International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-12, Special Issue-1, March-2024
https://doi.org/10.55524/CSISTW.2024.12.1.35
Computing for Sustainable Innovation: Shaping Tomorrow's World (CSISTW-2024) on 16th-17th February, 2024
Organized by B.N. College of Engineering and Technology, Lucknow, India

Improvement of Performance of Vehicular Adhoc Network by applying Game Theory Approach

Shobhit Mani Tiwari[1], Anurag Singh Baghel[2] and Himanshu Kumar Shukla[3]

[1,3]Department of Computer Science and Engineering, Faculty of Engineering and Technology, University of Lucknow, Uttar Pradesh, India.
[2]Department of Computer Science and Engineering, School of ICT, Gautam Buddha University Greater Noida, Uttar Pradesh, India.

Correspondence should be addressed to Shobhit Mani Tiwari: smtewari.u2@gmail.com

ABSTRACT- In this paper, we give the focus on the continuous advancement in the domain of Vehicular ad hoc networks (VANET's) and that is developed as a tool for developing the base for platform intelligent mode in the communication (inter vehicle communications) and needful for enhanced improvement under the performance effect and traffic safety. Here, we have deployed the game theory method in the VANET domain and thereafter categorizes between the hop vehicle and the source vehicle. The New approach to the VANET analysis we have identified and used the social parameters and hence made it look more novel approach."Researching vehicle ad hoc networks poses challenges due to their dynamic nature, the movement of large vehicles, unlimited energy resources, and the evolution of wireless networks. Game theory is commonly employed in wireless networks to explore the interplay between competition and cooperation. In this study, we present a system for ad hoc networks in cars, utilizing game theory to automate car groups and board elections. This approach eliminates the necessity for regular bulk updates. Furthermore, the social behavior of each car is leveraged to create clusters in the car environment. The K-means algorithm in machine learning is applied to develop social cars. The proposed system underwent testing for various characteristics, including CH lifetime, average group lifetime, average number of joins, throughput, and packet loss rate. The results demonstrate that VANET performs exceptionally well, achieving an overall performance ranging from 0.95 to 0.989."

KEYWORDS- WECT (Wind Energy Conversion Technology), FRT (Fault Recovery), RTU, VANET, RSU, MANET, V2V, CH Life, Internet of Things (IoT), ITS (Intelligent Transportation System), VN (Vehicle Network), V2V (Vehicle-to-Vehicle), V2I (Vehicle-to-Infrastructure), RSU (Roadside Unit), GT (Game Theory), 5G (Fifth Generation), QoS (Quality of Service), MAC (Media Access Control), 4G (Fourth Generation), MEC (Mobile Edge Computing), V2R (Vehicle to Roadside), TDMA (Time Division Multiple Access), CSMA (Carrier Sense Multiple Access), CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance), BSM (Basic Safety Message), CBR (Channel Bit Rate), DCC (Broadcast Data Confusion), SU (Secondary User), PU (Primary User), SINR (Signal-to-Interference plus Noise Ratio), MEC (Mobile Edge Computing), HetNet (Heterogeneous Network for Vehicles).

I. INTRODUCTION

Game Theory in the context of Vehicular Ad Hoc Networks (VANETs) involves the study of strategic interactions among self-interested entities (such as vehicles or nodes) to model and analyses their behavior in a networked environment. VANETs are a specific type of ad hoc network Game Theory provides a useful framework to understand and optimize the behavior of autonomous and self-interested entities in VANETs. Here are some aspects of Game Theory in the context of VANETs:

Cooperative Game Theory: In VANETs, vehicles can cooperate to achieve common goals, such as improving traffic flow sharing information about road conditions. Cooperative Game Theory can model how vehicles form coalitions and share resources for mutual benefits.

Non-cooperative Game Theory: Vehicles in VANETs may act selfishly to optimize their individual objectives, such as minimizing travel time or fuel consumption. Non-cooperative Game Theory can be used to model scenarios where each vehicle acts independently, and the interactions between vehicles result in a Nash equilibrium, where no vehicle has an incentive to unilaterally change its strategy.

Resource Allocation: Game Theory can be applied to model how vehicles compete for limited resources, such as bandwidth for communication or access to roadside infrastructure. This is particularly relevant in VANETs where efficient resource allocation is crucial for the overall network performance.

