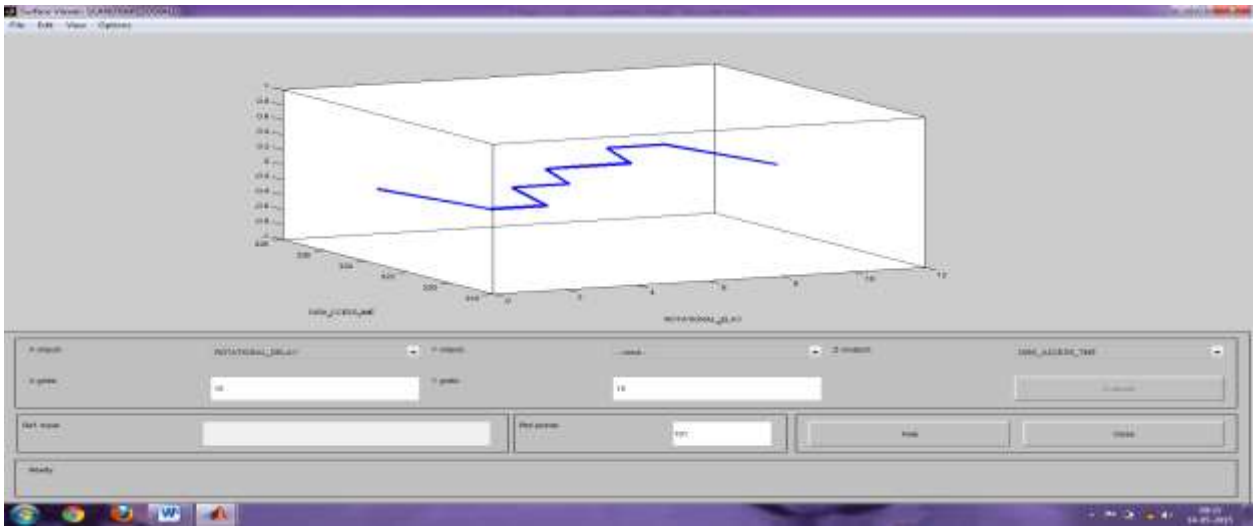
The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.

SCAN IN TRIANGULAR FUZZY: -

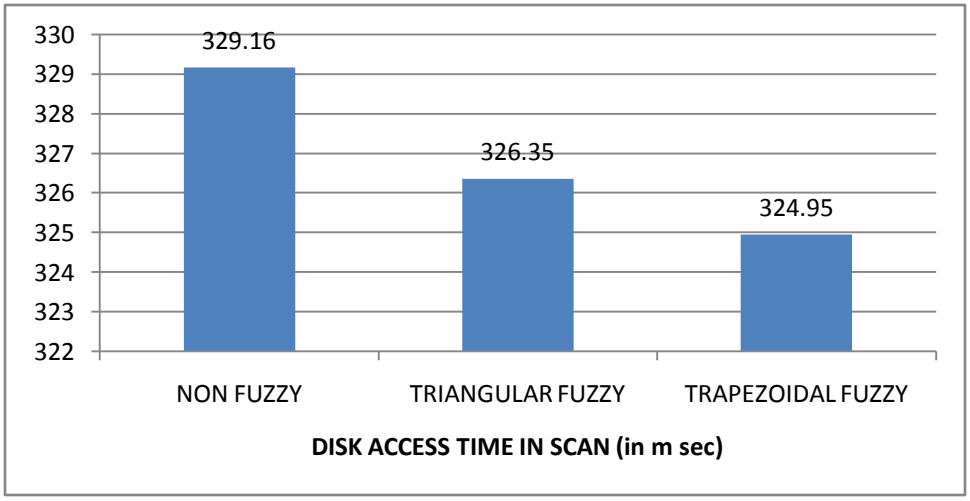


Fuzzy Surface view for Rotational Delay V/s Disk Access Time

SCAN IN TRAPEZOIDAL FUZZY:



Fuzzy Surface view for Rotational Delay V/s Disk Access Time



6.4 C-SCAN- In this algorithm seek time can be easily find out with these track requests. By keeping the same **Seek time, Average seek time, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

