Transmission Power Based Intelligent Model in VANET

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Abstract —Vehicular ad-hoc networks is very popular research domain in which research work is going on at various aspects like routing the data without loss end-to-end. Routing in such networks is very tedious task due to frequently changing the position of vehicles location-wise. In this paper an intelligent model has been developed on the basis of adaptive neuro fuzzy system for OLSR routing protocol in VANET. The proposed model is designed based on input parameters average goodput and mac/phy-overhead. Based on these parameters, transmission power can be predicted. Triangular and Gaussian membership functions have been applied for designing the decision model. A comparison work also has been carried out for Gaussian, triangular functions and NS-3 based results. At the same time, the model is investigated by simulation work carried out on network simulator-3 (NS-3) platform.

***Index Terms*—**Goodput, mac-overhead, transmission power, ANFIS, triangular MF

I. Introduction

Wireless communication is developing rapidly with time worldwide. Researchers are working nowadays mostly in the field of wireless communication. Vehicular ad-hoc network is the most likely domain research area in wireless communication. VANET networks are developing with the passage of time In view of aforesaid, in this paper we have enhanced OLSR routing protocol in VANET [1]. After reviewing and analyzing the literature work, we have proposed an intelligent model for OLSR in VANET network.

VANET is a type of ad-hoc network which manages its data transmission system itself without any dependency on any other infrastructure.

Routing in vehicular ad-hoc network is a very challenging task without loss of transmission data. In such a network environment, routing protocols are required to enhance the efficiency in respect of average goodput and overhead.

OLSR routing protocol [2]:

- ✓ OLSR refers to optimized link state routing
- ✓ OLSR is specially designed for MANET
- ✓ It is a proactive routing protocol
- ✓ It is enhanced version of link state algorithm that was designed especially for wireless local area networks
- ✓ MPRs(Multi Point Relays) is the main concept that is used on OLSR routing protocol
- ✓ To reduce the message overhead, OLSR is used
- ✓ Optimal routes are provided by OLSR routing protocol
- ✓ If there is a dense and big size wireless networks, in that environment, OLSR is best suitable routing protocol
- ✓ OLSR is a proactive table driven routing protocol
- ✓ OLSR can work independently without any support
- ✓ At random traffic, OLSR works well
- ✓ Hop to hop routing concept is used in OLSR
- ✓ Reliable transmission is not required in OLSR
- ✓ Format of IP packets is well suitable for OLSR routing protocol. There is need to change that format.
- ✓ Port number 698 and UDP are used during packets communication process in OLSR

As OLSR was developed especially for mobile ad-hoc networks, it will not work well in respect of performance in VANET. To improve the performance of OLSR in VANET, some modifications are required. OLSR routing protocol is enhanced through ANFIS based model based on average goodput, overhead and transmission power. Model is designed, analysed and at the same time, it is verified at the platform of NS-3 (network simulator-3).

Section II presented the literature review of the related research work. Methodologies, findings, and comparison work is described in this section. ANFIS based proposed intelligent model for OLSR routing protocol in vehicular ad-hoc networks is elaborated in section III. A verification and justification work for proposed intelligent model is carried out at NS-3 (network simulator-3) through simulation tests. This paper is concluded through section-IV. All findings and summarization of the paper is described in this section.

II. Related Work

In [3] *et al.* proposed an intelligent stabilization framework is designed by Ramanpreet Kaur using neuro fuzzy system. The multi-stage nodes have been used to develop the proposed framework. Two modules have been used in proposed intelligent stabilization framework: decision module with finger table, neuro fuzzy based prediction module with observation data. In ANFIS

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structure, four input parameters with Gaussian, triangular and bell-shaped membership functions were applied to produce the output. Total 160 rules were designed with 60 non-linear parameters. It was claimed that proposed framework works with more accuracy.

In [4], to detect the black hole attack, an adaptive neuro fuzzy inference system based scheme has been designed. To improve the efficiency of ANFIS, particle swarm optimization technique has been used. The performance of proposed scheme is evaluated at network simulator-2 in MANET environment. Total 200s simulation time was carried out with UDP-CBR traffic type. It was claimed that proposed ANFIS and PSO based scheme has an effective black hole detection rate and low false alarm rate.

