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CONGESTION CONTROL IN WSN BASED ON BIOLUMINESCENCE PROPOSED RUDA BEHAVIOUR

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ABSTRACT

Congestion control is an extremely important area within wireless sensor networks (WSN), where traffic becomes greater than the aggregated or individual capacity of the underlying channels. Therefore, special considerations are required to develop more sophisticated techniques to avoid, detect, and resolve congestion. The constrained resources of the WSN must be considered while devising such techniques to achieve the maximum throughput. Various approaches have been introduced in the past few years that include routing protocols aided with congestion detection and control mechanism, and dedicated congestion control protocols. In the former schemes, the congestion avoidance is performed by the sink node that causes topology reset and bulk traffic drop. As a consequence, the latter mentioned congestion control protocols addressing the congestion avoidance, detection, and resolution were introduced at the node level. In this paper, we explore mechanisms for controlling congestion in the WSNs and present a comparative study. The congestion control schemes are categorized as centralized with partial congestion control and distributed with dedicated congestion control.

1 INTRODUCTION

Firefly algorithm is a new nature inspired algorithm for optimization that needs to be explored further to solve a number of problems to show its real potential. Routing is a well-known techniques for prolonging the life of the wireless sensor networks. The current work focuses on solving aforementioned related problem using firefly algorithm. The Routing algorithm is developed with novel fitness function based on residual energy, node degree and distance. Firefly algorithms are extensively tested on various scenarios to show its performance and compared with conventional algorithms such as PSO, DHCR and Hybrid Routing. Experimental results depicts that proposed algorithms performs better as compared with some existing one.

PSO

Particle swarm optimization has been used to solve many optimization problems Developed by Kennedy and Eberhart in 1995 [11]. A population based optimization technique inspired by social behavior of bird flocking or fish schooling, PSO consists of a swarm of particles. Each particle resides at a position in the search space. The fitness of each particle represents the quality of its position. The particles fly over the search space with a certain velocity. The velocity (both direction and speed) of each particle is dependent on its own best position found so far and the best possible solution that was found so far by its neighbors. Eventually the swarm will converge to optimal positions by using (12) and (13) equation.

In Congestion Control System there are many algorithm can used such that Hierarchical Tree Alternative Path (HTAP) , RAHTAP Algorithm, Hybrid Algorithm, CODA Algorithm, PSO Algorithm and many more. In Firefly Algorithmic rule is implemented that relies on the attractiveness issue of the firefly insect to control congestion in WSN at transport layer. The resource control algorithm Hierarchical Tree Alternative Path (HTAP) create a dynamic alternative paths to the sink for attempts through simple steps and minor computations to mitigate congestion in wireless sensor networks .Another algorithm named hybrid of rate control and resource control algorithm. It can be used to control congestion considering the priority of the packets. A Redundancy Aware Hierarchical Tree Alternative Path (RAHTAP) algorithm used for eliminates the duplicate packets from the network and achieve reduction in network load. As per packets basis it create dynamic alternative path from source to sink when congestion on a particular node. Congestion Detection and Avoidance (CODA) deals with various degrees of congestion depending on the sensing application. And Particle Swarm Optimization (PSO) deals on network lifetime and throughput of the network. All this Algorithm used in Congestion Control in Wireless Sensor Network. So, We are going to measure the result of Firefly Algorithm, Hierarchical Tree Alternative Path (HTAP) , RAHTAP Algorithm, Hybrid Algorithm, Congestion Detection and Avoidance (CODA) and Particle Swarm Optimization (PSO) in Congestive Control system using an analytical survey of various congestion control algorithms.

Objectives:

i. To briefly introduce Firefly Algorithm.
ii. To briefly describe the working process of Firefly.
iii. To Modified Firefly Algorithm.
iv. Compare Proposed Algorithm Into Firefly and PSO Algorithm.
v. Introduce a new Bioluminescence Algorithm.