Security and Privacy: Game Theory can be employed to analyses security and privacy concerns in VANETs. For example, it can model scenarios where malicious vehicles attempt to disrupt communication or compromise the privacy of other vehicles. Game-theoretic models can help design strategies to enhance security and privacy in such environments.

Incentive Mechanisms: Game Theory can be used to design incentive mechanisms to encourage cooperation and information sharing among vehicles. Incentives can include rewards for providing useful information or penalties for misbehavior.

Routing and Traffic Management: Game Theory can assist in modeling and optimizing routing strategies in VANETs, considering the interactions among vehicles to minimize congestion and improve overall traffic flow. By applying Game Theory to VANETs, researchers and engineers can gain insights into the complex dynamics of these networks, design more robust protocols and algorithms, and understand the incentives that drive the behavior of individual entities within the network. The integration of Game Theory and Machine Learning techniques in Vehicular Ad Hoc Networks (VANETs) aims to enhance the dynamic behavior of the network, particularly in the context of reliable and stable routing. Let us break down the key components of this approach:

Dynamic Behavior of VANETs: VANETs are characterized by the dynamic nature of vehicular movements, changing network topologies, and varying communication conditions. Vehicles in VANETs need to adapt to real-time changes, such as traffic conditions, road incidents, and intermittent connectivity.

Game Theory: Game Theory is used to model the strategic interactions among self-interested entities, such as vehicles in VANETs. Cooperative and non-cooperative game models can be employed to represent how vehicles collaborate or act selfishly to achieve their objectives.

Game Theory helps in understanding the incentives and strategies that influence the decision-making of individual vehicles.

Machine Learning Techniques: Machine Learning algorithms can be applied to predict and adapt to the dynamic behavior of VANETs. Predictive models can use historical data to forecast changes in traffic patterns, identify potential congestion points, and predict connectivity issues. Reinforcement Learning techniques can be used to enable vehicles to learn and adapt their routing strategies based on feedback from the network. Reliable and Stable Routing: The primary objective is to design routing algorithms that ensure reliable and stable communication in VANETs. Integrating Game Theory and Machine Learning helps in creating routing strategies that consider both individual vehicle incentives and the overall network dynamics. Adaptive routing algorithms can dynamically adjust to changing conditions, optimizing the use of network resources, and ensuring a more stable and reliable communication infrastructure.

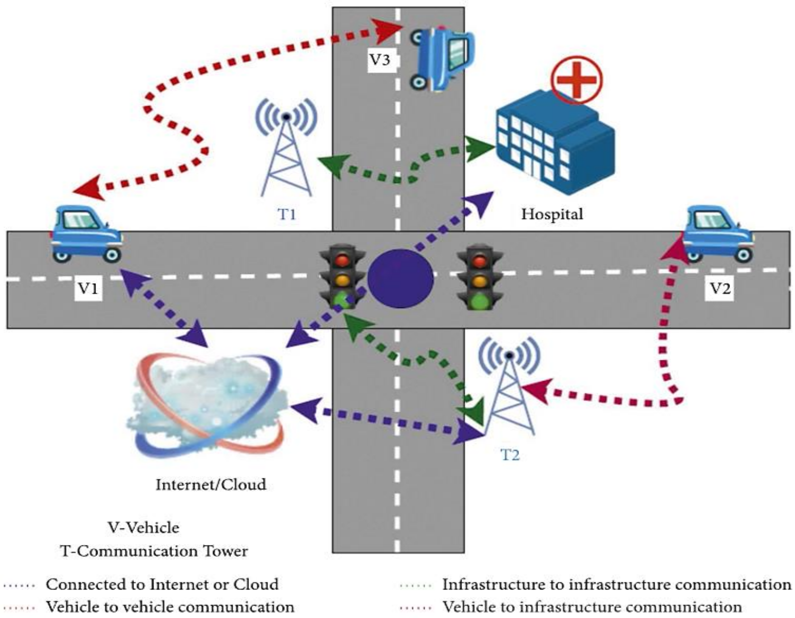

Figure 1: Vehicular ad hoc network architecture

II. BENEFITS AND APPLICATIONS

Improved Traffic Flow: Adaptive routing can help in optimizing traffic flow by dynamically adjusting routes based on real-time conditions.

