EasyChair Preprint

№ 7296

A Survey on AGPA Nature-Inspired Techniques in Vehicular Ad-Hoc Networks

Smita Rani Sahu and Biswajit Tripathy

January 5, 2022

A Survey on AGPA Nature-Inspired Techniques in Vehicular Ad-hoc Networks

Smita Rani Sahu[1], Dr. Biswajit Tripathy[2]

[1] *Department of Computer Science and Engineering, Biju Patnaik University, Rourkela, Odisha 769004, India*

[2] Department of Computer Science and Engineering, Gandhi Institute of Technological Advancement (Autonomous), Badaraghunathpur Madanpur Bhubaneswar- 752054, India

[1]smitasahu.jitm2002@gmail.com
[2]biswajit_cse@gita.edu.in

Abstract
Recent Wireless technology boons smart solutions and offers high networking pliability. Through wireless sensor networks, users can access their information remotely at any time, and anywhere. In Vehicular Ad-hoc Networks (VANETs), the nodes that communicate among themselves to share the information have limited energy and resources. Moreover, as the nodes are highly dynamic in nature i.e. able to leave or join the network arbitrarily, which increases network power complexity and design challenges in this type of network. Consequently, several Vehicular Ad-hoc routing protocols have been evolved to conserve energy, improve network performance, and address the encountered design challenges. The literature presents an ample variety of techniques and models that have been proposed for efficient, power-aware optimization in VANETs. In this paper, we propose a new taxonomy that categorizes the most common VANET routing perspectives published in the literature. The paper presents a comparative exploration of power optimization approaches to better understand the current research directions in VANET power optimization in routing.

Keywords— Vehicular Ad-hoc Networks, Ant Colony Optimization, Genetic Algorithm, Particle Swarm Optimization, Artificial Bee Colony.

I. INTRODUCTION

Vehicular Ad-hoc Network (VANET) is one type of wireless ad-hoc network [1]. Wire- less ad-hoc network has several variations in terms of applications such as mobile ad- hoc network, hybrid ad-hoc network, transparent wireless ad-hoc network, and vehicular ad-hoc network [2-7]. In the real-life scenario, communication system increases rap- idly due to variation of transportations. So, the demand in various applications on vehicle academic researchers are paying more attention on communication in vehicular network i.e. VANET. It is a self-organized network in which the communicating entities are vehicles, they communicate with each other without any prior infrastructure that causes reducing deployment cost [8]. VANET provides an Intelligent Transportation System (ITS). It helps to provide the services to the users for providing fast data exchange and security services. ITS provides applications like prevention of collisions, nearby information services, and real-time detour routes, co-operative traffic monitoring, control of traffic flows, blind crossing [9]. One of the major initiatives of ITS is totransfer necessary information from the surrounding to the driver. It can be used to reduce accidents, predicting condition of roads and positions of the neighboring vehicles. In VANET moving vehicles acts as receivers, senders as well as routers to generate a movable network. Vehicles participating as node in network can transmit the data up to the transmission radius of 100m to 300m. VANET provides Vehicles to Vehicles (V2V), Road-side Unit to Road-side Unit (R2R) and Vehicles to Road-side Unit (V2R)communication [10].

VANETs provide an extensive range of applications that classified into (i) Safety related applications, (ii) Non-safety related applications. The examples of safety related applications are (a) vehicles intersection collision warning, (b) information about roadconditions, (c) vehicles lane change and navigation information, (d) vehicle traffic as- sistance to prevent traffic jams. The examples of non-safety related VANET applications are (a) To allocate various point of interests like parks, restaurants, (b) electronictoll collection, (c) car parking.

The nature of the VANET is dynamic and flexible. So, in the above-mentioned appli- cations possess several types of issues and uncertainties. Several works are exist for solving different uncertainties related problems such as outlier detection or anomaly detection, fault diagnosis, intrusion detection, mobility prediction [11, 12]. Most of the outlier detection and prediction algorithms are outperform with the help of machine learning algorithms [13, 14]. The reason is robustness of the algorithm in order to optimization [15-17]. Nature-inspired algorithm is an effective and robustness technique which is used to solve complex real life problem that totally depends on the nature phenomena. It has several types, but it this paper, a short survey is illustrated based on three nature-inspired techniques such as: Ant colony optimization-Genetic algorithm- Particle swarm optimization-Artificial bee colony (AGPA).

