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Enhancing The Performance Of 6lowpan For WSN Using Soft Computing ANFIS Technique

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Abstract:

WSN is gaining its idolization due to its advancement in commutation and composite connectivity. Connecting devices to the internet and transferring data packets via the internet over different heterogamous objects plays a crucial task in today's wireless communication. The enhancement of 6LoWPAN was a significant resolution for dealing with existing wireless communication. As these devices are restrained to low power, less memory, and low –cost. Low bit-rate obtaining low- delay and reduction of energy in a network are becoming essential factors in the field of WSN. In this paper, soft computing technique like ANFIS is used for fine-tuning of parameters like Beacon interval, Back-off-Tx, and Buffer-size to minimize the energy consumption and reduce delay for the 6LoWPAN protocol. This approach used a fuzzy interface system, an experiment has made by using a cooja simulator along with Mat-lab resulted that when compared with De-facto, the Fuzzy Soft Computing technique reduced Power to 5.21%and Delay to 11.765% similarly when we compare De-facto to ANFIS the Power has minimized to 8.36% and Delay is reduced to 12.87%.

1. **Introduction:**

IoT aims to incorporate real-world objects on the internet so that objects can establish a connection and are used for transferring the data packets through the internet to reach the destination in a self-regulating manner. In this view Wireless Local Area Networks, and Wireless Personal Area networks are been admired on a great scale. The utilization of internet protocol (IP) over a WPN or WLAN commenced the growth of IPV6 for WPN, which is Low Power personal area network, this combination of IPv6 and Low Power Personal Area network is defined as 6LoWPAN.

They are a great number of issues associated with 6LoWPAN, the impact of different topologies on the 6LoWPAN network, Energy-related issues, and QoS Metrics. Security, DDOS attacks, etc.

The identification of 6LoWPAN is demanded in the convergence of IPV6 over the IEEE802.15.4 network. This mechanism is applied to small devices in different types of wireless networks like WPN, and WLAN this popularity has vanished the growth of version 4 Low power personal area network (4LoWPAN).

2. **6 Low Power Wireless Area Network**

The 6LoWPAN consists of different layers like the Application layer, Transport Layer, Network layer, Adaptation Layer, IEEE802.15.4 MAC, IEEE802.15.4 PHY. The network consists of different routing mechanisms like mesh routing, Route-over, and Hierarchical routing. And the adaptation layer which is responsible for services like Fragmentation Reassemble, header compression, and Mesh addressing.

The Physical layer is responsible for transferring data packets from MAC and PHY over the radio channel and provides access to its upper layers and maintains a database concerning its wireless personal area.

The MAC data service is to let the transmission and receiving of MAC protocol data units (MPDU) across the PHY data service. In IEEE 802.15.4 standard defined 4 frame structures for the MAC layer: a data frame, a beacon frame, an acknowledgment frame, and a MAC command frame.

Transferring and receiving of (MPDU) MAC protocol data unit is done by the MAC layer. MAC layer contains four different frames namely data, beacon, acknowledgment, and command frame. Where the data frame is responsible for transferring data, Synchronization is achieved with the help of the coordinator. MAC command frame is handled by the MAC management entity.

The 6LoWPAN adaptation layer deals with three foremost elements like fragmentation – reassembling, Header compression, and routing.

The internetworking competence for sensor nodes is taken care of by the network layer and address mapping and routing protocols are the main responsible taken care of by the Network layer.

The transport layer is capable of processing data to the relevant host in the network. UDP and TCP are the protocols applicable for transferring the data packets based on the type of connection established on the application.

A socket interface –API is used by the application layer for a suitable application. A socket that acts as an interface between the transport layer and application layer is used for sending and receiving data packets where the socket is affiliated to either TCP or UDP protocol and destination.

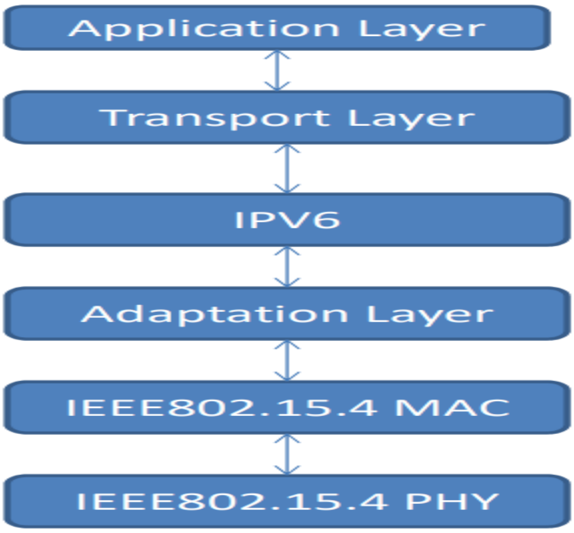

Fig 1: Layers of 6LoWPAN.