Enhanced Reliability: By considering the reliability of communication links and predicting potential disruptions, the network can maintain a more stable connection.

Efficient Resource Utilization: Machine Learning algorithm scan optimize the allocation of resources, such as bandwidth, based on the evolving needs of the network.

III. CHALLENGES

The integration of Game Theory and Machine Learning introduces complexities in designing and implementing algorithms. Ensuring the security and privacy of communications is crucial, especially when considering the strategic interactions modelled by Game Theory.

In summary, the integration of Game Theory and Machine Learning in VANETs aims to create more adaptive, reliable, and stable routing strategies. This interdisciplinary approach considers both the strategic interactions among vehicles and the ability to learn and adapt to the dynamic nature of vehicular networks.

In Vehicular Ad Hoc Networks (VANETs), a "hop vehicle" refers to a vehicle that acts as an intermediate relay or forwarding node in the communication process between other vehicles or between a vehicle and roadside infrastructure. These hop vehicles play a crucial role in enabling communication over a multi-hop network topology.

In VANETs, communication between vehicles is often achieved through a multi-hop relay process, especially when the direct communication range between two vehicles is limited. If a vehicle is out of the direct communication range of another vehicle or roadside unit, one or more intermediate hop vehicles can relay the information to bridge the gap and facilitate communication. Here is a brief explanation of the

Concept of hop vehicles:

Direct Communication Range Limitations: The communication range of a vehicle's wireless communication device is limited. If two vehicles are beyond each other's direct communication range, they cannot communicate directly.

Multi-Hop Communication: To overcome the limited communication range, hop vehicles come into play. When a vehicle wants to communicate with another that is out of its direct range, the message can be relayed through one or more intermediate vehicles.

Hop Vehicle Functionality: A hop vehicle receives a message from one vehicle and then retransmits or forwards that message to another vehicle or roadside unit.

The hop vehicle serves as an intermediary node in the communication path, helping extend the effective communication range.

Dynamic Topological Network: Since Units are movable and hence due to the mobility of units the availability of hop vehicles can change rapidly as vehicles move in and out of communication range.

Routing Protocols: Routing protocols in VANETs are designed to determine the most efficient path for communication, considering the dynamic nature of the network. Hop vehicles play a role in establishing these communication paths.The use of hop vehicles in VANETs helps in maintaining connectivity and enabling communication in scenarios where direct communication between vehicles or between a vehicle and infrastructure is not possible. This multi-hop communication is essential for disseminating information about traffic conditions, safety warnings, and other relevant data throughout the VANET.

In the context of Vehicular Ad Hoc Networks (VANETs) and Game Theory, a "cluster" refers to a group of vehicles that form a cooperative coalition to achieve common objectives or goals. Clustering is a strategic approach where vehicles collaborate with each other for mutual benefits, and Game Theory is often applied to model and analyses the interactions within these clusters. The concept of clusters is part of cooperative game models in VANETs.

Here is a breakdown of clustering in the context of Game Theory in VANETs:

Cooperative Game Theory: Cooperative Game Theory is used to model scenarios where entities (in this case, vehicles) cooperate to achieve common goals. In VANETs, vehicles can form clusters to collectively address challenges such as improving traffic flow, enhancing communication, or sharing information about road conditions.Formation of Clusters: Vehicles in a VANET may choose to form clusters based on shared interests, geographical proximity, or specific objectives. Clusters can be dynamic and may form and dissolve based on the real-time needs and conditions of the network.Common Objectives: Vehicles within a cluster work together to achieve common objectives, such as optimizing routing, sharing traffic information, or collectively addressing challenges like congestion.Resource Sharing: Clusters may involve resource sharing among vehicles. Resources can include communication bandwidth, processing power, or information about the environment.Game-Theoretic Modelling: Game Theory is applied to model the strategic interactions within and between clusters. This includes the decision-making processes of individual vehicles within a cluster and the interactions between different clusters.

Incentive Mechanisms: Game Theory helps design incentive mechanisms to encourage vehicles to participate in clusters and contribute to the common goals.

Incentives may include rewards for sharing valuable information, contributing to efficient traffic management, or assisting in the overall improvement of the VANET.