The rest of the paper describes as follows. Section II illustrates

several existing works related to four popular nature-inspired techniques such as Ant colony optimization-Genetic algorithm-Particle swarm optimization-Artificial bee colony known as AGPA. Section III gives a comparative study of the various algorithms. Section IV discusses about the various algorithms reviewed and Section V conclude the paper as conclusion.

II. RELATED WORKS

In this section, some existing works are illustrated in the context of AGP. Each work describes some contributory information that guide to the research in term of application.

2.1 Ant Colony Optimization based Protocol

Ant Colony Optimization (ACO) is used in several routing protocols in VANET. Short descriptions of these works are as follows. Sattari et al. [18] used an ACO inspired algorithm for routing in VANET. In this work, a vehicle-to-traffic light counter based model is proposed which can be used for traffic lights optimization as well as finding optimal path for vehicles. Finally, a cellular-ant based algorithm is designed to find an optimal solution. Wilmer et al. [19] proposed a novel dynamic traffic assignment algorithm coined as reverse online algorithm for analysing the dynamic traffic of the net- work. In this work, ACO uses the information that collected from other neighbouring vehicles, perceives the traffic and changes route if necessary. The algorithm employs clusters to report traffic information and wipes out after the report is broadcasted. Boukhatem et al. [20] proposed an intersection based vehicular routing protocol known as IRQV based on ACO. It dynamically chooses the best interaction for data transfer among the adjacent interactions with the use of greedy algorithm. This paper concentrates on three different processes (i) maintaining QoS at network survey for local global end-to-end connection, (ii) selection of optimal path, and (iii) selection for terminal intersection. Chatterjee & Das [21] proposed a reactive routing protocol called E-Ant-DSR that designed with the merging of DSR protocol with ACO. The paper mainly focuses on increasing the efficiency of routing with decrease in congestion and maintaining the links. The probability for selecting a path is planned with concentration on link metric, congestion metric and hop count. Eiza et al. [22] proposed a routing algorithm for VANET named as S-AMCQ. In this algorithm, ACO is used for detecting feasible paths and determining the traffic in VANET with multiple constrains for QoS. This algorithm uses the advanced graph models for detecting route control messages. Hence, it provides the better security. Ani et al. [23] proposed an algorithm that pre- vents congestion during data transmission named as QoRA. It takes care of congestion with two components: (i) QoRA which parallel runs in each node to detect the optimal path with respect to the QoS requirements, and (ii) use of SNMP and MIB for obtaining relevant information. H. Singh & P. Singh [24] proposed ACO based clustering routing protocol for finding shortest path. It selects the most optimal path that reduces the prob- ability of link breakage while changing the network topology. It helps in elimination of congestion and finding shortest paths. But, it fails in fulfilling QoS requirements. Melaouene and Romadi [25] proposed an improved algorithm by relating ACO with VANETs. The main aim is to find the shortest optimal path by concentrating on the number of hops and the delay.

2.2 Genetic Algorithm Based Optimization Protocol

Genetic Algorithm (GA) is a bio-inspired, adaptive and robust search technique in- spired by natural selection and genetics in biology. It is an optimization approach based on a population of individuals (chromosomes) which evolves another population during iteration [26]. Some of the works are proposed in last few years as follows. Girijalakshmi et al. [27] proposes a GA based DSDV routing protocol that increase the efficiency and throughput of the existing DSDV routing protocol. Zhang et al. [28] pro- posed GA based QoS perception routing protocol named as GABR. The main idea is to increase the QoS by concentrating on packet transmission and maintaining link stability. GA is used to optimize the global paths. It also focuses on the intersections by using greedy carry forward algorithm to deliver the packets efficiently. Bello et al. [29] proposed an improved GA based route optimization technique. This protocol deter- mines optimal path to communicate among vehicles between road intersections. It uses parameters like frequency of communication, received signal strength, transmit power and path loss. This algorithm helps to cluster the chromosomes into two number over-lapping clusters using K-means algorithm.