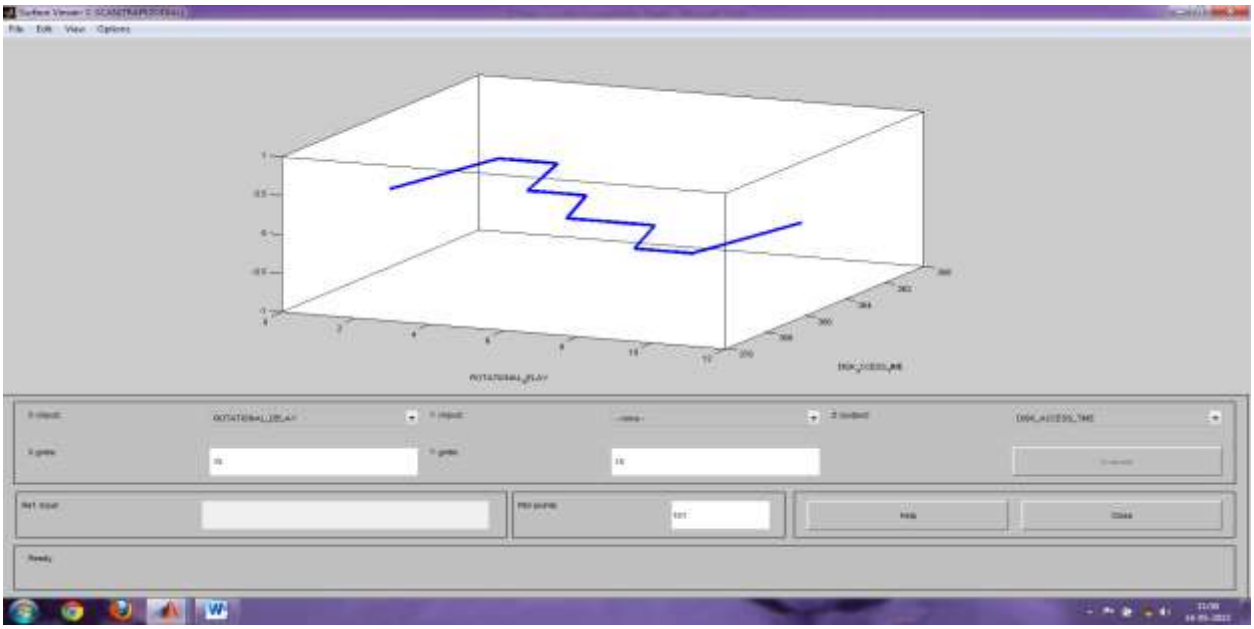
Seek time=223 m sec, Average seek time = 223 / 8 = 27.87 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 27.87 + 5.5 +136.05 +0.3 = 169.72 m sec = 0.170 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) = 8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME = 223+136.05+11.11=370.16m sec = 0.370sec	**DISK ACCESS TIME= 223+136.05+8.3025=367.35m sec = 0.367sec**	**DISK ACCESS TIME= 223+136.05+6.90=365.95m sec = 0.366sec**
DISK LATENCY = 223+11.11+136.05+0.3=370.46 m sec =0.370 sec	**DISK LATENCY = 223+8.3025+136.05+0.3=367.65 m sec =0.368 sec**	**DISK LATENCY = 223+6.90+136.05+0.3=366.25 m sec =0.366 sec**

C-SCAN IN TRIANGULAR FUZZY:

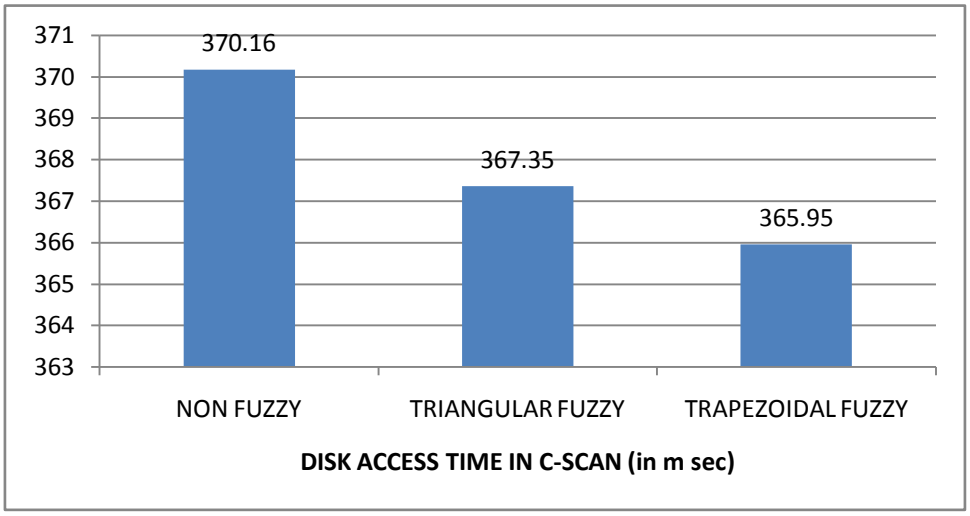
The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.