3. Literature Review:

Keng et al.,[1] Discussed about different techniques of routing header encapsulation in the 6LoWPAN protocols stack is done and also stated that routing is one of the important aspects of the 6LoWPAN protocol. A new protocol like Hierarchal (Hi-LoW) is used to boost up the network lifetime and did comparison study among AODV, DYMO, LOAD, and Hi-LoW has been done on variables hop-count and control message stated that each routing protocol has its own importance based on usage.

MATUL et al.,[2] stated the existence of 6LoWPAN in the field of heterogeneous networks, reviewed the relation between different layers and their mechanism, and some comparisons between IPV4 and IPV6 also viewed. A part of those routing types are discussed like Mesh Routing, Route -Over, Hierarchal routing and concluded that every routing has its own importance based on its type of network and scalability.

Jen et al.,[3] proposed a WSN application to detect the conducted temperature using Adaptive neuro fuzzy system, ANFIS model is proposed to control the motors present in fans and made an attempt to reduce energy. Discussed architecture for ANFIS based WSN for air condition controller and designed and ANFIS model with logical operations, obtained different output values by changing the values of inputs and the 3D view is used to representation an interfaces system. Proposed many it then rules with their input membership functions to bring out set of inputs and outputs so as to acquire different fuzzy interface system.

Acharya et al.,[4] conducted an research for fault tolerance in Wireless sensor network . The major contribution is done on inter clustering and intra clustering Fault detection in WSN using ANFIS model. The cluster head behaves as a intra fault detector and data collection manager. The cluster head identifies the faulty non cluster heads by using ANFIS mechanism. Further explored different collaborations of fault tolerance cases and also studied the relative representation of the proposed NFOM (Neuro Fuzzy Optimization Model) algorithm and compared with different fault tolerance algorithms like Distributed Fault Detection, Fuzzy Knowledge based Fault Tolerance concluded that the proposed algorithm gives best results in term of energy and network life time and detecting fault.

Vijaykumar et al.,[5]In this paper an ANFIS logic based jamming detection is used in WSN so as to enhance the performance of network and to reduce energy. In this article different jamming techniques are considered and compared with proposed Fuzzy Interference system. Fuzzy model and ANFIS model are done in the MATLAB. Future investigating the performances of ANFIS and FUZZY using Analysis of Variance (ANOVA) it was resulted that ANFIS Jamming detecting system is giving best performance when compared to existing and proposed fuzzy.

Syed et al.,[6] Proposed an ANFIS –Software Fault tolerance approach in Wireless Sensor Networks. Fault models like soft continuous faults, difficult continuous faults, and transited, intermittent faults have been considered for study. The experimentation is done by considering nearly 1200 cell nodes and percentage of faults is varied to 10%,20% 30% 40% in different fault algorithms like(intermittent, transited ,ANFIS-Fault).Observed that the proposed ANFIS model is giving best results and performance in detecting false alarm rate, fault detection and fault positive rates.

Y.V.S.Sai et al.,[7] In this paper Adaptive Neural Fuzzy Interference system is consider to enhance the performance of LAR routing protocol in MANETS. States that when security is integrated to the protocol energy is been increased, so as to reduce the energy an ANFIS –S-LAR approach is considered. Training to the parameters, Network model, if then rule editor are utilized to optimize the energy related issues. And concluded by comparing the ANFIS-S-LAR with Fuzzy-S-LAR ,20% of energy is minimised in ANFIS model and average 0.3% PDR is improved in ANFIS-S-LAR approach.

Srikanth et al.,[8] In this paper an Fuzzy based ICMP-RPL protocol is built so as to reduce the energy the and delay and to increase the network life time. Considered the de-facto ICMP vales of RPL routing protocol and made an attempt to reduce the energy and delay so as to increase the network life time ,No of nodes ,Tx-Ratio are considered as inputs and achieved output as ICMP_Interval. A Triangular membership function is chosen for Tx-Ratio. and concluded that by approaching this fuzzy based ICMP-RPL model the energy is minimised to 3.65% and delay by 3.57% when compared to the static de-facto RPL routing protocol.

C.R.Raman et al,[9] In this research article TORA routing protocol for MANETS is considered. An experimentation is done by comparing the de-facto TORA with Fuzzy TORA so as to optimise the QoS parameters and Energy related issues in this context two modes have been considered proactive and reactive mode ,in proactive mode Throughput was increased by 29.28% in smaller networks, 3.52% in Medium networks and 5.42% in the Large networks. And Throughput was increased by 26.44% in medium, 12.09% in Large Network in Reactive mode.

4. ANFIS MODEL for 6LoWPAN:

6LoWPAN performance using De-facto values of Back off Transmission is not robost for real networks (dynamic).Thus a soft computing technique ANFIS is used for obtaining back off transmission value.