Cluster Stability: The stability of clusters is essential for their effectiveness. Game Theory can help analyses the stability of clusters over time, considering factors such as changes in network conditions, the arrival or departure of vehicles, and the evolution of shared objectives. In summary, clusters in Game Theory within VANETs represent groups of vehicles that collaborate for common goals. The application of Game Theory helps model the strategic interactions within these clusters, enabling a better understanding of how cooperation and coordination among vehicles can be optimized for the overall benefit of the VANET.

Channel (CH) selection in the VANETs domain is a critical aspect of network management, so it involves the process of choosing the appropriate communication channel for transmitting data among vehicles or between vehicles and infrastructure. The selection of channels is crucial to ensure efficient and reliable communication in the dynamic and challenging environment of VANETs. Here are some key considerations and approaches to CH selection in VANETs:

Frequency Bands: VANETs typically operate in dedicated frequency bands allocated for Intelligent Transportation Systems (ITS) communication. Common frequency bands include the Dedicated Short-Range Communications (DSRC) spectrum.

Interference and Congestion: CH selection considers the level of interference and congestion on different channels. Channels with low interference and congestion are preferred to ensure better communication performance.

Dynamic Spectrum Access: VANETs often operate in a dynamic and unpredictable environment. Dynamic Spectrum Access (DSA) techniques may be employed to adaptively select channels based on real-time spectrum availability and conditions.

Channel Quality: The quality of a channel can be assessed based on factors such as signal strength, signal-to-noise ratio, and signal stability. Channels with better quality are preferred for communication.

Traffic Characteristics: The traffic characteristics of the network, including the density of vehicles and the type of data being transmitted, influence CH selection. For example, in congested areas, channels with higher capacity may be preferred.

Cooperative Spectrum Sensing: Vehicles in VANETs can engage in cooperative spectrum sensing to share information about the quality and availability of channels. This collaborative approach can improve the accuracy of CH selection.

Game Theory Approaches: Game Theory can be applied to model the strategic interactions among vehicles in the context of CH selection. Vehicles may strategically choose channels to maximize their individual utility or collectively optimize network performance.

Centralized or Distributed Approaches: CH selection can be managed in a centralized or distributed manner. In a centralized approach, a central entity makes decisions for the entire network, while distributed approaches involve vehicles making individual or localized decisions.

Adaptive Algorithms: Adaptive algorithms can be employed to dynamically adjust CH selection based on changing network conditions. Machine learning techniques may also be used to predict and adapt to channel conditions over time.

Standardization: Standardization bodies, such as the Institute of Electrical and Electronics Engineers (IEEE), may define protocols and standards for CH selection in VANETs to ensure interoperability and consistency.

Effective CH selection in VANETs contributes to the overall reliability, efficiency, and performance of communication in intelligent transportation systems. It requires a balance between real-time adaptation to dynamic conditions and strategic decision-making for optimal network operation.
Research objectives here are indicated as mentioned below.

Stage 1: Initialize the relationship between all tools when using VANET.

Stage 2: Evaluate the relationship scores of each part of VANET and create groups of tools using k-means clustering.

Step 3: Cluster initialize nodes and specify the cluster head of each cluster using the new method from the previous step.

Step 4: Apply game evolution theory to evaluate the stability of the formation group.

Stage 5: If the partner

Stage 6: RSU to send the packet of this stage Use.

Stage 7: Send the packet to the next destination (destination); calculate the average CH lifetime upon arrival, average group member lifetime, Average member time, Transmission, and packet loss.

IV. DESCRIPTION METHOD

In this section the model of the design process is introduced. The progress of the edge of IoT data is discussed., it solves the problem of still alarm in the network and congestion in the data center by distributing the traffic outside the edge servers. But the needs of the special request of successful request require a new description process, which requires traffic-specific rules according to the user's expectations.

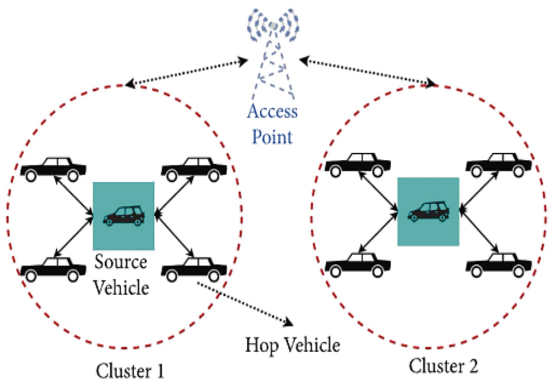

Figure 2: Schematic representation of cluster structure

VANET Game Theory: Each interactive device possesses unique characteristics related to its environment. The network group, once again, forms a part of the relationship among similar and dissimilar devices. In this context, game theory is employed to facilitate grouping. The system is divided into three main components:

(1) **Vehicle component:** Represents vehicles generating messages and data for communication.