Fuzzy Surface view for Rotational Delay V/s Disk Access Time

C-SCAN IN TRAPEZOIDAL FUZZY: - The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay using trapezoidal membership function over Disk access time.



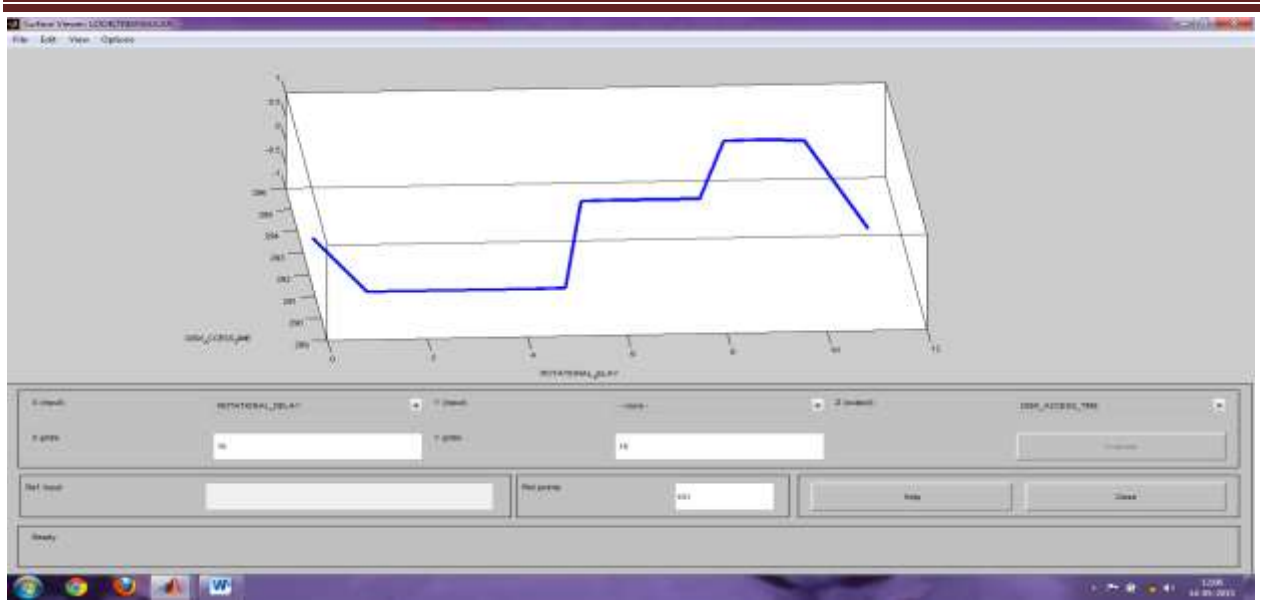
Fuzzy Surface view for Rotational Delay V/s Disk Access Time



6.5 LOOK- In this algorithm seek time can be easily find out with these track requests. By keeping the same **Seek time, Average seek time, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