Data aggregation scheme has been proposed by Sasmita Acharya and C R Tripathy [5] for wireless sensor networks. the proposed scheme is designed with the help of adaptive neuro fuzzy interface system. ANFIS estimator used in proposed scheme has four inputs and one output. Four input parameters are: residual node energy, packet delivery ratio, fault ratio, and number of re-transmissions. The linguistic variables were used: very low, low, medium, and high. Five different simulation cases were designed to evaluate the proposed scheme.

In [6] Y.V.S. Sai Pragathi et al. used ANFIS to enhance the efficiency of LAR (Location aided routing) routing protocol in mobile ad-hoc network. ANFIS based proposed model reduces the energy consumption as compared to secure LAR and LAR. Two input parameters are considered with three linguistic variables (for each input) to produce the output. The proposed method is evaluated through simulation work at the platform of network simulator-2. Simulation work was carried out for 100 seconds varying the network size. Proposed model was compared with LAR and S-LAR using performance metrics like average packet delivery ratio, throughput, average energy consumed overhead, average end-to-end delay. It was declared that proposed ANFIS based model is energy saving model as compared to LAR and S-LAR routing protocol.

ANFIS based multiple quality of service (QoS) routing is presented using static and dynamic agents [7]. The five steps were followed by the scheme using three different types of agents (route creation agent, optimization agent, and manager agent). The proposed scheme used ANFIS which has three input parameters with 4 rules. To compute the inputs, Sugeno method has been applied. Quality of service is produced using bandwidth, delay, and protocol loss rate. The proposed QoS routing scheme is simulated at MAT Lab 7.0 and implementation of output was carried out using C programming language. To evaluate the efficiency of proposed scheme, several performance parameters were used: packet delivery ratio (PDR), path success ratio (PSR), average end-to-end delay (Average E2E delay), overall control overhead, average number of hops. It was observed that proposed scheme works well as compared to SATR (Shortest Agent Tree Routing) scheme.

In [8], Wafa Benaatou *et al*. proposed an intelligent vertical handover system based on ANFIS to decide the best destination network. To reduce the energy consumption and unnecessary handovers, the proposed approach was designed. ANFIS model having three inputs (SNR, Bandwidth, Energy consumption) with three linguistic variables. Total twenty seven fuzzy rules were designed with 78 nodes. To implement the proposed scheme, MATLAB have been applied. A comparison work was carried out for ANFIS**,** Fuzzy logic, SNR, RSS and traditional approach. It was claimed that proposed ANFIS algorithm works well to minimize handover and energy consumption as compared to other traditional approaches.

Pushpender Sarao proposed an enhancement and comparison work [9], [10] for AODV, DSR, and DSDV routing protocol. For comparison purpose, simulation work was carried out on network simulatror-2 (NS-2.35) with performance metrics as throughput, delay, average delay and Normalized Routing Load (NRL) while in enhancement of AODV routing protocol, MAT Lab and NS-2 are used for developing and simulating the proposed model. With the help of fuzzy logic tool kit of MAT Lab, a model was designed for AODV routing protocol. A comparison work was also carried out for proposed routing protocol and existing routing protocol like AODV, DSR, and DSDV.