(2) **Relay vehicle:** Functions as a data transfer vehicle, aiding in the rapid transmission of information to the ground.

(3) **Access points:** All fixed points utilized in VANETs are considered as access points.

Figure 2 illustrates the schematic diagram of the cluster, where each group includes a lead vehicle and other vehicles transmitting data to and from the lead vehicle and nearby vehicles. Considering the provided information, there will be X number of cars and Y number of vehicle relays during the game. For simplicity, it is assumed that each underlying vehicle will select a vehicle relay to transmit data to. Table 1 outlines the game theory approach for relay selection.

Table 1: Indicating CH selection on Game theory-based VANET classification

Steps	Description
1	Initialization of the system
2	Number of vehicles (nodes) in the system
3	For $i = 1 : N$
4	If $S(i)$ $E > 0$ means node is live
5	Cluster details and id is gathered
6	If node needs to forward the data
7	Else >> system is inactive
8	If >> social parameter score is high
9	Make the node as head for transmitting the data
10	Else >> act as hop vehicle
11	End

The entire map is shown in Figure 3. The concept of this game starts using VANET and then divides it between locations and traffic. The subsequent analysis of each vehicle's network accuracy provides a method for VANET analysis. New and innovative approach when correlation scores are calculated, the K-group task means selecting group leaders (CHs).