This thesis paper is going to measure the result of Firefly Algorithm, Hierarchical Tree Alternative Path (HTAP) , RAHTAP Algorithm, Hybrid Algorithm in Congestive Control system using an analytical survey of congestion control and avoidance algorithms. And try to proposed a new bio inspired algorithm for congestive control system in wireless sensor network. The target measurement for previous algorithm and newly proposed algorithm would be X-distance(m),Y-distance(m),Transmission Power, Max Data rate, Transmission current, Fragment Size, Buffer Size, Network Protocol, MAC protocol, Energy Model Specification and also try to reduce residual energy of node and increasing the hop count.

2 LITERATURE REVIEW

Nilima Rani Das et. al. surveyed a number of congestion control schemes to solved congestion problem like Rate based congestion control, Adaptive resource control scheme to alleviate congestion, Datagram Congestion Control Protocol (DCCP), Hierarchical medium access control (HMAC), Congestion Detection and Avoidance (CODA), Firefly Algorithm, Hierarchical Tree Alternative Path (HTAP) , RAHTAP Algorithm, Hybrid Algorithm.[2] Charalambos Sergiou et. al. also presented the Hierarchical Tree Alternative Path (HTAP) resource control algorithm that attempts, through simple steps and minor computations, to mitigate congestion in wireless sensor networks by creating dynamic alternative paths to the sink. HTAP is compare with another resource control algorithm (TARA), as well as with a traffic control algorithm (SenTCP) by assessed in several scenarios, and also the case where no congestion control exists in the network (no CC).[3] Ashish Kumar Luha et.al. implemented Redundancy Aware Hierarchical Tree Alternative Path (RAHTAP) algorithm. In this algorithm excludes the duplicate packets from the network. When congestion on a particular node create dynamic alternative path from source to sink as per packets basis is achieve reduction in network load. This algorithm works over the thought of existing congestion control algorithm HTAP. The researchers use QualNet Simulator to mimic the consequence.[4] Congestion is a crucial factor. It effects the performance of a wireless sensor network. Neha Pant et. al. observed a hybrid of rate control and resource control algorithm in wireless sensor network . In Hybrid congestion control algorithm system it increases the total number of packets that are finally delivered to the base station though it increasing the throughput. it also increases the lifetime of the network and reduces the number of dropped packets. The researcher measure the percentage of the higher priority packets received at the base station also increases.[5]Congestion in Wireless Sensor Network (WSN) is an important issue of concern for several researchers in recent years. Mukhdeep Singh Manshahia et. al. proposed an algorithmic rule which may realize the optimized route on the idea of parameters like residual energy, range of retransmissions and the distance between source and destination.[6]

3 TECHNICAL BACKGROUND OF RUDA

3.1 *Overview of Proposed RUDA:*

Reactive routing technique [12] is used in the proposed work. In reactive routing the route is computed on demand basis. When a node wishes to transmit data then it will generally generate RREQ message which is a route request message and is flooded in the network. It will result in a delay in initiating the communication from source to destination. In reactive routing the route is considered in which the RREQ message reaches earlier through either single hop or multiple hops. A RUDA Algorithm based approach is proposed to control congestion in WSN at transport layer. RUDA insect

produces flashes of short duration through a process called bioluminescence. It is used to attract potential prey or partner or for the issue of warning against predator. Thus intensity of flash becomes an important parameter or the other ruda insects. Ruda Algorithm follows three rules [13]:

1) Ruda of any gender can attract towards the other ruda;
2) An attractiveness factor is taken into account which depends on the brightness of the flash, as the rudas' move towards the more attractive fireflies;

3) The brightness of rudas is calculated through an objective function.