III. ANFIS BASED INTELLIGENT MODEL

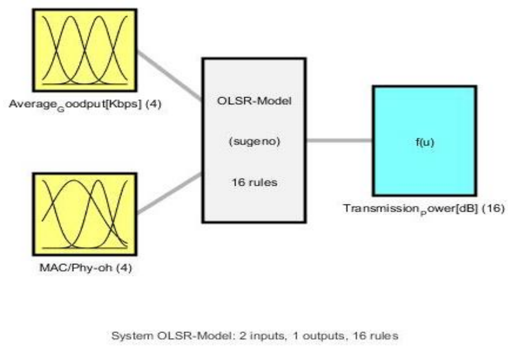

Fig. 1. OLSR-Model with 2 inputs, 1 output, 16 fuzzy rules

An ANFIS based intelligent model, (see Fig. 1) to analyze the transmission effects have been proposed. We have used triangular membership functions and Gaussian membership functions (see Fig. 2, 3, 4, and Fig. 5). Total 16 fuzzy rules were designed both for triangular and Gaussian membership functions. Two input parameters (Table I, II) (average goodput and MAC/Phy overhead) were used to produce one output parameter ‘Transmission power’ (Table III). The linguistic variables were used as: Low, Medium, High, and Very High. Adaptive neuro fuzzy information system was designed with following details as detailed: Data sets=2Training data set(25) Checking data set(15) Train FIS: optimization method=hybrid Error Tolerance=100 Epochs=50 ANFIS Information: No. of inputs=2, No. of outputs=1 No. of Input membership functions=2(4, 4) Output-MF Type=linear For generating FIS, we have chosen Grid Partition option. The detailed input parameters and output parameter are described in table, table, and table.

TABLE I: INPUT PARAMETER 'AVERAGE GOODPUT PARAMETERS

Input-I			
Membership function Name: Average Goodput[Kbps]			
Variable Name	**Range**	**Membership function type**	**Params**
Low	[7.066 17.51]	Gaussmf	[1.478 7.066]
Medium	[7.066 17.51]	Gaussmf	[1.479 10.55]
High	[7.066 17.51]	Gaussmf	[1.478 14.03]
V High	[7.066 17.51]	Gaussmf	[1.479 17.51]

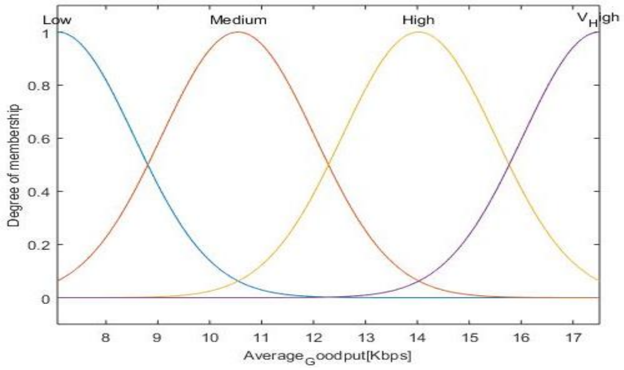

Fig. 2. Input membership function 'Average Goodput'

TABLE II: MEMBERSHIP FUNCTION MAC/PHY OVERHEAD PARAMETERS

Input-II			
Membership function Name: MAC/Phy-oh			
Variable Name	Range	Membership function type	Params
Low	[0.296 0.368]	Gaussmf	[0.01019 0.296]
Medium	[0.296 0.368]	Gaussmf	[0.01963 0.3227]
High	[0.296 0.368]	Gaussmf	[0.008937 0.3434]
V High	[0.296 0.368]	Gaussmf	[0.009224 0.3688]

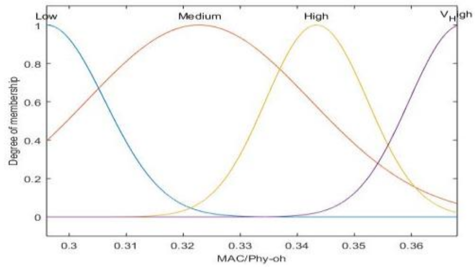

Fig. 3. Input membership function 'MAC/Phy-oh'

TABLE III: OUTPUT PARAMETER 'TRANSMISSION POWER' PARAMETER

Output	
Membership Function Name	**Transmission Power[dB]**
Range	[1 40]
Params	[-2.378 -0.7498 25.83]

ANFIS refers to adaptive network based fuzzy inference system. ANFIS is very strong system which is the combination of fuzzy logic system and neural networks [11], [12]. ANFIS structure has five layers. ANFIS rule base have fuzzy rules (if then rules). Weighted output of each rule is combined into one output at layer five. fis = anfis(trainingData) generates a single-output Sugeno fuzzy inference system (FIS) and tunes the system parameters using the specified input/output training data. The FIS object is automatically generated using grid partitioning.