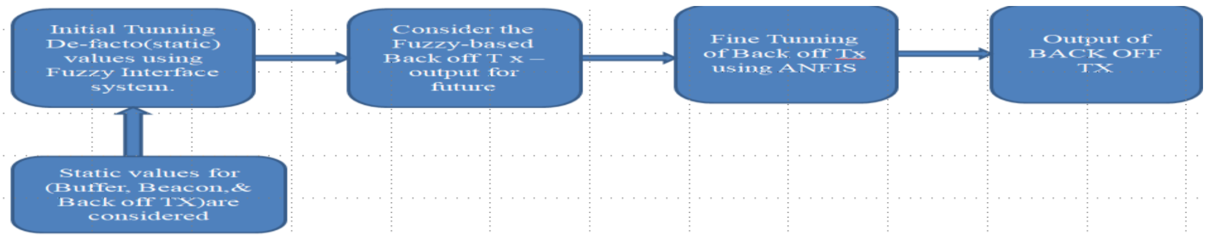

Fig 2: Block Diagram Procedure for Performing ANFIS

The above block diagram shows the strategy of performing the ANFIS modelling.

Adaptive Neuro-Fuzzy Interface System (ANFIS) is a fuzzy model constructed on the bases of Artificial Neural Networks (ANN). Which Fuzzy Logic and ANN can interact to overcome their limitations and also improve the capability of the model. This ANFIS model is used for many industrial and real-time applications like identifying, filtering, minimizing error, regulating noise, etc. In this paper, we use ANFIs to minimize the error and improve the performance of the network.

The ANFIS interface system is implemented by loading data from the workspace which has inputs and outputs. In this experimentation, we are considering two inputs Beacon Interval and Buffer Size to obtain Dynamic Back off Transmission. Each input is comprehended with a triangular membership function, and an epoch is considered as 500 concerning Error Tolerance and generating a Fuzzy Interface System with Grid partition.

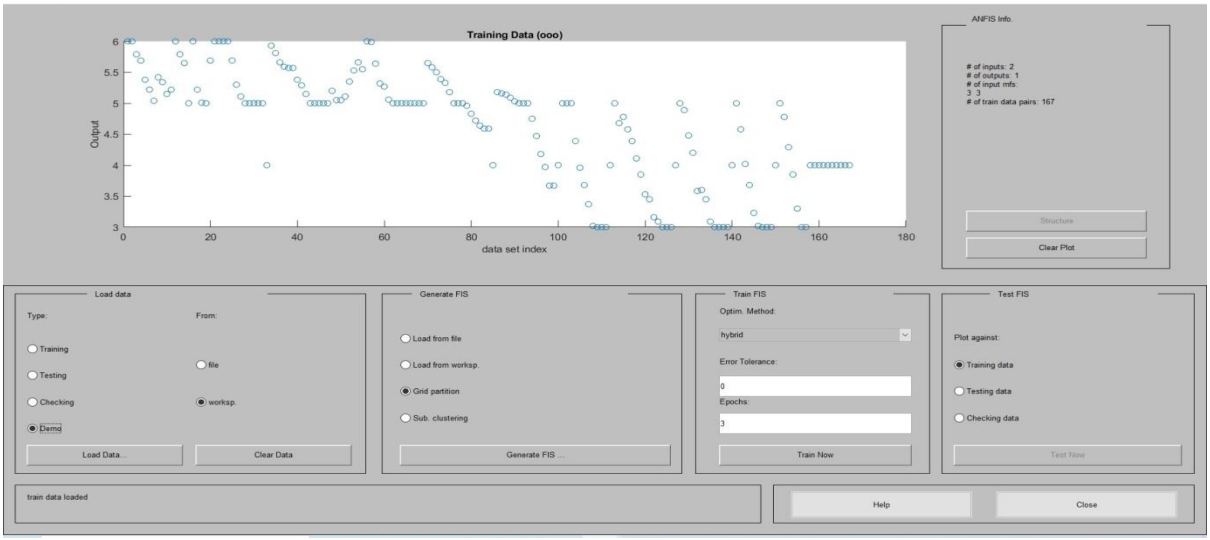

Fig 3: Load Data from Workspace.

The ANFIS are used to train the data with respect to epochs for the input data so as to minimize the error rate and to increase the network life time.