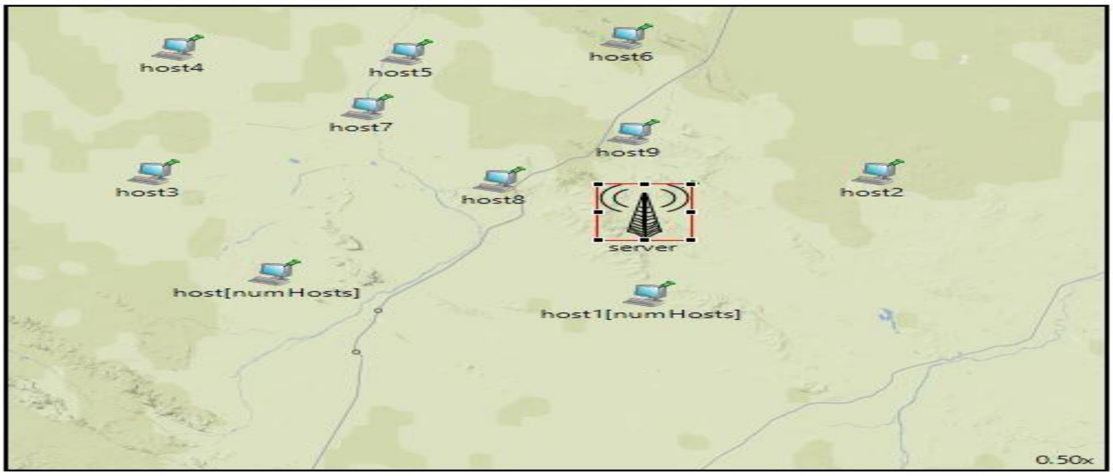
3.2 *Design of RUDA:*

RUDA architecture consists numbers of Led bulbs or lamps, many wireless devices such as PDA, Mobile Phones, and laptops. Important factors we should consider while designing ruda as following:

- Presence of Light
- Line of Sight(Los)

For better performance use fluorescent light & LED As shown in figure streaming content must have proper integration with server & internet network, so that it is easily possible to work

Figure 1: Design of RUDA System.



Using visible light as transmission medium, ruda provides wireless indoor communication. The bit rate achieved by ruda cannot be achieved by Wi-Fi. Prof. Dr. Herald Haas, human eye cannot detect it. If LED is on , then we transmit a digital signal 1,and if the LED is off , then we transmit a digital signal 0.A controller is connected at the back side of these LED bulbs to code data to these LED‘s.

3.3 Working Principles of RUDA:

This technology is based on the Visible Light Communication which uses the visible light for data communication. In VLC, we use a source of illumination which can not only produce illumination but also send information using the same light. So we can say that VLC is illumination along with communication. Now imagine a torch which we might use to send some sort of a signal, maybe Morse code. We can do so manually by switching the torch ON and OFF repeatedly.

But in this case, we may not be able to use the torch as an efficient source of illumination, so we cannot strictly consider it as VLC as per our definition. Now suppose we switch the torch ON and OFF very quickly using a computer system. In this case, due to the rapidity of the motion of switching between ON and OFF states, the torch appears to be ON constantly, and additionally we also cannot “see” the data being transmitted. We would, of course, need a receiver. Literally, any form of information that can be sent using a light signal that is visible to humans could be considered to be VLC but by our definition we should be able to see the light, but cannot “see” the data. So although there seems to be no universally agreed definition of VLC, we can at least agree what we mean by VLC. The sending of the data in the above mentioned manner has been made possible by the widespread use of the LED bulbs. These bulbs can be switched ON and OFF very rapidly thus permitting us to send the required data via light. The rapid adoption of LED light bulbs has created a massive opportunity for VLC. The problem of congestion of the radio spectrum utilized by Wi-Fi and cellular radio systems is also helping to create the market for VLC.

4 ANALYSIS OF THE TECHNOLOGY

4.1 Internal Structure Design:

The intensity of the flash light which is also defined as attractiveness is inversely proportional with *r* distance from the light source. This shows that the attractiveness increases as the distance decreases and *vice-versa*.

Reduce Energy= Total Energy-Energy Used

I = Flash light intensity; 0 I = Initial flash light intensity; $\tilde{a}$ = The light absorption coefficient; r = Distance between firefly i and j. The flash light intensity is proportional to the attractiveness and is given by β .

$$\text{Distance} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

β = Attractiveness at *r* is 0.
Cartesian Distance Formula is used to calculate the distance between two fireflies.

$$\text{Throughput} = \frac{\text{Packet Size}}{\text{Receive Time} - \text{Send Time}}$$

The movement of the less attractive firefly *i* towards the more attractive one *j* is given by:

$$\text{Fitness Function}\left(f_j\right) = \sum_{i=1}^{N}\left(w_1 * \tau_i + w_2 * \left(1 - P_{Li}\right) + w_3 *\right.$$