2.3 Particle Swarm Based Optimization Protocol

Particle Swarm Optimization (PSO) is used in several routing protocols in VANET. Short descriptions of these works are as follows. Kaiwartya et al. [30] proposed a geo- cast routing protocol as GeoPSO for the optimal selection of the next hop node. It mainly helps to enhance the network load and packet delivery ratio of the VANET. Lobiyal et al. [31] proposed a meta-heuristic method i.e. PSO for finding an optimal combination in AOMDV. It is implemented and tested on real map and observed an improvement in QoS. Dongyao et al. [32] proposed an improved shuffled algorithm as ISFLA with the main aim of this algorithm is to avoid congestion during data transmission. The fitness function for particles involved in path establishment depends on the predicted degree of congestion, the minimum number of hops and the remaining energy for generating frogs. Frogs are distinct as the adaptation values that are required to create normalization for path-selection model. The proposed leapfrog algorithm is up- dated during local optimization with discrete processing. The performance of individual frogs is enhanced with a threshold selection strategy that helps from weaker individuals to better one. Similarly for global optimization, multi-path routing idea is selected for getting optimal path. Saritha et al. [33] proposed a PSO based optimised multipath routing protocol using learning automata. It is used to obtain optimal multiple paths for transmission depending on link stability. It employed to classify the ideal number of paths required for transmission. It performs well for QoS parameters by increasing the packet delivery ratio and

throughput.

2.4 Artificial Bee Based Optimization Protocol

Artificial Bee Colony (ABC) is also used in several routing protocols in VANET. Short descriptions of these works are as follows. Saravanan et al. [34] have proposed an ABC based routing protocol using fuzzy logic named as GRP. It enhances the geographical routing protocol by implementing fuzzy controller and optimization rule. It helps to find an optimal solution based on finding the position and getting a fitness solution. Sampath et al. [35] proposed an ABC based for clustering the network. This method is used dynamically for clustered the nodes of the network. It is used to finds an optimized path using greedy approach with ABC algorithm. Mohammed et al. [36] proposed a method for QoS in VANET for finding an optimal route. It basically uses ABC algorithm with clustering technique. This method optimizes the best route by using parameters bandwidth, delay, jitter and link stability. Taqwa et al. [37] proposed an optimal routing method for broadcasting the RREQ packets. It also focuses on the reduction ofroutes error and contention overhead by enhancing the efficiency of the selected routes, by predicting the route lifetime using fuzzy controllers. Among the selected optimal paths for route discovery, the best route with lowest cost will be chosen for forwarding data packets. In this protocol, ABC algorithm is used to optimize all used fuzzy systemsand obtain the optimal highest rank of links cost values within which the neighbors could be selected as relay nodes in route discovery process.

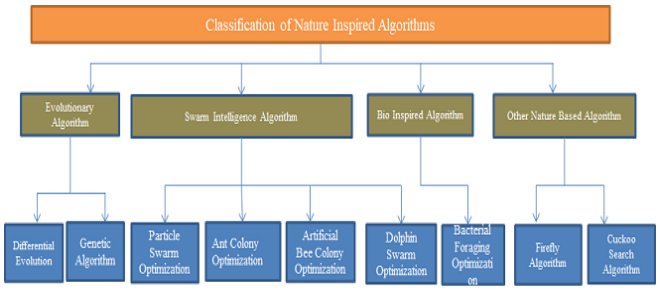

Fig 1: Classification of Nature Inspired Algorithms

III. DISCUSSION

In the previous sections, we have presented and classified the existing approaches of nature inspired routing algorithms for VANETs.

To review, the sturdiest feature covered by bio-inspired approaches for VANET routing is the complexity of finding routes from source nodes to destinations, used to broadcast and forward data packets in the network. Subsequently, routing overhead and the average end-to-end delay are reduced. Conversely, there are certain design criteria and additional evaluation metrics which should be investigated in future bio-inspired approaches for VANET routing. These metrics include the strength of network connectivity, scalability in terms of network density, and the need to consider more realistic vehicular mobility patterns like rural areas. Moreover, we recommend in additional research works, to study VANET routing as a multi-objective and multi-constraint problem with power constraints. In other words, new quality of service metrics should be taken into account in the objective function like transmission cost, bandwidth, routing overhead, jitter, packet delivery ratio, and others, where some of these objectives can be restricted by the user and explained in the computational studies by multiple constrains (e.g. minimum used bandwidth, maximum accepted jitter etc.).