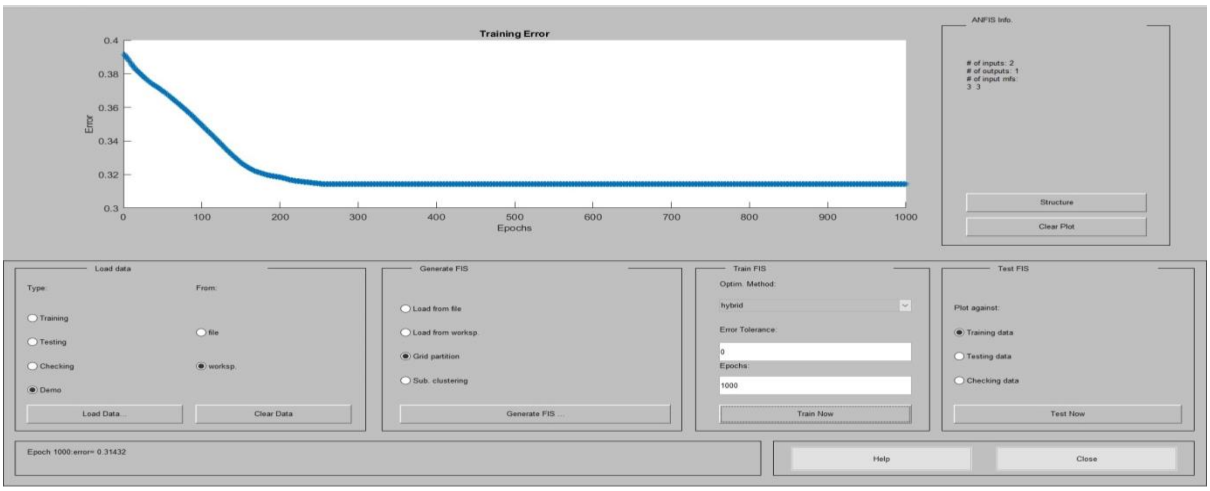

Fig 4: Data Training with Epochs.

The Beacon Interval is taken as first input which has three triangular membership function which ranges from [1 5].The input is taken into consideration for obtaining the Dynamic Back off Transmission which is ranging from 3 to 6.

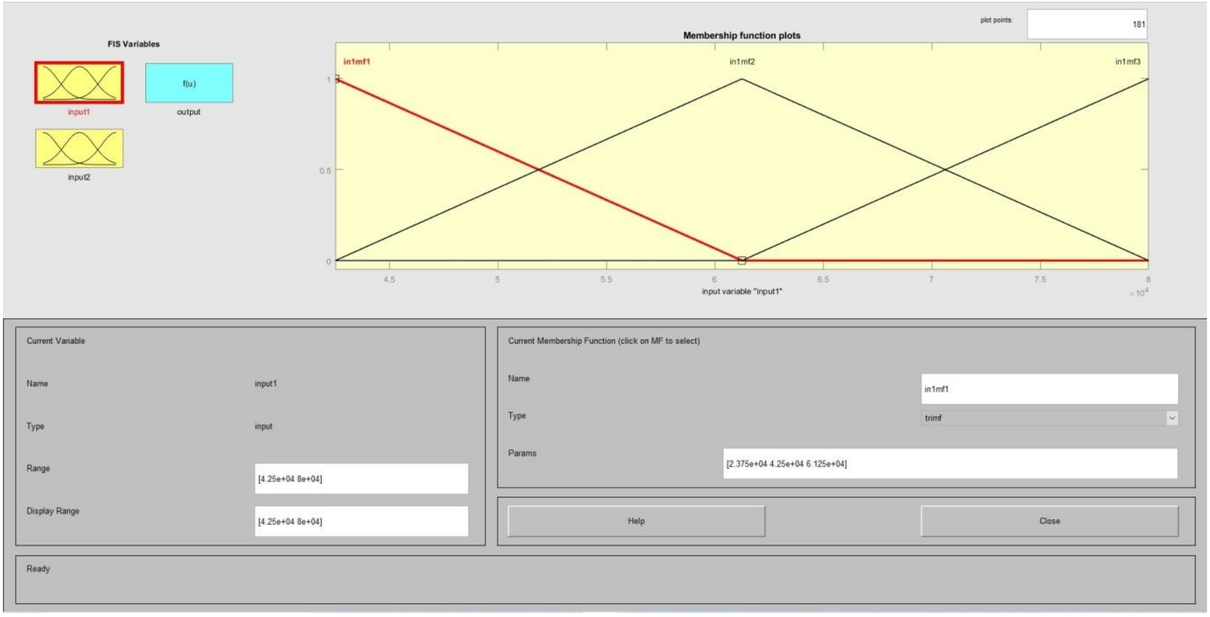

Fig 5: Input1 is Beacon Interval with three Triangular Membership Functions.

The second input is considered as Buffer-Size which is range from [40000 to 80000] which has three triangle membership functions which is seen in membership function plots for obtaining the Dynamic Back off Transmission which varies from 3 to 6.