In Equation (4), if light absorption coefficient approaches zero then the attractiveness is almost constant otherwise if the coefficient approaches infinity, the attractiveness decreases. The second term in the equation is used for randomization.
In the algorithm described above, light intensity is replaced by Residual Energy of a node, and hence attractiveness ($\hat{a}$) is proportional to energy. i, j r is the distance between two nodes i x and j x . Now, at first the nodes in the network are clustered and each node in the cluster shares its information related to residual energy, its distance from other nodes in the cluster and number of retransmissions of data. This information is used to select the cluster head. After each round this information is updated on each node and re clustering and cluster head selection is performed. The bandwidth of the network is limited and each node trying to send its data to the cluster head which further sends its data to the base station. The congestion in the network is occurred because of the data travelling from source to sink. The congestion is detected by monitoring the window size and the queue size of each node. This information is also shared by each node in the network. In case of congestion if the data travelling from source to sink then the nodes lies in the path, which may be either belong to one cluster or to different clusters, have information of other nodes of its cluster and directs the data through other nodes based on the value of queue size and window size. Efforts are being made detect and reduce the congestion of data from each node. The objective is to maximize the throughput of the network by optimizing the objective function.

4.2 *Structure of RUDA Algorithm*

In RUDA Algorithm, light intensity and attractiveness are the two important variables. RUDA is attracted toward the other ruda that has brighter flash than itself. The attractiveness is dependent with the light intensity.

Figure 2: Proposed RUDA Algorithm

```
Proposed RUDA Algorithm

1.Procedure Begin
2.Initialize node number and
3.Maxgen: the maximal number of generation.
4.alpha,bita,gama: the particular distance from the light sources.
5.d: the domain space.
6.Initialize UpperBound and LowerBound.
7.Set the paramiters function.
8.if(initalization<dimendion)
9.     set upperbound=0;
10.    set lower bound=2;
11.End if;
12.Generate the initial population of ruda or xi (i=1,2....n)
13.For(init<node Count)
14.        For(init<Dimension)
15.                while(init<maxgen)
16.                        For i= 1 to n (all n ruda)
17.                                For j = 1 to n (all n ruda)
18.                                       if(Ij>Ii)
19. move ruda i towords j by
20. End if;
21. End for j;
22. End for i;
23. End while;
24. End for;
25. End for;
26.For index<node-1
27.    Sort of ruda according to fitness value;
28.    Evaluate new solutions and update light intensity;
29.    if(new value)
30.         replace value f[i],f[j];
31. End if;
32. End for index;
33. Calculate result and visualization;
34. End procedure
```

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4.3 Figure Dissemination:

In firefly based approach (Figure 3), the residual energy value plays a major role as this value is shared among other nodes in the network. Number of retransmissions of every node and the distance value between any two nodes in the cluster is calculated. Based on these values and the values of residual energy, a new route is found in the network from source to sink. The nodes which have low energy value attracted towards the high energy node and an attractiveness factor is calculated. The congestion on any node is determined by the same method as described earlier. Based on the remaining queue size value an optimum route is computed by putting the above values in the objective function.

4.4 Comparison:

We are comparing our proposed approach with the following two approaches,

Firefly: Firefly is algorithm is scalable, requiring only per-neighbor state and by piggy-backing control information on data packets, there is no need for additional control packets. Finally, since congestion control and fairness is followed in the transport layer, the solution is independent of the routing in the network layer, as well as the MAC protocol in the data-link layer. However the problem of unfairness exists in small networks.