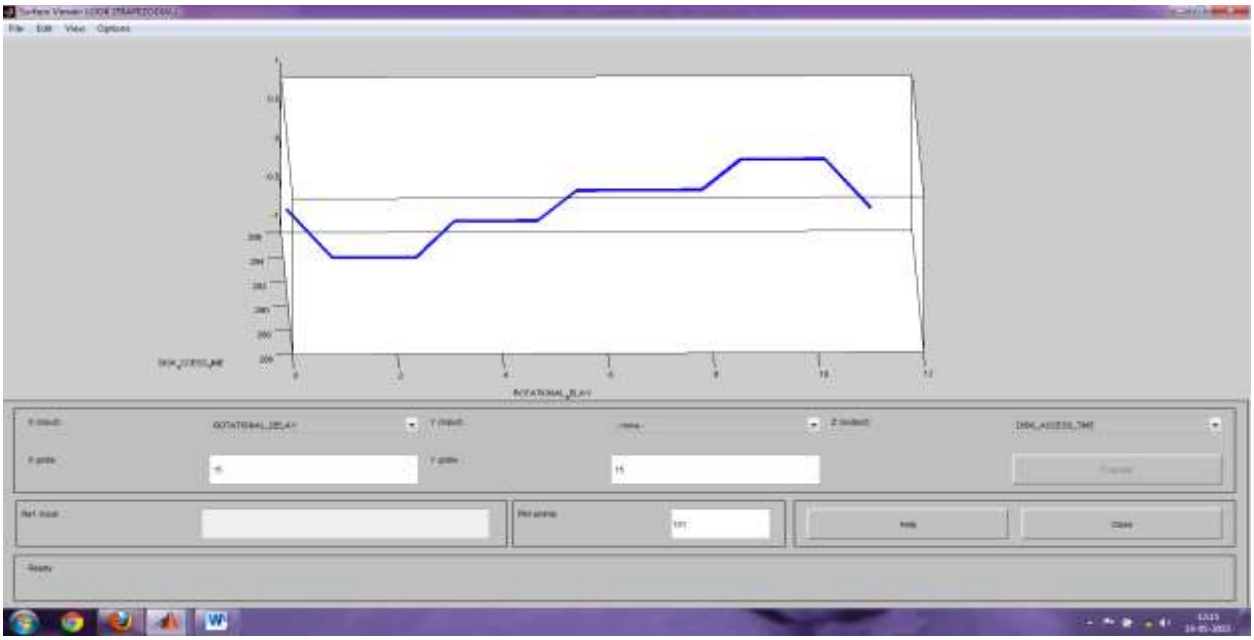
Seek time=150 m sec, Average seek time = 150 / 8 = 18.75 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 18.75 + 5.5 +136.05 +0.3 = 160.6 m sec = 0.161 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) = 8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME = 150+136.05+11.11=297.16m sec = 0.297sec	**DISK ACCESS TIME= 150+136.05+8.3025=294.35m sec = 0.294sec**	**DISK ACCESS TIME= 150+136.05+6.90=292.95m sec = 0.293sec**
DISK LATENCY = 150+11.11+136.05+0.3=297.46 m sec =0.297 sec	**DISK LATENCY = 150+8.3025+136.05+0.3=294.65 m sec =0.295 sec**	**DISK LATENCY = 150+6.90+136.05+0.3=293.25 m sec =0.293 sec**

LOOK IN TRIANGULAR FUZZY: The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.

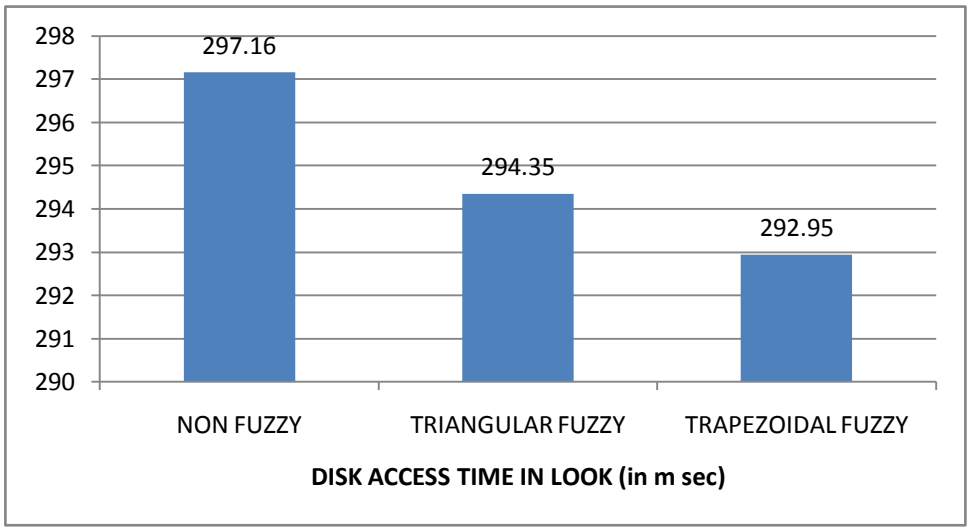


Fuzzy Surface view for Rotational Delay V/s Disk Access Time

LOOK IN TRAPEZOIDAL FUZZY: - The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay using trapezoidal membership function over Disk access time.