TABLE IV: ANFIS INFORMATION (TRIANGULAR MEMBERSHIP FUNCTION)

Parameter	Value
Number of nodes	53
Number of linear parameters	48
Number of nonlinear parameters	24
Total number of parameters	72
Number of training data pairs	25
Number of checking data pairs: 15	15
Number of fuzzy rules: 16	16

Different values for ANFIS parameters were considered as shown in Table IV.

```
FUZZY RULES(GAUSSIAN MEMBERSHIP FUNCTION)
>> fis= readfis('OLSR-Model.fis')

fis =

        name: 'OLSR-Model'
        type: 'sugeno'
   andMethod: 'prod'
    orMethod: 'probor'
 defuzzMethod: 'wtaver'
   impMethod: 'prod'
   aggMethod: 'sum'
       input: [1x2 struct]
      output: [1x1 struct]
        rule: [1x16 struct]

>> plotfis(fis)
>> showrule(fis)

ans =

1. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf1) (1)
2. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf2) (1)
3. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf3) (1)
4. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf4) (1)
5. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf5) (1)
6. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is
```

```
Medium) then (Transmission_Power[dB] is out1mf6) (1)
7. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf7) (1)
8. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf8) (1)
9. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf9) (1)
10. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf10) (1)
11. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf11) (1)
12. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf12) (1)
13. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf13) (1)
14. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf14) (1)
15. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf15) (1)
16. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf16) (1)

>> neuroFuzzyDesigner

ANFIS info:
        Number of nodes: 53
        Number of linear parameters: 48
        Number of nonlinear parameters: 16
        Total number of parameters: 64
        Number of training data pairs: 25
        Number of checking data pairs: 15
        Number of fuzzy rules: 16


Start training ANFIS ...

  1        0.964402   9.99149
  2        1.05865    10.7944
```

```
FUZZY RULES (TRIANGULAR MEMBERSHIP FUNCTIONS)
>> neuroFuzzyDesigner

ANFIS info:
        Number of nodes: 53
        Number of linear parameters: 48
        Number of nonlinear parameters: 24
        Total number of parameters: 72
        Number of training data pairs: 25
        Number of checking data pairs: 15
        Number of fuzzy rules: 16

Warning: number of data is smaller than number of modifiable parameters

Start training ANFIS ...

  1        1.21863    11.3294
  2        0.946617   10.0429

Designated epoch number reached --> ANFIS training completed at epoch 2.

>> fis= readfis('OLSR-MODEL-Triangular.fis')

fis =
```

```
          name: 'OLSR-MODEL-Triangular'
          type: 'sugeno'
     andMethod: 'prod'
      orMethod: 'probor'
  defuzzMethod: 'wtaver'
     impMethod: 'prod'
     aggMethod: 'sum'
         input: [1x2 struct]
        output: [1x1 struct]
          rule: [1x16 struct]
>> gensurf(fis,1)
>> gensurf(fis,2)
>> showrule(fis)

ans =

1. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf1) (1)
2. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf2) (1)
3. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf3) (1)
4. If (Average_Goodput[Kbps] is Low) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf4) (1)
5. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf5) (1)
6. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf6) (1)
7. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf7) (1)
8. If (Average_Goodput[Kbps] is Medium) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf8) (1)
9. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf9) (1)
10. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf10) (1)
11. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf11) (1)
12. If (Average_Goodput[Kbps] is High) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf12) (1)
13. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is Low) then (Transmission_Power[dB] is out1mf13) (1)
14. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is Medium) then (Transmission_Power[dB] is out1mf14) (1)
15. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is High) then (Transmission_Power[dB] is out1mf15) (1)
16. If (Average_Goodput[Kbps] is V_High) and (MAC/Phy-oh is V_High) then (Transmission_Power[dB] is out1mf16) (1)

>> plotfis(fis)
```

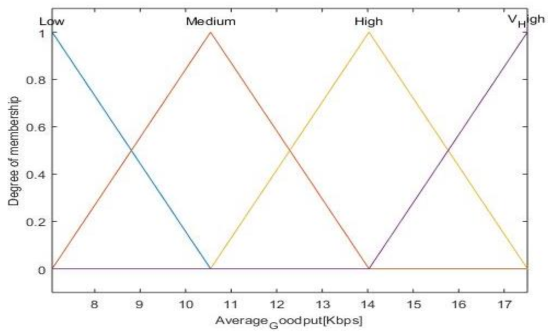

Fig. 4. Membership function 'Average Goodput'