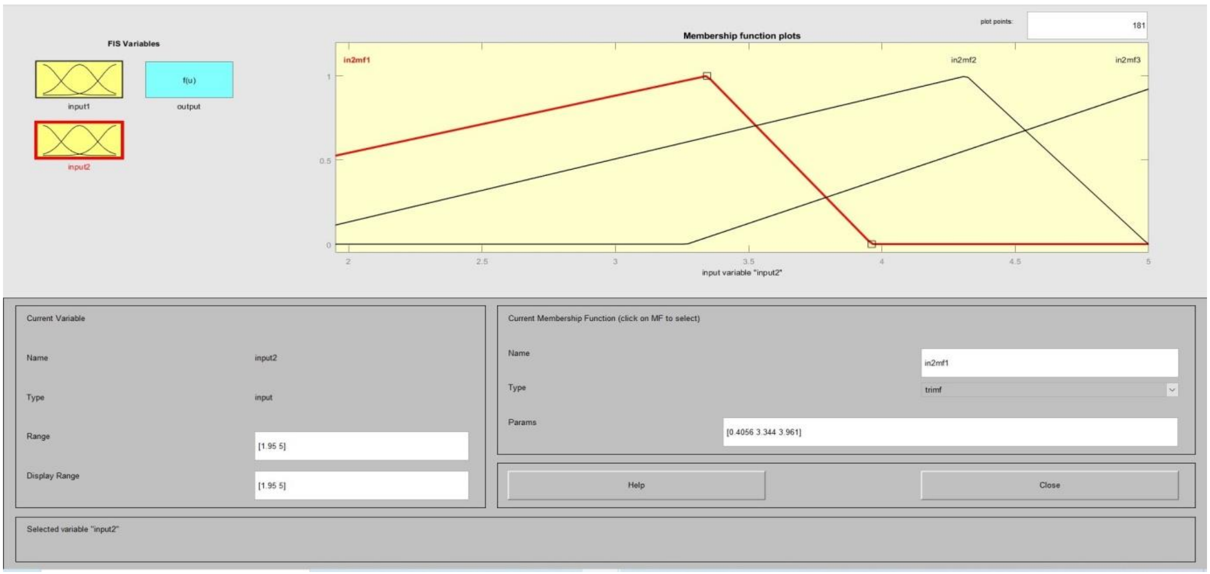

Fig: 6 Input 2 is Buffer Size with three Triangular Membership Functions.

Fig 7: Output Layout with nine membership functions for Back off Transmission.

The ANFIS outputs have been achieved using Fuzzy Logic Viewer which is generated by ANFIS which leads to Fine Tunning of De-facto parameters for WSN. After training the data with respect to epochs the output Back off Tx has improved from 6 to 6.663 which can be seen in ruler view.

Fig 8: Shows the ruler view of trained data

The Surface viewer shows the 3D view, for the input1 as Beacon interval and Input 2 as Buffer Size and Back off TX is considered as output.

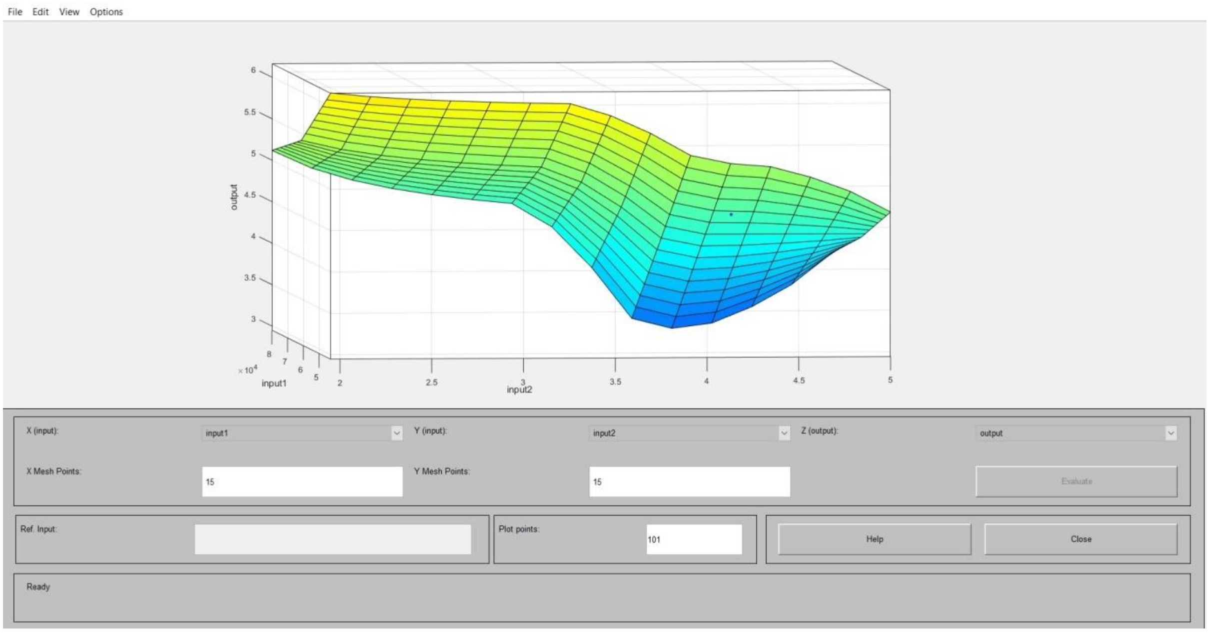

Fig 9: shows the 3D view of the ANFIS model

The tabulated data can be seen the parameters which are being consider and the respective values of those parameters for deriving results.