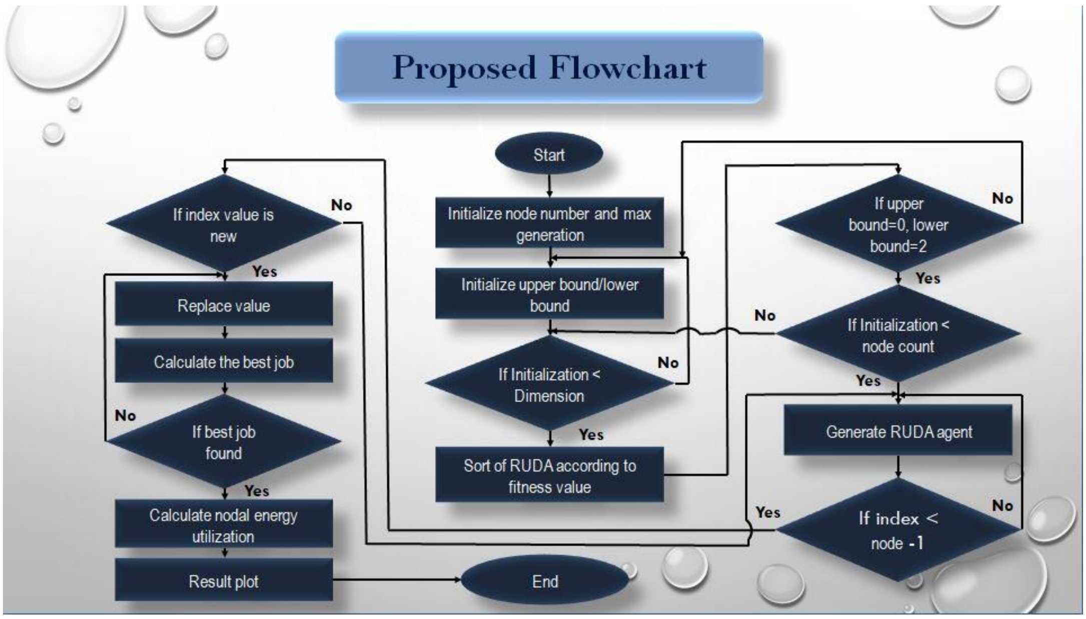
PSO: Particle Swarm Optimization is a method of finding the mathematical solution of the problem in terms of position and velocity .The PSO iteratively calculates the candidate solution by moving particles in the search space. The particles move from the best known position to the other best position calculated using the formula and updates its value for position. Swarm will follow the path calculated by the particles in the search space.

4.5 Proposed Flowchart:

Our Proposed Ruda Algorithm is,

a) **Capacity:** Light has 10000 times wider bandwidth than radio waves. Also, light sources are already installed. So, Ruda has got better capacity and also the equipment are already available.
b) **Efficiency:** Ruda operates using visible light technology. Because offices and homes already use LED light bulbs, the same source of light can be used to transmit data wirelessly. Even though the light needs to be on to transmit data, it's possible to set the Ruda.
c) **Cost:** The Cost of packet transfer is much reduce than previous. So If we use our algorithm then the packet sending rate and

Figure 3: Proposed RUDA Algorithm Flowchart



propagation delay would be much lower than others.

5 APPLICATIONS OF RUDA

5.1 Adaptive Emergency Evacuation :

Ruda creates an optimal schedule for the relocation of victims and resources for an evacuation center. The proposed decision aid model and the adaptive system can be applied in supporting the National Security Council's respond mechanisms for handling disaster management level especially in providing better management of the flood evacuating centers.

5.2 Airlines and Aviation's:

Ruda is often prohibited in aircrafts. Because, its radiation can effect crash to failing the ATC room. However, since aircrafts already contain multiple passenger lights, thus Ruda can be used for data transmission .This will not harm to the navigation system.

5.3 Power Plants and Hazardous Environment:

Power plants still require fast and interconnected data systems for monitoring grid intensity, demand, temperature etc. In place Ruda can provide safe connectivity throughout the power plant. Ruda offers a safe alternative to electromagnetic interference due to radio waves in environments such as petrochemical plants and mines.

5.4 Traffic:

Ruda can be used for communications between the LED lights of cars to reduce and prevent traffic accidents. LED headlights and tail-lights are being implemented for different cars. Traffic signals, signs and street lamps are all also transitioning to LED. With these LED lights in place, ruda can be used for effective vehicle-to-vehicle as well as vehicle-to-signal communications. This would of course lead to increased traffic management and safety.

5.5 RF Avoidance:

Ruda can be used as a solution to any situation in which high sensitivity to radio frequencies is a problem and radio waves cannot be used for communication or data transfer.

To find the single objective of JSSP .The analysis of the experimental results on Firefly algorithm is compared with other algorithms with best known solution. The computational experiment was designed and conducted using twenty five benchmarking datasets of the JSSP instance from the OR-Library published by Beasley.