We also propose that the VANET community of researchers apply other bio-inspired methods which are not applied to solve routing problems for VANETs and could give promising results. In this context, relevant bio-inspired methods such as Differential Evolution [38], Evolutionary Programming [39], Estimation of Distribution Algorithm [40], Evolution Strategy [41] and Genetic Programming [42] may prove very beneficial.

IV. CONCLUSION

In this paper, we have presented a survey on the four popular bio-inspired approaches such as such as Ant colony optimization-Genetic algorithm-Particle swarm optimization-Artificial bee colony applied to VANET routing which support ITS applications. The implementation of these methods drastically improves the routing performance in comparison to the traditional routing algorithms in VANET. In fact, it has been shown that the bio-inspired methods are more effectual for large-scale vehicular networks, which disseminate data packets with low complexity. Also, bio-inspired VANET routing is adaptive and robust which maintains an improved routing performance despite network interruptions. After presenting the VANET routing background and existing standards, we described the basic concepts and operations of recently proposed bio-inspired algorithms and techniques reported in the literature which include genetic algorithms, ant colony optimization, particle swarm optimization, bee colony optimization. This paper helps to guide the researchers in new directions or innovate the existing directions. Each described work in this paper deal with some problems that consist of several type uncertainties and their solutions. The solution of the problems works as intelligent technique to solve the issues intelligently as like human.

Table 1: Comparitve and classification of varios Nature Inspired Algorithms

	References	Proposed Algorithm	Advantages	Disadvantages
Ant Colony Optimization	Sattari MRJ, Malakooti H, Jalooli A, Noor RM (2014)	Cellular Ant-based Algorithm(2014)	Used for traffic lights optimization as well as finding optimal path for vehicles.	Not concentrates on Shortest path
	Wilmer Arellano and Imad Mahgoub (2014)	Reverse Online Algorithm for the Dynamic-Traffic-Assignment Ant-Colony-Optimization inspired (Road-ACO)(2014)	Improves traffic without prior knowledge of the traffic demand or the schedule of the cars which helps in improving road safety	Haven't investigated the performance in larger and complex networks.
	Li, G., Boukhatem L., & Martin S (2015)	Intersection-based Vehicular routing protocol (IRQV)	Chooses the best interaction for data transfer among the adjacent interactions with the use of greedy algorithm. And also selects the best optimal path	Haven't investigate the effects of IRQV on weight parameters and the quality in implementation with road safety
	Chatterjee, S., Das (2015)	Enhanced Ant DSR(E-Ant-DSR)	Combination of Dynamic Source Routing(DSR) and ACO. Concentrates on increasing the efficiency of routing with decrease in congestion and maintaining the links	Poor in maintaining QoS issue
	D. Jinil Persis and T. Paul Robert (2015)	Secure ACO-based Multi Constrained QoS(S-AMCQ) routing algorithm	Used for detecting feasible paths, provides better security through security QoS routing algorithm, and maintains QoS	Performs poor if implemented in Multi objective functions
	H. Singh, P. Singh (2017)	Ant Colony Optimization based (AODV-R)	Selects the optimal path and reduces the probability of link breakage during transmission	Doesn't fits to complex network
	Noussaiba Melaouene, Rahal Romad (2019)	Enhanced Routing Algorithm using Ant Colony	Aims to find the shortest path in addition, a storage on static nodes is installed in each intersection	Congestion during rush hours in urban areas is not taken into consideration
Particle Swarm Optimization	Kaiwartya, O., Kumar, S. (2014)	Geocasting in vehicular adhoc networks using particle swarm optimization(GeoPSO)	Mainly focuses on network load and packet delivery ratio	Not concentrated of link breakage
	D K Lobiyala, C P Kattia, A K Giri (2015)	Ad-hoc on demand multipath distance vector routing (AOMDV)	Determines the optimal value of parameters to improve the QoS, also communicates with alternate path available when there is link breakage	Haven't tried to use other metaheuristics to optimize UDP, DSR and different other protocols
	Dongyao, J., Shengxiong, Z., Meng, L., & Huaihua, Z. (2016)	Improved Shuffled Frog-Leaping Algorithm (ISFLA)	Congestion avoidance during transmission, The proposed leapfrog algorithm is updated during local optimization with discrete processing.	Not concentraed on time criteria
	V. Saritha, P. Venkata Krishna, Sudip Misra, Mohammad S. Obaidat (2017)	MultiPath Routing based on Learning Automata and Leapfrog Method (LA-MPRLF).	Used obtain optimal multiple paths for transmission depending on link stability and performs well for QoS parameters by increasing the packet delivery ratio and throughput.	Lack of advanced techniques
Genetic Algorithm	S. Girijalakshmi, K. Sivakumar, and C. Chandrasekar (2016)	Genetic DSDV protocol	Increase the efficiency and throughput of DSDV	Not concentrated on energy efficiency
	Guoan Zhang, Min Wu, Wei Duan, Xin mi(2018)	GABR protocol	Improves packets transmission delay and packet loss rateand, by maintining QoS	Speed of seaarching is a little slower
	H. Bello-Salau , A.M. Aibinu , Z. Wang, A.J. Onumanyi , E.N. Onwuka, J.J. Dukiya (2018)	Improved Genetic Algorithm based Route Optimization Technique (IGAROT)	Determines optimal routes required to communicate road anomalies effectively between vehicles. GA clusters chromosomes into two non-overlapping groups using iterative KMeans algorithm. The algorithm updates the size of the good chromosome to form cluster	Difficult to implement in a real time scenario.
Artifici	Saravanan, P., Arunkumar, T. (2014)	Bee-optimized Fuzzy Geographical Routing Protocol (GRP)	Enhances routing by implementing fuzzy controller and optimization rule. Finds an optimal solution based on finding the position and getting a fitness	A complex and advanced strategy