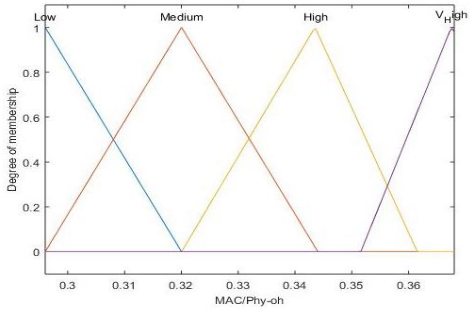

Fig. 5. Membership function 'MAC/Phy-Overhead'

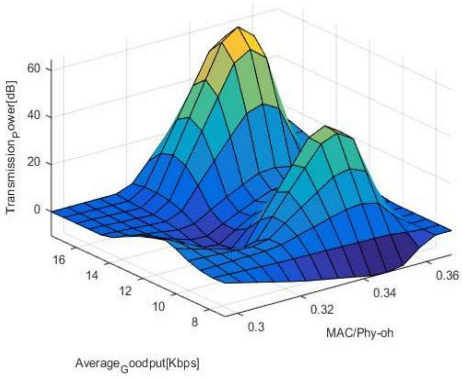

Fig. 6. Surface plot(triangular membership functions) for transmission power with average goodput and MAC/Phy overhead

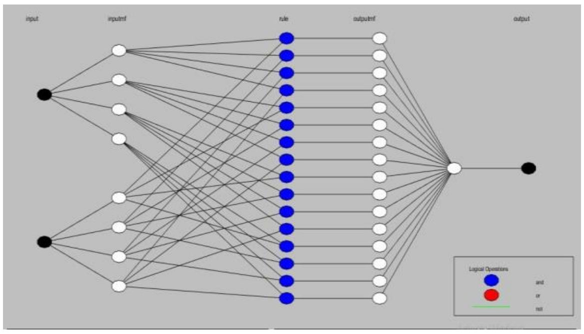

Fig. 7. ANFIS architecture RMSE of the ANFIS model during training

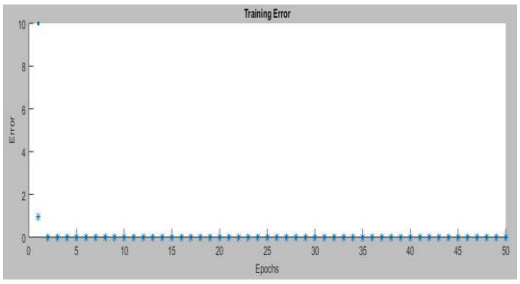

Fig. 8. Training data training

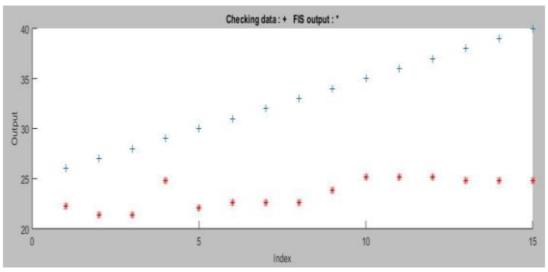

Fig. 9. Checking data training

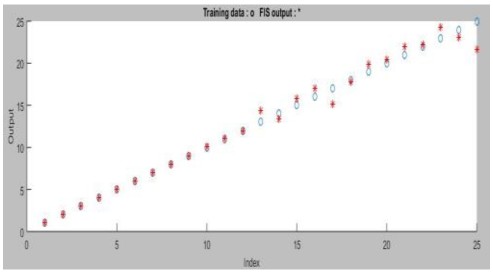

Fig. 10. Training data with output

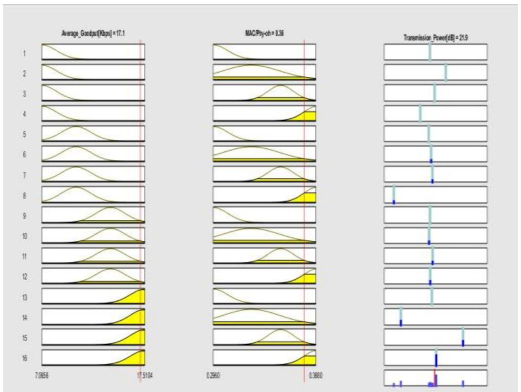

Fig. 11. Fuzzy rule viewer

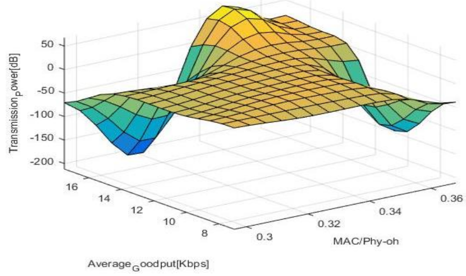

Fig. 12. Output Surface plot for transmission power with average goodput and MAC/Phy overhead