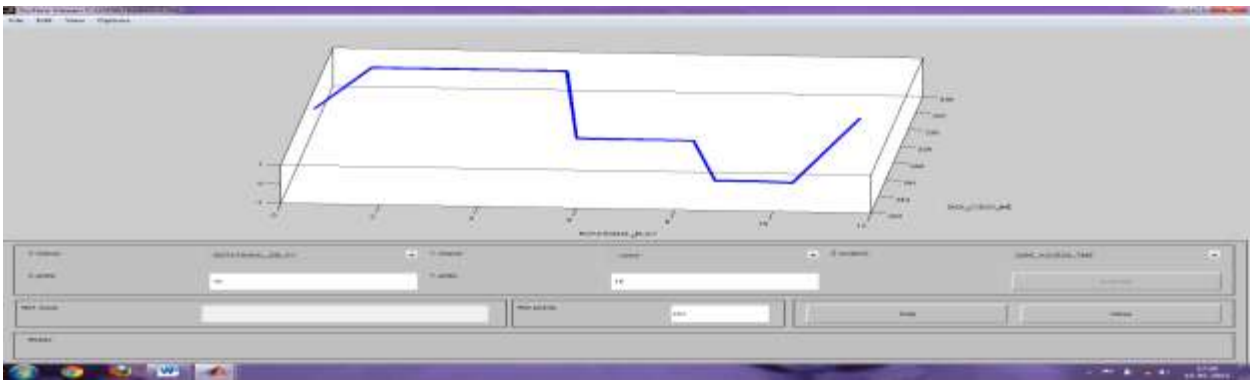
Fuzzy Surface view for Rotational Delay V/s Disk Access Time



6.6 C-LOOK- In this algorithm seek time can be easily find out with these track requests. By keeping the same **Seek time, Average seek time, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

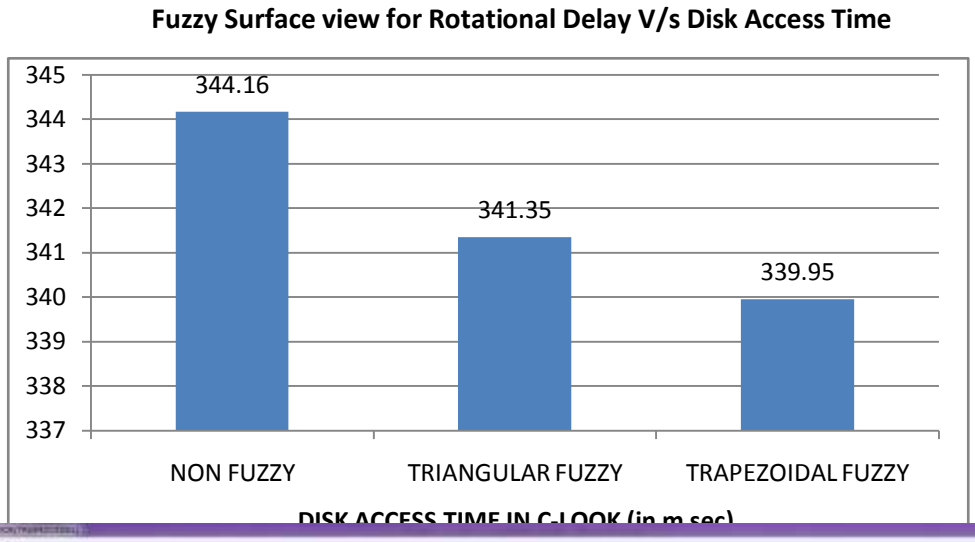
Seek time=197 m sec, Average seek time = 197 / 8 = 24.625 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 24.625 + 5.5 +136.05 +0.3 = 166.375 m sec = 0.166 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) = 8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME = 197+136.05+11.11=344.16m sec = 0.344sec	**DISK ACCESS TIME= 197+136.05+8.3025=341.35m sec = 0.341sec**	**DISK ACCESS TIME= 197+136.05+6.90=339.95m sec = 0.340sec**
DISK LATENCY = 197+11.11+136.05+0.3=344.46 m sec =0.344 sec	**DISK LATENCY = 197+8.3025+136.05+0.3=341.65 m sec =0.342 sec**	**DISK LATENCY = 197+6.90+136.05+0.3=340.25 m sec =0.340 sec**