Parameters	Values
Radio channel	UDGM
TX Ratio, Rx Ratio	100%,100%
Nodes	10,20,30,40
Topology	Mesh
Traffic	CBR(Constant Bit Rate)
Buffer size	40000,5000,60000,70000,80000
Beacon Interval	1000,500
Back off Tx	2,3,5,6,
Simulator time	300 sec

Table 1: Parameters for Simulation

5. Result Analysis:

Power: It is the amount of energy generated by sink nodes to transfer packets from source to destination, the summation of CPU-time, Listen-time, transmit time is considered as power.

The Experimentation is based on Back off Transmission output values generated by Fine Tunning of input parameters using ANFIS Soft Computing Technique for different sizes of networks.

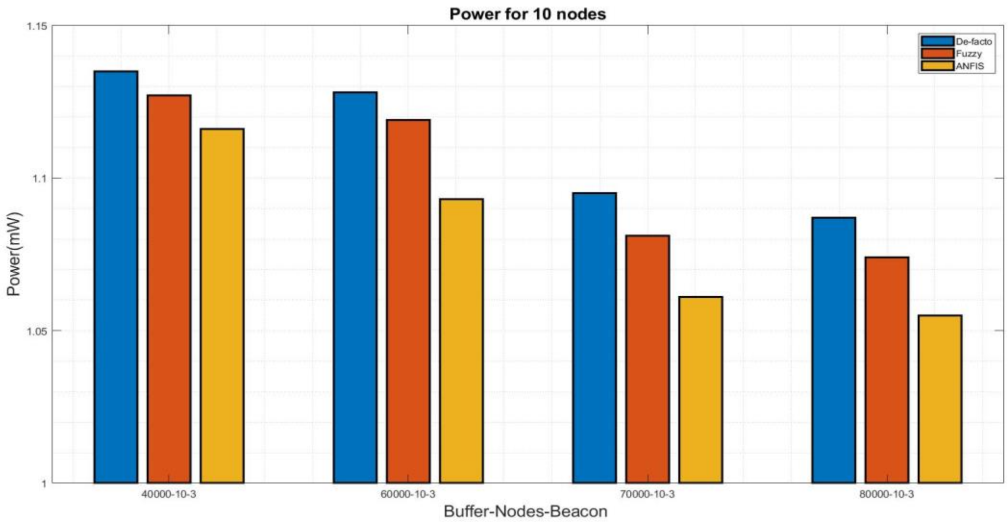

Fig 10 (a): Power reduced by AFIS for 10 nodes network.

In the Fig 10(a) we considered Beacon Interval as 1000, No of Nodes as 10 and Buffer size ranged from 40000,50000,70000,80000. The combination of thee parameters (Buffer size. No of nodes, Beacon Interval are taken on X-axis and power is taken on Y-axis.

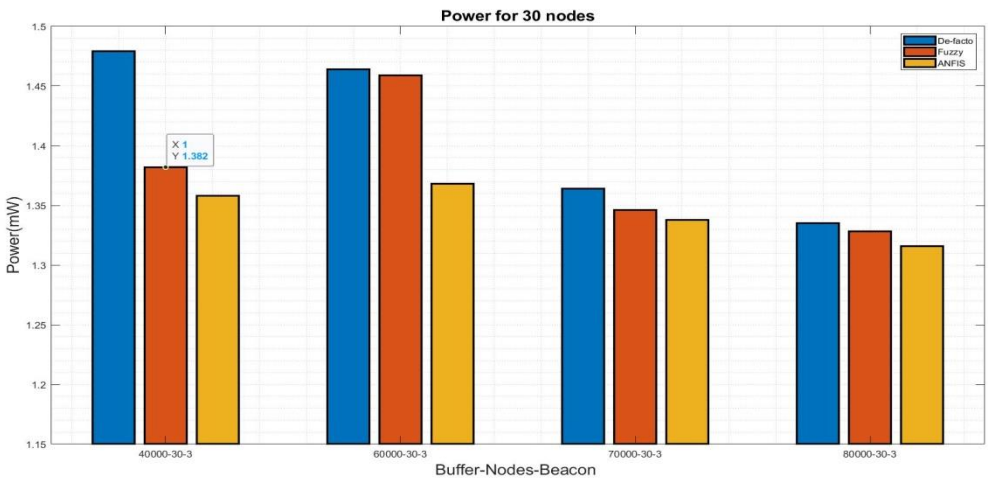

Fig 10 (b): Power reduced by AFIS for 30 nodes network

From the Figure 10(b) it was shown by comparing the De-facto, Fuzzy, ANFIS values for different parameters like Buffer size, Beacon interval and No of nodes which are considered on X-axis and Power on Y –axis.