			solution	
	S. Sampath Kumar, D. Rajaguru, T. Vengattaraman, P. Dhavachelvan, A. Juanita Jesline and J. Amudhavel (2015)	ABC for clustering	Cluster the nodes dynamically to find an optimized path with efficient data transmission.	Not considered numerous clustering parameters like load balance, density, and incoming, ongoing, and outcoming speed
	Mohammed El Amine Fekair, Abderrahmane Lakas, Ahmed Korichi (2016)	CBQoS-Vanet	Find optimal route in a VANET to provide QoS.This protocol concentrates on QoS by finding the best route: bandwidth, delay, jitter and link stability	
	Taqwa O. Fahad, Abduladhem A. Ali (2018)	Optimized Fuzzy AODV (OFAODV)	Focuses on the reduction of routes error and contention overhead by enhancing the efficiency of the selected routes, by predicting the route lifetime using Fuzzy Controllers.	

REFERENCES

[1] Das, Santosh Kumar, Samanta, Sourav, Dey, Nilanjan and Kumar, Rajesh. Design Frame- works for Wireless Networks, Springer, Lecture Notes in Net-works and Systems, ISBN: 978-981-13-9573-4, pp. 1-439.

[2] Yadav, A. K., Das, S. K., & Tripathi, S. (2017). EFMMRP: Design of efficient fuzzy based multi-constraint multicast routing protocol for wireless ad-hoc network. Computer Net- works, 118, pp. 15-23.

[3] Das, S. K., & Tripathi, S. (2018). Intelligent energy-aware efficient routing for MANET. Wireless Networks, 24(4), pp. 1139-1159.

[4] Das, S. K., Yadav, A. K., & Tripathi, S. (2017). IE2M: Design of intellectual energy efficient multicast routing protocol for ad-hoc network. Peer-to-Peer Networking and Applications, 10(3), pp. 670-687.

[5] Das, S. K., & Tripathi, S. (2019). Energy efficient routing formation algorithm for hybrid ad-hoc network: A geometric programming approach. Peer-to-Peer Networking and Appli- cations, 12(1), pp. 102-128.