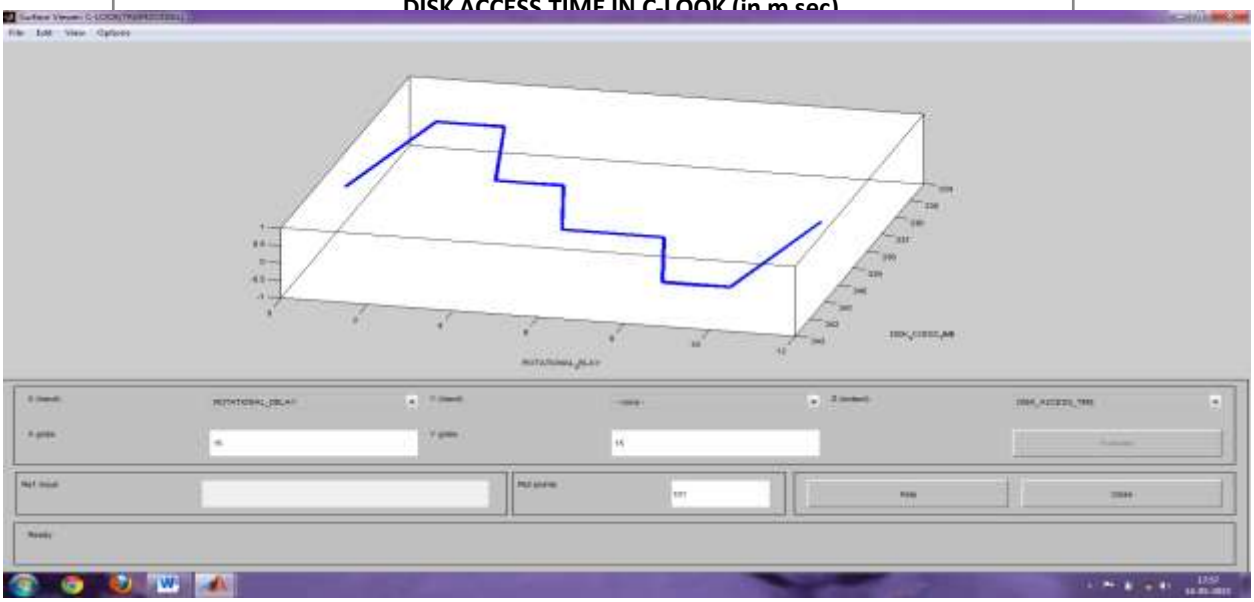
C-LOOK IN TRIANGULAR FUZZY: - The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.



Fuzzy Surface view for Rotational Delay V/s Disk Access Time

C-LOOK IN TRAPEZODIAL FUZZY:





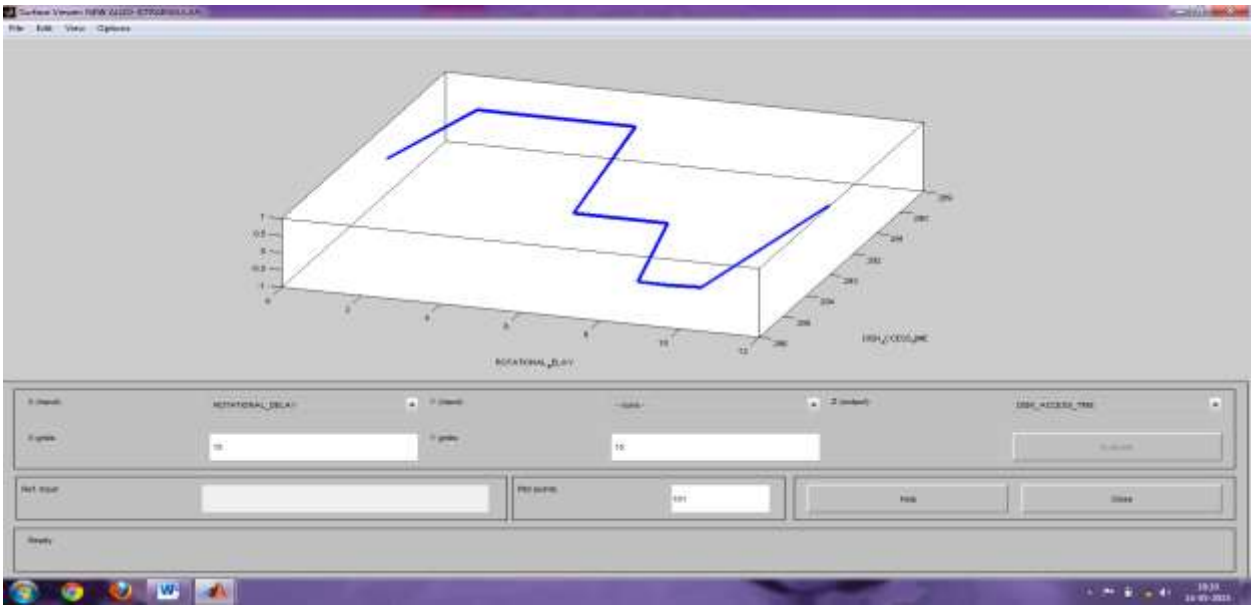
6.7 NEW ALGORITHM-3- Recently, Ramanpreet et.al (2015)explored new scheduling policy by sorting all the request in an ascending order.**1)** Find out the distance between head position and smallest track request &no. of request in same side. In this if both values are minimum then check the condition. If both the conditions are true then head moves to the starting position first then moves to the other end.

2) If not then find out the distance between head position and largest track request & no. of request in same side. If both values are minimum then check the condition. In case, both the conditions are true then head moves to the ending position first then moves to the other end.

3) In case both the conditions may false then head moves to the minimum distance first then to other side. In this algorithm seek time can be easily find out with these track requests with this algorithm. By keeping the same **Seek time, Average seek time, Transfer time, Average Rotational Delay, Controller Overhead, Queuing Delay, Average Disk Access Time** we get following results.

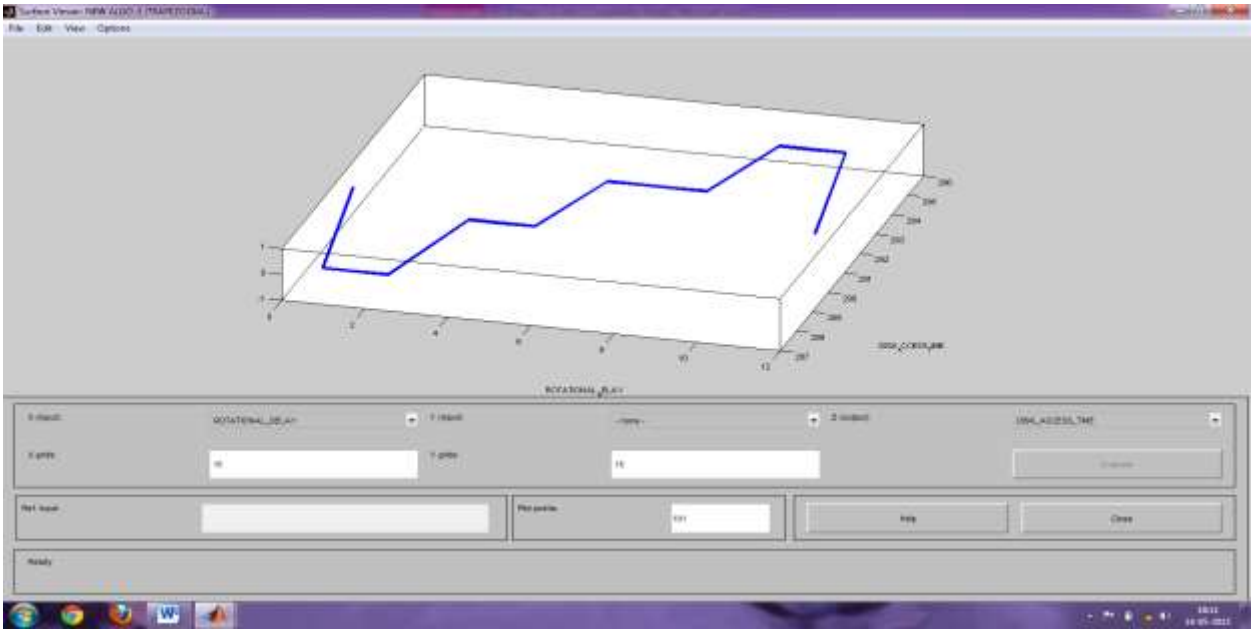
Seek time=150 m sec, Average seek time = 150 / 8 = 18.75 m sec, Transfer time = 136.05 m sec , Average Rotational Delay=11.11 / 2=5.5 m sec , Controller Overhead = 0.3 m sec (max) , Queuing Delay=Idle , Average Disk Access Time = 18.75 + 5.5 +136.05 +0.3 = 160.6 m sec = 0.161 sec		
NON FUZZY	**TRIANGULAR FUZZY**	**TRAPEZOIDAL FUZZY**
ROTATIONAL DELAY = 11.11 m sec	**ROTATIONAL DELAY (after defuzzification) = 8.3025 m sec**	**ROTATIONAL DELAY (after defuzzification) = 6.90 m sec**
DISK ACCESS TIME = 150+136.05+11.11=297.16m sec = 0.297sec	**DISK ACCESS TIME= 150+136.05+8.3025=294.35m sec = 0.294sec**	**DISK ACCESS TIME= 150+136.05+6.90=292.95m sec = 0.293sec**
DISK LATENCY = 150+11.11+136.05+0.3=297.46 m sec =0.297 sec	**DISK LATENCY = 150+8.3025+136.05+0.3=294.65 m sec =0.295 sec**	**DISK LATENCY = 150+6.90+136.05+0.3=293.25 m sec =0.293 sec**