On our proposed ANFIS architecture (Fig. 7), two types of data training processes were executed: training data and checking data (see Fig. 8, Fig. 9, Fig. 10). Finally we got some outputs: fully rule viewer (see Fig. 11) with results and surface viewer (Fig. 6, Fig. 12) exploring the transmission effects.

IV. Fuzzy Results

Transmission power required in respect to average goodput and MAC/Phy-overhead is shown in table V. From table, it has been observed that at constant overhead, when average goodput is increased, transmission power is required more, but as average gooodput is required more, transmission power also varies up and down. When average goodput is keeping constant, but MAC/Phy-overhead is increasing the transmission power is also increased. But at some cases, when average goodput and MAC/Phy-overhead is kept at constant position, transmission power is also required at constant position i.e. no variation for transmission power. In table, transmission power with Gaussian membership functions and triangular membership functions is analysed in respect of average goodput and MAC/Phy-overhead. Transmission power required less for average goodput at low overhead for Gaussian membership functions as compared to transmission power with triangular membership functions. The proposed ANFIS model gives more accurate results (as shown in Table V) with Gaussian membership functions as compared to triangular membership functions.

TABLE V: TRANSMISSION POWER WITH TRIANGULAR AND GAUSSIAN MEMBERSHIP FUNCTIONS

Sr. No.	Average Goodput	MAC /Phy-oh	Transmission Power[dB] [Gaussmf]	Transmission Power [Triangular]
1	8.6	0.31	5	5
2	7.97	0.333	3.21	3.98
3	9.68	0.333	8.22	19.1
4	10	0.366	15	12.8
5	11.9	0.333	6.51	5.21
6	13.9	0.333	2.42	7.17
7	15.4	0.333	-15.7	32.1
8	15.8	0.368	17	12.2
9	16.6	0.333	-4.96	32.3
10	17.2	0.333	-69.6	25.3
11	12.1	0.31	-1.95	-1.21
12	12.1	0.317	1.96	-5.72
13	12.1	0.328	5.41	-0.456
14	12.1	0.337	7.52	7.13
15	12.1	0.348	3.18	12.4
16	12.1	0.36	-66.6	3.13
17	12.1	0.366	-89.5	2.18
18	20.5	17.5	0.36	16.4
19	21.7	0.36	17.3	20.8
20	21.9	0.36	17.1	19.5
21	25.2	0.359	17.1	19.5

V. SIMULATION SETUP FOR OLSR IN VANET

OLSR:

Fuzzy results got from ANFIS model are verified at the platform of NS-3(Network Simulator-3). Also a comparison work for ANFIS values and NS-3 values is carried out and analysed with proper justification.

OLSR is simulated on NS3 network simulator for 15 seconds in Vehicular Ad-hoc Network (VANET) scenario. Several simulation parameters were taken as shown in table VI. Total 40 vehicles were considered in the region size 300×1500 m. all nodes (vehicles) transmits safety message of 200 bytes safety message 10 times per second at 6 Mbps. In our experimental work, mainly goodput and MAC/Phy-overhead were considered as performance parameters. Transmission power was taken with a rage 5dB to 35 dB. All the 40 vehicles have a maximum speed of 15 m/s during all the simulation work. Goodput is the useful data received per unit time in a particular network.