[6] Das, S. K., & Tripathi, S. (2018). Adaptive and intelligent energy efficient routing for trans- parent heterogeneous ad-hoc network by fusion of game theory and linear programming. Applied Intelligence, 48(7), pp. 1825-1845.

[7] Das, S. K., & Tripathi, S. (2017). Energy efficient routing formation technique for hybrid ad hoc network using fusion of artificial intelligence techniques. International Journal of Communication Systems, 30(16), pp. 1-16, e3340.

[8] Bilal, S. M., Bernardos, C. J., & Guerrero, C. (2013). Position-based routing in vehicular networks: A survey. Journal of Network and Computer Applications, 36(2), pp. 685-697.

[9] Li, F., & Wang, Y. (2007). Routing in vehicular ad hoc networks: A survey. IEEE Vehicular technology magazine, 2(2), pp. 12-22.

[10] Patel, N. J., & Jhaveri, R. H. (2015). Trust based approaches for secure routing in VANET: A Survey. Procedia Computer Science, 45, pp. 592-601.

[11] Jain, P. K., & Pamula, R. (2019). Two-Step Anomaly Detection Approach Using Clustering Algorithm. In International Conference on Advanced Computing Networking and Informat- ics, Springer, Singapore, pp. 513-520.

[12] Mishra, G., Agarwal, S., Jain, P. K., & Pamula, R. (2019). Outlier Detection Using Subset Formation of Clustering Based Method. In International Conference on Advanced Compu- ting Networking and Informatics, Springer, Singapore, pp. 521-528.

[13] Kumari, P., Jain, P. K., & Pamula, R. (2018, March). An efficient use of ensemble methods to predict students academic performance. In 2018 4th International Conference on Recent Advances in Information Technology (RAIT), IEEE, pp. 1-6.

[14] Punam, K., Pamula, R., & Jain, P. K. (2018, September). A Two-Level Statistical Model for Big Mart Sales Prediction. In 2018 International Conference on Computing, Power and Communication Technologies (GUCON), IEEE, pp. 617-620.

[15] Das, S. P., & Padhy, S. (2018). A novel hybrid model using teaching–learning-based opti- mization and a support vector machine for commodity futures index forecasting. Interna- tional Journal of Machine Learning and Cybernetics, 9(1), pp. 97-111.

[16] Das, S. P., & Padhy, S. (2017). Unsupervised extreme learning machine and support vector regression hybrid model for predicting energy commodity futures index. Memetic Compu- ting, 9(4), pp. 333-346.

[17] Das, S. P., & Padhy, S. (2017). A new hybrid parametric and machine learning model with homogeneity hint for European-style index option pricing. Neural Computing and Applica- tions, 28(12), pp. 4061-4077.

[18] Sattari, M. R. J., Malakooti, H., Jalooli, A., & Noor, R. M. (2014). A dynamic vehicular traffic control using ant colony and traffic light optimization. In Advances in Systems Sci- ence (pp. 57-66).