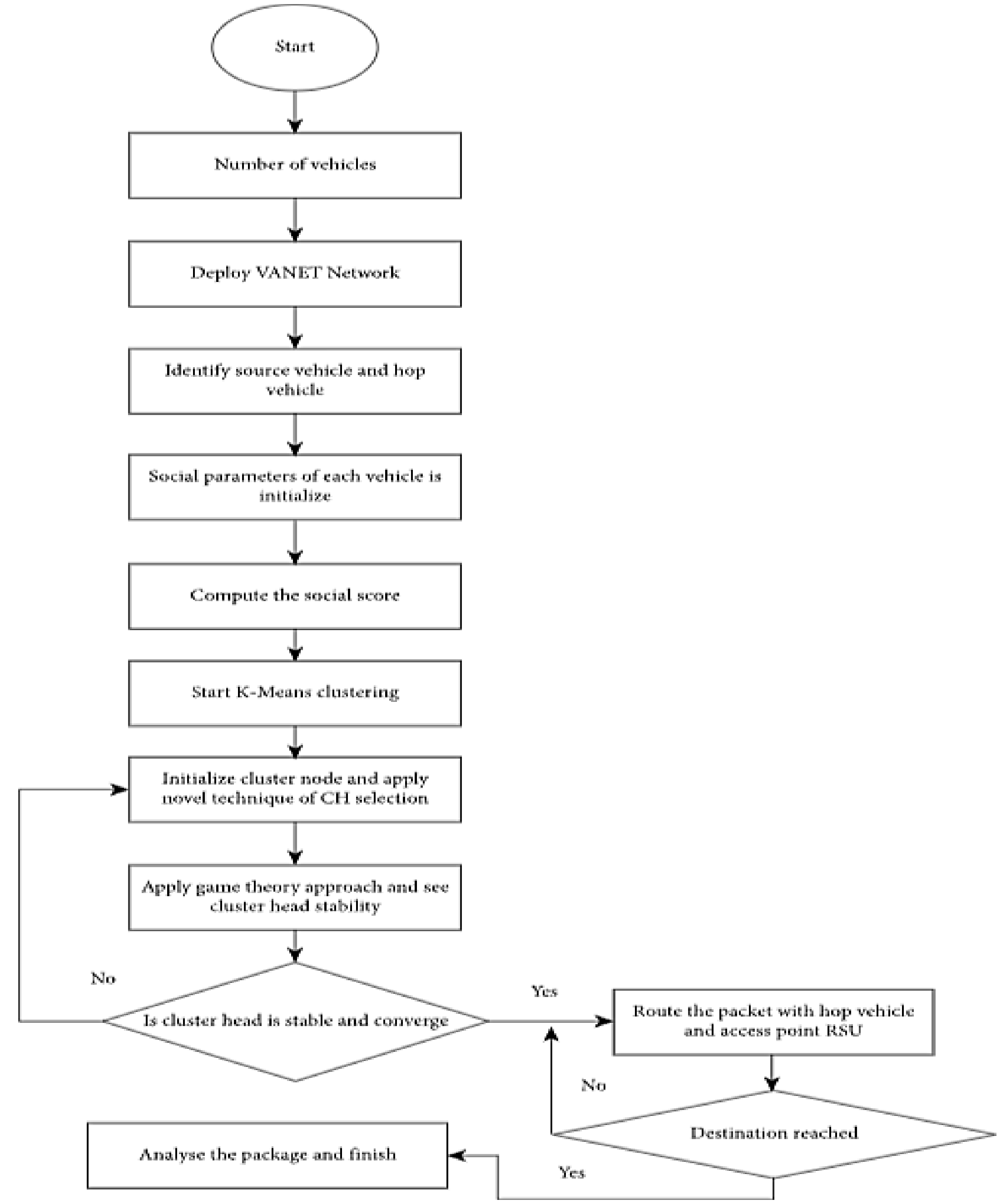

Figure 3: Flow of process for proposed approach

V. CONCLUSION

The node's distribution model, the incorporation of the Global Positioning System (GPS) for nodes, and the network's scalability are all vital aspects of VANET, setting it apart from other self-participatory ventures. Additionally, the heterogeneity of VANET nodes stems from the diverse types of vehicles sharing the road at any given moment, necessitating distinct utilization based on intelligence, such as for emergency vehicles, including police. Vehicles can issue emergency warnings to oncoming vehicles, facilitated by GPS, providing real-time location and weather information to nodes. Furthermore, the organization or rearrangement of nodes is contingent on space and time, resulting in a variable number of nodes in the network corresponding to changes in vehicle speed and density.

CONFLICT OF INTERREST

The authors declare that they have no conflict of interest

REFERENCES

[1] D. Y. Jiang, H. Zhang, H. Kumar et al., "Automatic control model of power information system Access based on artificial intelligence technology," Mathematical Problems in Engineering, vol. 2022, Article ID 5677634, 6 pages, 2022.

[2] V. Jagota, M. Luthra, J. Bhola, A. Sharma, and M. Shabaz, "A secure energy-aware game theory (SEGaT) mechanism for coordination in WSANs," International Journal of Swarm Intelligence Research, vol. 13, no. 2, pp. 1–16, 2022.

[3] M. Yang, P. Kumar, J. Bhola, and M. Shabaz, "Development of image recognition software based on artificial intelligence algorithm for the efficient sorting of apple fruit," Inter-

national Journal of System Assurance Engineering and Management, Springer Science and Business Media LLC, vol. 13, no. 1, pp. 322–330, 2021.

[4] S. Zeadally, R. Hunt, Y. S. Chen, A. Irwin, and A. Hassan, “Vehicular Ad Hoc Networks (VANETS): Status, Results and Challenges,” Telecommunication Systems, vol. 50, no. 4, pp. 217–241, 2010.

[5] Y. W. Lin, Y. S. Chen, and S. L. Lee, “Routing protocols in vehicular ad hoc network a survey and future perspectives,” International Journal of Information Science and Engineering, vol. 26, no. 3, pp. 913–932, 2010.

[6] S. Zhang, K. Srividya, I. Kakaravada et al., “A Global Optimization Algorithm for Intelligent Electromechanical Control System with Improved Filling Function,” Scientific Programming, vol. 2022, Article ID 3361027, 10 pages, 2022.

[7] H. S. Park, M. W. Park, K. H. Won, K. H. Kim, and S. K. Jung, ‘‘In-vehicle AR-HUD system to provide driving-safety

[8] information,’’ ETRI J., vol. 35, no. 6, pp. 1038–1047, Dec. 2013.

[9] S. Y. Cho, ‘‘Development of an IGVM integrated navigation system for vehicular lane-level guidance services,’’ J. Positioning, Navigat., Timing, vol. 5, no. 3, pp. 119–129, Sep. 2016.