NEW ALGORITHM-3 IN TRIANGULAR FUZZY: - The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay over Disk access time.

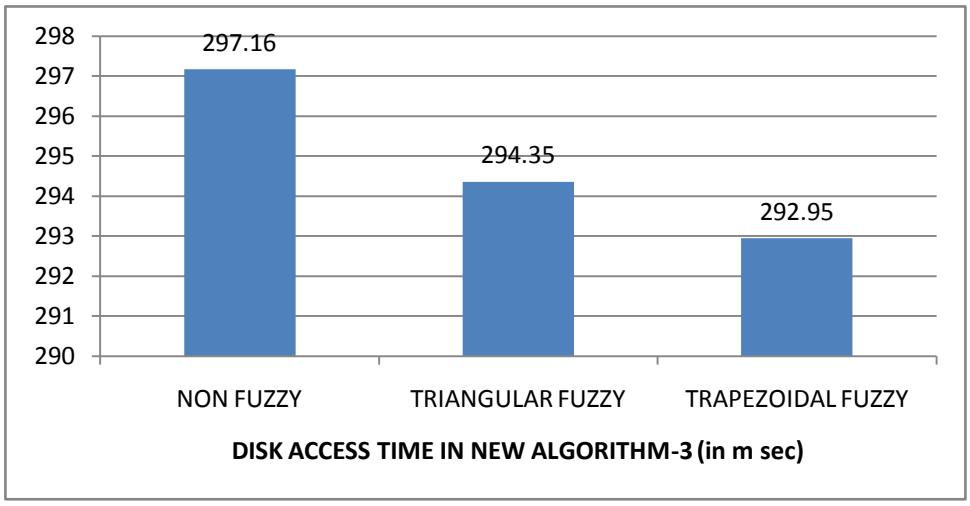


Fuzzy Surface view for Rotational Delay V/s Disk Access Time

NEW ALGORITHM-3 IN TRAPEZOIDAL FUZZY: The 3-Dimensional view (surface view) below represents the effect of fuzzified rotational delay using trapezoidal membership function over Disk access time.



Fuzzy Surface view for Rotational Delay V/s Disk Access Time



7. CONCLUSION: -

From the observed results, fuzzy surface view for rotational delay v/s disk access time and through bar diagram it is clear that the **NEW ALGORITHM-3** shows better performance than other disk scheduling algorithms(FIFO,SSTF,SCAN,C-SCAN and LOOK,C-LOOK).The average seek time and transfer time has been improved by this algorithm which increases the efficiency of the disk performance. In our future problem**NEW ALGORITHM-3** can be better implemented in real time systems. In this paper we have calculated Disk Access time under taking rotational delay in fuzzy, Average Disk Access Time & Disk Latency So we can easily say that algorithm 3 is applicable in any case.

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