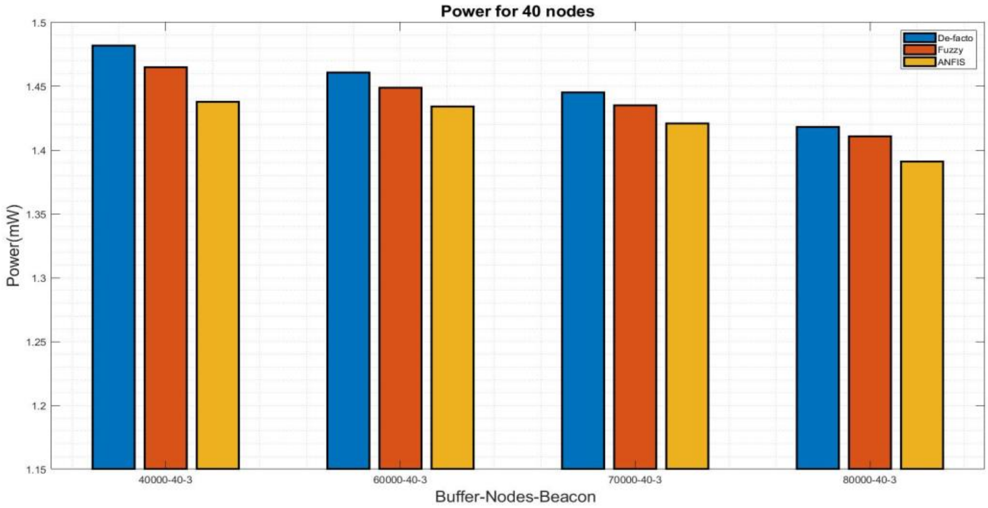

Fig 10 (c) Power reduced by AFIS for 40 nodes network

In the Figure 10(c) we considered Beacon interval as 1000, No of Nodes as 40 and Buffer size varied as 40000,50000,70000,80000. The combination of thee parameters (Buffer size. No of nodes, Beacon Interval are considered on X-axis and Power is considered on Y-axis.

Delay:

The amount of time taken for the packets sent from source to destination in a given network we considering end to end delay.

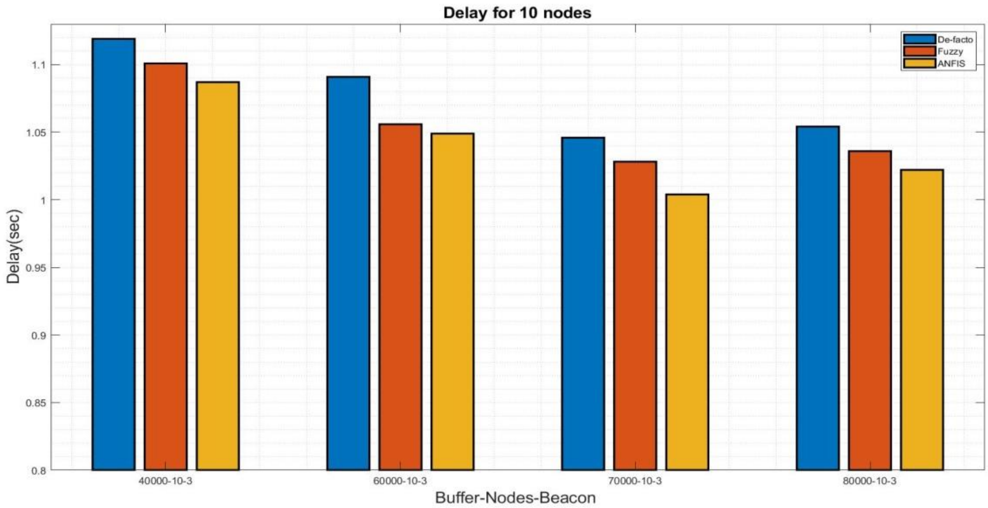

Fig11 (a). Delay reduced by ANFIS for 10 nodes network

In the Figure 11(a) we have No of nodes as 10 Beacon interval- 500 and Buffer sizes are 40000,60000,70000,80000 on X-axis and Delay on y Axis for De-facto, Fuzzy ,ANFIS are considered.