TABLE VI: SIMULATION PARAMETERS FOR NS-3

Simulation Parameter	Value
Simulator Type	NS3
Network Type	VANET
No. of nodes(Vehicles)	40
Region	300×1500 m
Wi-Fi	802.11p
Control Channel	10 MHz
Transmission Range	145 m
No. of routing sinks	10
Wave packet size	200
GPS Accuracy	40
PhyMode	802.11p
Data Rate	2048 bps
Fading	0
Mobility	Trace
PhyModeB	802.11b
Verbose	0
Loss Model	Friis
Intervals	0.2 s
Protocol	OLSR
Transmission Power	5,10,15,20,25,30,35 dB
Pause time	20s
Simulation time	15s
Speed	15 m/s

TABLE VII: TRANSMISSION POWERS FOR GAUSSIAN MEMBERSHIP FUNCTIONS

Transmission Power	Average Goodput	MAC/Phy-oh
5	8.6	0.31
10	15	0.366
15.8	17	0.366
20.5	17.5	0.36
21.7	17.3	0.36
21.9	17.1	0.36
25.2	17.1	0.359

TABLE VIII: TRANSMISSION POWERS FOR TRIANGULAR MEMBERSHIP FUNCTIONS

Transmission Power	Average Goodput	MAC/Phy-oh
5	8.6	0.31
9.83	15	0.366
15.2	17	0.368
20.7	17.5	0.36
21.6	17.3	0.36
21.8	17.1	0.36
25.1	17.1	0.359

TABLE IX: TRANSMISSION POWERS FOR NS-3

Transmission Power	Average Goodput	MAC/Phy-oh
5	8.6016	0.310067
10	14.9845	0.36607
15	16.9984	0.368031
20	17.5104	0.360045
25	17.2715	0.359846
30	17.0667	0.359882
35	17.0667	0.358948

A comparison work is carried out (as shown in table VII, VIII, IX) for transmission power required as per NS-3, ANFIS(Gaussian), ANFIS(Triangular) with respect to average goodput and MAC/Phy-overhead. It has been analysed that at initial stage of average goodput at constant overhead, transmission power(ANFIS) required more as compared to transmission power(NS-3). But, at later stages, transmission power (ANFIS) at little bit higher overhead required less as compared to transmission power (NS-3). Transmission power (ANFIS-Gaussian) and transmission power (ANFIS-Triangular) is required approximately same at all cases. It has been identified that our proposed intelligent model is 90% accurate.

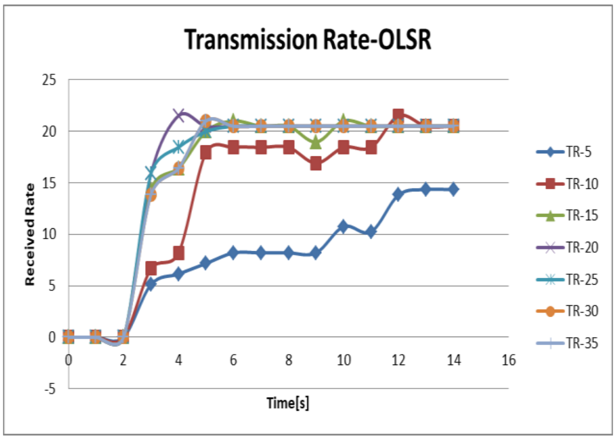

Fig. 13. Transmission rate w.r.t. transmission power

Fig. 13 illustrates the received rate varying the simulation times with respect to transmission powers (5Db-35dB). For transmission power 5dB, received rate is very low, while received rate is highest at transmission power 35dB. Received rate is average for transmission power 10dB. From simulation time 4s-16s, received rate is same for transmission power 30Db and 35dB. Received rates are fluctuating for transmission powers 5dB-25bB.