[10] H. Peng, L. Liang, X. Shen, and G. Y. Li, ‘‘Vehicular communications: A network layer perspective,’’ IEEE Trans. Veh. Technol., vol. 68, no. 2, pp. 1064–1078, Feb. 2019.

[11] R. Sanchez-Iborra, J. Sanchez-Gomez, J. Santa, P. J. Fernandez, and A. F. Skarmeta, ‘‘IPv6 communications over Lora for future IoV services,’’ in Proc. IEEE 4th World Forum Internet Things (WF-IoT), Feb. 2018, pp. 92–97.

[12] P. C. Murschetz and D. Prandner, ‘‘‘Datafying’ broadcasting: Exploring the role of big data and its implications for competing in a big datadriven tv ecosystem,’’ in Competitiveness in Emerging Markets. Cham, Switzerland: Springer, 2018, pp. 55–71.

[13] P. K. Paul and M. K. Ghose, ‘‘A novel educational proposal and strategies toward promoting cloud computing, big data, and human–computer interaction in engineering colleges and universities,’’ in Advances in Smart Grid and Renewable Energy. Cham, Switzerland: Springer, 2018, pp. 93–102

[14] J. Li, C. Natalino, D. P. Van, L. Wosinska, and J. Chen, ‘‘Resource management in fog-enhanced radio access network to support real-time vehicular services,’’ in Proc. IEEE 1st Int. Conf. Fog Edge Comput. (ICFEC), May 2017, pp. 68–74.

[15] N. B. Truong, G. M. Lee, and Y. Ghamri-Doudane, ‘‘Software defined networking-based vehicular adhoc network with fog computing,’’ in Proc. IFIP/IEEE Int. Symp. Integr. Netw. Manage. (IM), May 2015, pp. 1202–1207.

[16] L. Atzori, A. Iera, G. Morabito, and M. Nitti, ‘‘The social Internet of Things (SIoT)—When social networks meet the Internet of Things: Concept, architecture and network characterization,’’ Comput. Netw., vol. 56, no. 16, pp. 3594–3608, Nov. 2012.

[17]] R. Hossen, M. Whaiduzzaman, M. N. Uddin, M. J. Islam, N. Faruqui, A. Barros, M. Sookhak, and M. J. N. Mahi, ‘‘BDPS: An efficient sparkbased big data processing scheme for cloud fog-IoT orchestration,’’ Information, vol. 12, no. 12, p. 517, Dec. 2021.

[18] S. Bharati, H. A. Omar, and W. Zhuang, ‘‘Enhancing transmission collision detection for distributed TDMA in vehicular networks,’’ ACM Trans. Multimedia Comput., Commun., Appl., vol. 13, no. 3s, pp. 1–21, Aug. 2017.

[19] C.-Y. Lin, K.-C. Chen, D. Wickramasuriya, S.-Y. Lien, and R. D. Gitlin, ‘‘Anticipatory mobility management by big data analytics for ultra-low latency mobile networking,’’ in Proc. IEEE Int. Conf. Commun. (ICC), May 2018, pp. 1–7.

[20] M. T. Rahman, M. J. N. Mahi, M. Biswas, M. S. Kaiser, and S. Al Mamun, ‘‘Performance evaluation of a portable PABX system through developing new bandwidth optimization technique,’’ in Proc. Int. Conf. Electr. Eng. Inf. Commun. Technol. (ICEEICT), May 2015, pp. 1–5.

[21] A. K. Widiawan and R. Tafazolli, ‘‘High altitude platform station (HAPS): A review of new infrastructure development for future wireless communications,’’ Wireless Pers. Commun., vol. 42, no. 3, pp. 387–404, Jun. 2007

[22] Z. Ning, S. Sun, X. Wang, L. Guo, S. Guo, X. Hu, B. Hu, and R. Kwok, ‘‘Blockchain-enabled intelligent transportation systems: A distributed crowdsensing framework,’’ IEEE Trans. Mobile Comput., early access, May 13, 2021, doi: 10.1109/TMC.2021.3079984.

[23] S. Roy, A. R. Shovon, and M. Whaiduzzaman, ‘‘Combined approach of tokenization and mining to secure and optimize big data in cloud storage,’’ in Proc. IEEE Region Humanitarian Technol. Conf. (R10-HTC), Dec. 2017, pp. 83–88.