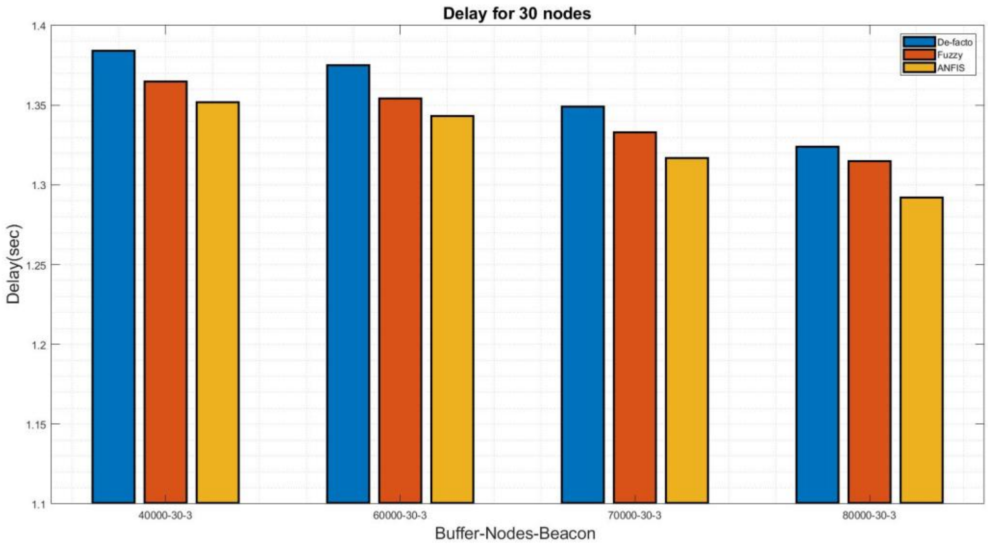

Fig11(b):Delay for 30 nodes

In the figure the X-axis vales are Buffer size, Beacon Interval, No of nodes and on Y-axis Back off Tx is consider which is varied in three scenarios De-facto, Fuzzy, ANFIS.

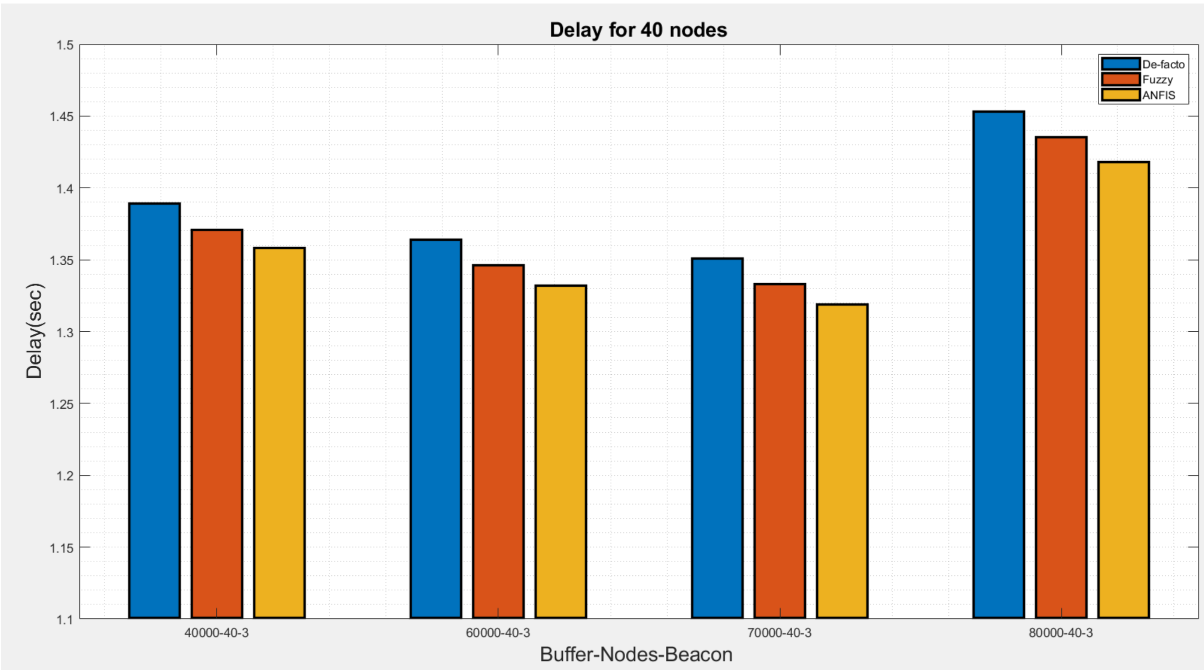

Fig11(c): Delay for 40 nodes

In the Fig11(c): Delay is observed for large network size of nodes consisting of 40 nodes Buffer size are 40000,60000,70000,80000 with Bean Interval 3,for De-facto, Fuzzy, ANFIS techniques.

6: Conclusion:

From the Experimentation study, it was revealed that by using soft computing techniques like Adaptive Neural Network (ANFIS) the (static) De-facto Back off Transmission has been fine-tuned to achieve (dynamic) Back off Transmission, to minimization of parameters like power and delay as they play a crucial rule in the area of wireless Sensor Networks which is a challenging task. To add with this experimentation will improve the network lifetime in different sizes of networks, for random topology.

It revealed that when compared with De-facto, the Fuzzy Soft Computing technique reduced Power to 5.21%and Delay to 11.765% similarly when we compare De-facto to ANFIS the Power has minimized to 8.36% and Delay is reduced to 12.87%.

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