6 SELECTED LEGAL CHALLENGES REGARDING LI-FI

6.1 Light Sources:

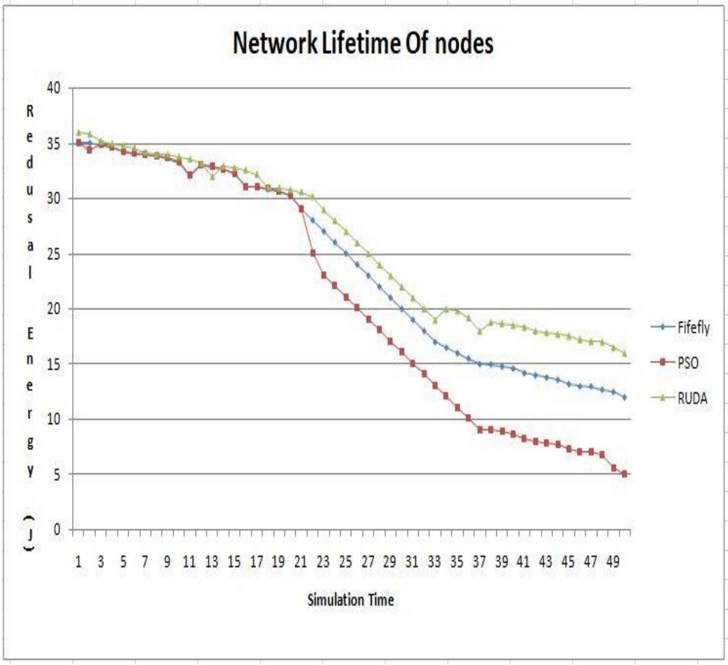
Light Sources : Since ruda requires source, this is a big Issue with ruda technology. During day time though the sunlight cannot reach properly in home but still the data transmission takes place with low data speed. But when in the dark night or where the light cannot reach how people can access their data. So there is a proposed solution given in next chapter.

6.2 Light Wave Blockage:

Light waves can easily be blocked and cannot penetrate thick walls like the radio waves can. The radio and light waves are part of the electromagnetic spectrum, but they are very different. Radio waves are much bigger than light waves. Radio waves are bigger then the size of atoms in a wall that is why they go through, while light is a small wave and cannot get through the wall.

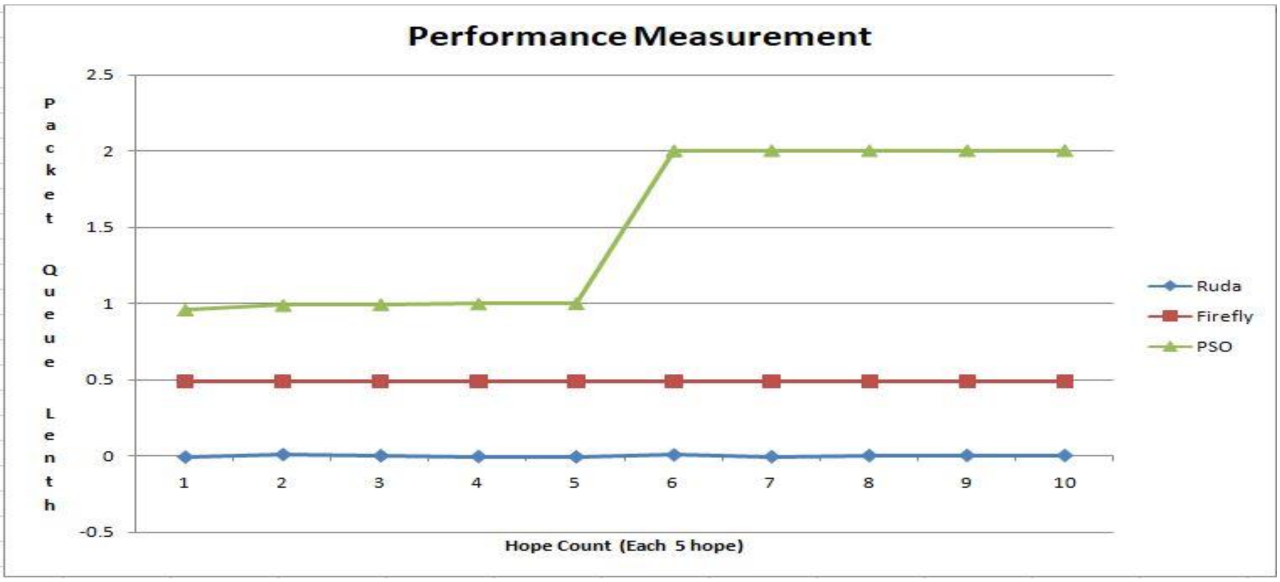
7 COMPARE ANALYSIS

Figure 4: Network Lifetime of nodes.