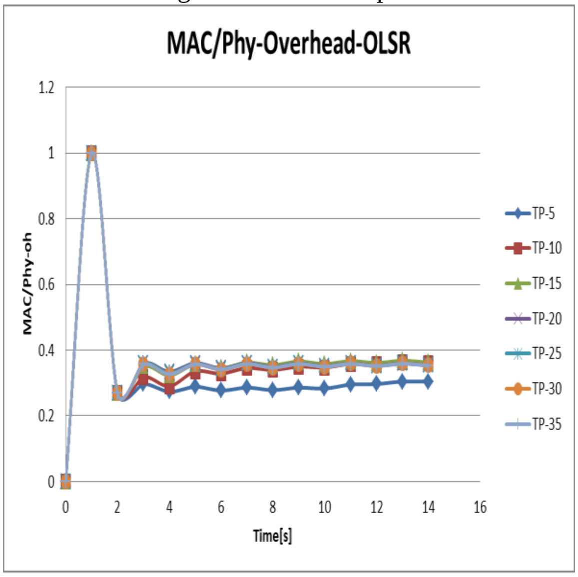

Fig. 14. MAC/Phy-overhead w.r.t. transmission power

Fig. 14 shows the MAC/Phy-overhead with respect to transmission power at various simulation times (0s-16s). For transmission power 10dB and 35dB, overhead is highest at simulation time 1s. From simulation times 2s-16s, overhead is fluctuating for transmission powers 5dB-35dB. MAC/Phy-overhead is lowest for transmission power 5Db, while it is almost same for transmission powers 10Db-35Db.

VI. Conclusion

Vehicle states are frequently changed in Vehicular ad-hoc networks. For OLSR routing protocol, an intelligent model has been proposed and verified within several performance parameters like goodput, transmission power and overhead etc. on the platform of NS-3 model is verified at various stages. A comparison work has been carried out for results got from fuzzy neuro system (with triangular and Gaussian membership functions) and findings from simulation work performed on network simulator-3. Triangular membership functions works well with accuracy as compare to Gaussian membership functions. Model is verified and 80 results are accurate and more accurate model will be designed in future. Mac/phy overhead, and goodput is evaluated with respect to transmission powers (5dB-35dB).as transmission power will be high; mac/phy overhead will be high. Received rate is evaluated with respect to transmission rate.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] M. R. Ghori, K. Z. Zamli, N. Quosthoni, M. Hisyam, and M. Montaser, "Vehicular ad-hoc network (VANET): Review," in *Proc. IEEE International Conference on Innovative Research and Development* (ICIRD), May 2018.

[2] Optimized Link State Routing Protocol (OLSR). [Online]. Available: https://tools.ietf.org/html/rfc3626

[3] R. Kaur, A. L. Sangal, and K. Kumar, "Modeling and simulation of adaptive Neuro-fuzzy based intelligent system for predictive stabilization in structured overlay networks," *Engineering Science and Technology, an International Journal*, pp. 310-320, 2017.

[4] H. Moudnia, M. Er-rouidib, H. Mouncifc, and B. E. Hadadia, "Black hole attack detection using fuzzy based intrusion detection systems in MANET," in *Proc. International Workshop on Web Search and Data Mining*, 2019, pp. 1176–1181.

[5] S. Acharya and C. R. Tripathy, "An ANFIS estimator based data aggregation scheme for fault tolerant wireless sensor networks," *Journal of King Saud University – Computer and Information Sciences*, vol. 30, pp. 334-348, 2018.

[6] Y. V. S. S. Pragathi and S. P. Shetty, "Design and implementation of ANFIS to enhance the performance of secure LAR routing protocol in MANETs," *International Journal of Computer Science Trends and Technology*, vol. 4, no. 5, pp. 205-208, 2016.

[7] V. R. Budyal and S. S. Manvi, "ANFIS and agent based bandwidth and delay aware any-cast routing in mobile ad

hoc networks," *Journal of Network and Computer Applications*, vol. 39, pp. 140-151, 2014.

[8] W. Benaatou, A. Latif, and V. Pla, "Applying ANFIS model in decision-making of vertical handover between macrocell and femtocell integrated network," *Journal of Telecommunication, Electronic and Computer Engineering*, vol. 11, no. 1, pp. 57-62, 2019.

[9] P. Sarao, "F-EEAODV: Fuzzy based energy efficient reactive routing protocol in wireless ad-hoc networks," *Journal of Communications*, vol. 13, no. 7, pp. 350-356, July 2018.

[10] P. Sarao, "Comparison of AODV, DSR, and, DSDV routing protocols in a wireless network," *Journal of Communications*, vol. 13, no. 4, pp. 175-181, April 2018.

[11] MATLAB for Artificial Intelligence. [Online]. Available: www.mathworks.com

[12] J. S. R. Jang, "ANFIS: Adaptive-network-based fuzzy inference system," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 23, no. 3, pp. 665 – 685, 1993.

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