Springer, Cham.
[19] Arellano, W., & Mahgoub, I. (2014). Reverse Online Algorithm for the Dynamic Traffic Assignment inspired by Ant Colony Optimization for VANETs. Int J of Swarm Intel Evol Comput, 3(111), 2.
[20] Li, G., Boukhatem, L., & Martin, S. (2015). An intersection-based QoS routing in vehicular ad hoc networks. Mobile Networks and Applications, 20(2), pp. 268-284.
[21] Chatterjee, S., & Das, S. (2015). Ant colony optimization based enhanced dynamic source routing algorithm for mobile Ad-hoc network. Information Sciences, 295, pp. 67-90.
[22] Eiza, M. H., Owens, T., & Ni, Q. (2015). Secure and robust multi-constrained QoS aware routing algorithm for VANETs. IEEE Transactions on Dependable and Secure Computing,13(1), 32-45.
[23] Al-Ani, A. D., & Seitz, J. (2015). QoS-aware Routing in Multi-rate Ad hoc Networks Basedon Ant Colony Optimization. Network Protocols & Algorithms, 7(4), 1-25.
[24] Singh, H., & Singh, P. (2017). Enhanced New Clustering Ant Colony Optimization based Routing Protocol AODV-R. International Journal of Computer Applications, 160(9).
[25] Melaouene, N., & Romadi, R. (2019). An enhanced routing algorithm using ant colony optimization and VANET infrastructure. In MATEC Web of Conferences (Vol. 259, p. 02009). EDP Sciences
[26] Saritha, V., Krishna, P. V., Misra, S., & Obaidat, M. S. (2017, May). Learning automata based optimized multipath routingusing leapfrog algorithm for VANETs. In 2017 IEEE In- ternational Conference on Communications (ICC) (pp. 1-5). IEEE.
[27] Girijalakshmi, S., Sivakumar, K., & Chandrasekar, C. DSDV addendum through genetic algorithm in VANET. International Journal of Computer Applications, pp. 1-5.
[28] Zhang, G., Wu, M., Duan, W., & Huang, X. (2018). Genetic Algorithm Based QoS Percep- tion Routing Protocol for VANETs. Wireless Communications and Mobile Computing, 2018.
[29] Bello-Salau, H., Aibinu, A. M., Wang, Z., Onumanyi, A. J., Onwuka, E. N., & Dukiya, J. J. (2019). An optimized routing algorithm for vehicle ad-hoc networks. Engineering Science and Technology, an International Journal.
[30] Kaiwartya, O., & Kumar, S. (2014, May). Geocasting in vehicular adhoc networks using particle swarm optimization. In Proceedings of the International Conference on InformationSystems and Design of Communication (pp. 62-66). ACM.
[31] Lobiyal, D. K., Katti, C. P., & Giri, A. K. (2015). Parameter value optimization of ad-hoc on demand multipath distance vector routing using particle swarm optimization. Procedia Computer Science, 46, pp. 151-158.
[32] Dongyao, J., Shengxiong, Z., Meng, L., & Huaihua, Z. (2016). Adaptive multi-path routing based on an improved leapfrog algorithm. Information Sciences, 367, pp. 615-629.
[33] Saritha, V., Krishna, P. V., Misra, S., & Obaidat, M. S. (2017, May). Learning automata based optimized multipath routingusing leapfrog algorithm for VANETs. In 2017 IEEE In- ternational Conference on Communications (ICC) (pp. 1-5). IEEE..
[34] Saravanan, P., & Arunkumar, T. (2014). Bee optimized fuzzy geographical routing protocol for VANET. Int. J. Comput. Electr. Autom. Control Inf. Eng, 8, pp. 2222-2228.
[35] Kumar, S. S., Rajaguru, D., Vengattaraman, T., Dhavachelvan, P., Jesline, A. J., & Amudha- vel, J. (2016). Intelligent collision avoidance approach in VANET using artificial bee colony algorithm. In Proceedings of the International Conference on Soft Computing Systems (pp. 545-551). Springer, New Delhi.
[36] Fekair, M. E. A., Lakas, A., & Korichi, A. (2016, April). CBQoS-Vanet: Cluster-based ar- tificial bee colony algorithm for QoS routing protocol in VANET. In 2016 International conference on selected topics in mobile & wireless networking (MoWNeT) (pp. 1-8). IEEE..
[37] Fahad, T. O., & Ali, A. A. (2018). Multiobjective Optimized Routing Protocol for VANETs. Advances in Fuzzy Systems,2018
[38] P. Rocca, G. Oliveri, and A. Massa (2011), "Differential evolution as applied to electromagnetics," IEEE Antennas Propag. Mag. Vol. 53, no. 1, pp. 38- 49, 2011.
[39] E. Eiben, and J. E. Smith (2002), Introduction to evolutionary computing. Springer, 2003.
[40] P. Larrañaga, and A. J. Lozano, "Estimation of distribution algorithms: A new tool for evolutionary computation," vol. 2, Springer, 2002.
[41] H. G. Beyer, and H. P. Schwefel (2002) "Evolution strategies–A comprehensive introduction," Natural Comput., vol. 1, no. 1, pp. 3-52, 2002.
[42] J. R. Koza (1992) , Genetic programming: on the programming of computers by means of natural selection. vol. 1, MIT press. 1992.