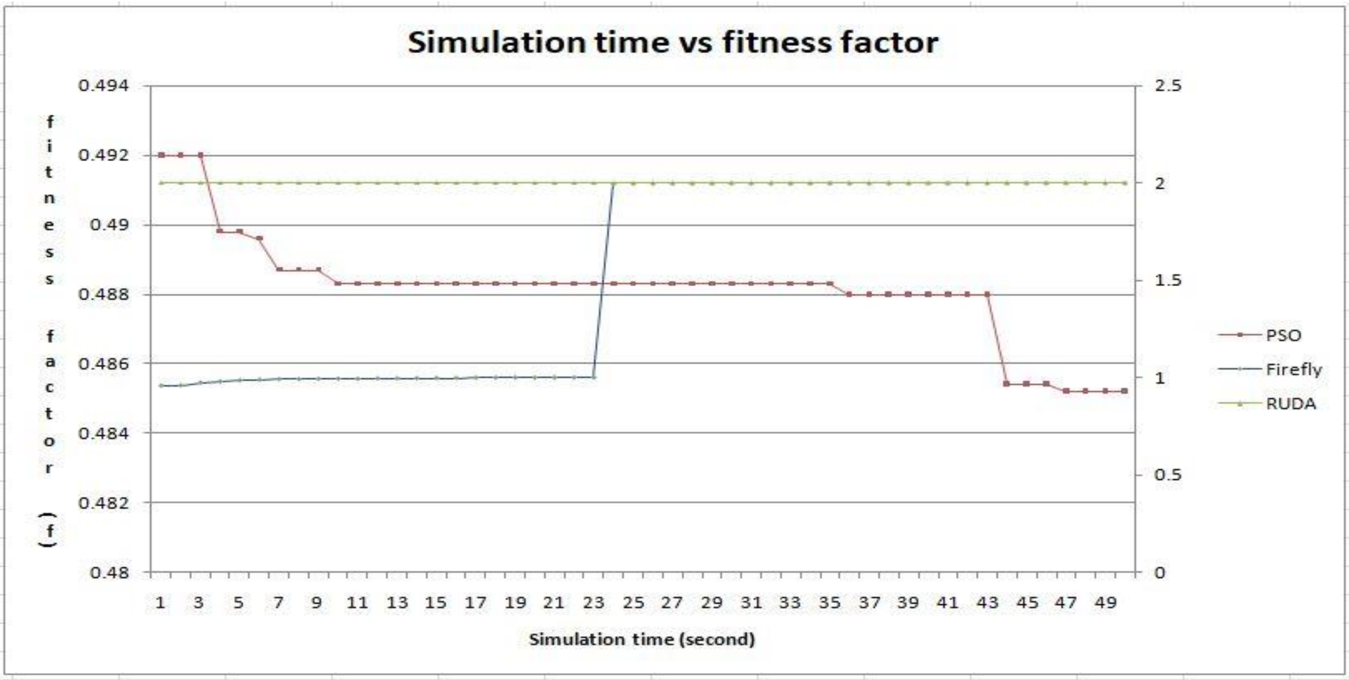
7.1 Performance Measurement:

Figure 5: Performance Measurement



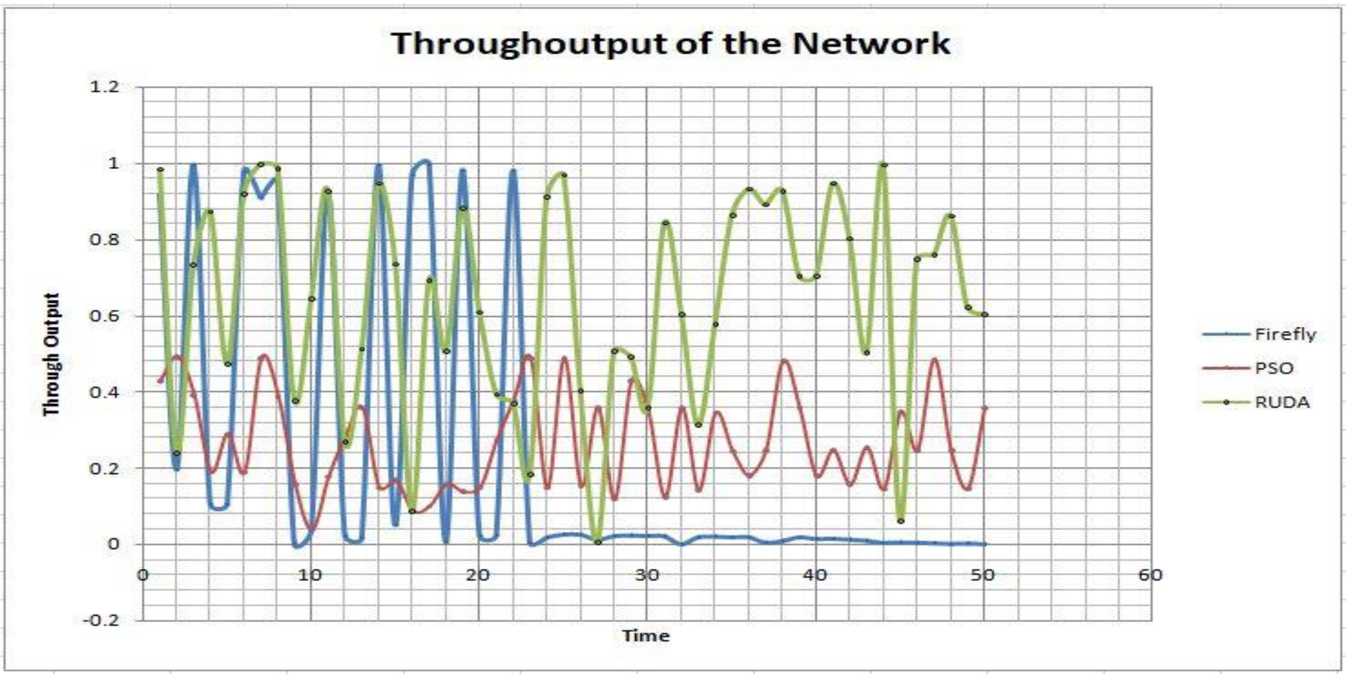
7.2 Simulation Time Vs Fitness Factor:

Figure 6: Simulation Time Vs Fitness Factor



7.3 Throughput of the network:

Figure 7: Throughput of the network



8 RESULT AND DISCUSSION

The graph (fig 8) displays the graph between simulation time and throughput of the network. The graph compares Particle Swarm Optimization (PSO), Firefly Algorithm and proposed RUDA Algorithm based approach. In case of RUDA Algorithm the throughput of the network is greater than the throughput calculated using the PSO algorithm and Firefly algorithm.

The graph (fig 5) displays the graph between the simulation time and the network lifetime of the nodes in the network. the graph showed that the network lifetime of nodes in case of RUDA Algorithm is greater than PSO and Firefly.

The graph (fig 6) shows that the queue length (number of packets) of each node with respect to the simulation time. In the graph, as we see the queue length of each node need time to transmit is much lower than another two algorithm. So our RUDA is much better than PSO and Firefly.

The graph (fig 7) between fitness factor and simulation time for different hop numbers. In our system, the fitness factor is much constant than other two. That means, our proposed system's various parameters like throughput, packets lost, energy are much constant than PSO and Firefly.

9 CONCLUSION & FUTURE WORK

Our Proposed algorithm results display the improvement in network lifetime and the throughput of the network. The graphs verify implementation and display much better result as compared to traditional PSO algorithm and Firefly algorithm.

Network lifetime has measured using the residual energy of node. In future, we can apply other bio inspired algorithms and compare the results with RUDA, Firefly and PSO algorithms.

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