Improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms

Meriama Abdurkadir Godi

A Thesis Submitted to the Department of Computer Science and Engineering

School of Electrical Engineering and Computing

Presented in Partial Fulfillment of the Requirement for the Degree of Masters in Computer Science and Engineering

Office of Graduate Studies
Adama Science and Technology University

June, 2023

Adama, Ethiopia

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Declaration

I hereby declare that this Master thesis proposal entitled **“Improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms**” is my original work .That is, it has not been submitted for the award of any academic degree,diploma or certificate in of any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

Meriama Abdurkadir_ ____________ _____________

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Recommendation

I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of thesis entitled "**Improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms**" prepared under my/our guidance by **Meriama Abdurkadir**. Submitted in partial fulfillment of the requirements for the degree of Mater's of Science in **Computer Science and Engineering**. Therefore, I/we recommend the submission of revised version of the thesis to the department following the applicable procedures.

Dr: Ing Frezewd Lemma ______________________ ___________________

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Co-advisor Signature Date

Approval Page

I/we, the advisors of the thesis entitled "**Improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms**" hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Dr: Ing Frezewd Lemma	____________________	__________________
Major Advisor	Signature	Date
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Co-advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by **Meriama Abdurkadir** have read and evaluated the thesis entitled """**Improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms** and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in **Computer Science and Engineering**.

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List Acronyms/Abbreviation

AODV	Ad hoc on-demand Distance Vector
AOMDV	Ad hoc on-demand Multipath Distance Vector
CH	Cluster Head
CM	Cluster Member
CBR	Constant Bit Rate
CBRD	Congestion Based Route Discovery
CU	Channel Utilization
CORA	Control overhead Reduction Algorithm
CBLTR	Cluster Based Life Time Routing
DSRC	Dedicated Short Range Communication
DSDV	Direct sequenced distance vector
DSR	Dynamic source routing
E2ED	End to End Delay
FTP	File Transfer Protocol
IDVR	Intersection Dynamic Vanet Routing
I2I	Infrastructure to Infrastructure
JOSM	Java Open Street Map
ISPDA	Improved Stability based Partially Disjoint
ITS	Intelligent Transportation Systems
LT	Life Time
MANET	Mobile Ad hoc Network
NDj-AODV	Node Disjoint Multipath Routing Based on AODV
NLOS	Non-Line of Sight
OBU	On Board Unit
OSM	OpenStreetMap
PDR	Packet Delivery Ratio
RREP	Route Reply
RREQ	Route Request
RSU	Road Side Unit
SUMO	Simulation of Urban Mobility
TraCI	Traffic Control Interface

TACRP	Traffic Aware Clustering Based Routing protocol
TMU	Traffic Management Unit
UDP	User Datagram Protocol
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
VANET	Vehicular Ad hoc Network
WOACNET	Whale Optimization Algorithm for clustering in VANE

ABSTRACT

Vehicular Ad hoc network are a subclass of mobile ad hoc networks that provide communications among nearby vehicles and between vehicles and nearby roadside equipment, although they differ from other networks due to their characteristics as well as challenging for designing such as high dynamic topology, frequent disconnected network, high mobility and so on. Because of high dynamic topology in VANETs design efficient routing protocol is challenging, this paper proposes improve the performance of cluster-based routing protocol in VANETs using hybrid algorithms to provide efficient routing protocol and increase network performance. Clustering is grouping object into classes of similar object or similar characteristic. By grouping comparable vehicles into numerous virtual groups, clustering technology is proven to be a viable way to increase routing reliability and scalability. Each cluster has a capital vehicle called a cluster head that is in charge of overseeing communication inside the cluster. The paper addresses the problem of improving the performance of cluster-based routing protocols in Vehicular Ad-hoc Networks (VANETs). While existing routing protocols have limitations, the authors propose a new algorithm that uses fuzzy logic and k-means clustering to address these limitations and enhance the performance of cluster-based routing protocols in VANETs. Overall, the statement of the problem is to improve the performance of cluster-based routing protocols in VANETs by proposing a new algorithm that can address the limitations of existing protocols and enhance the reliability and efficiency of communication among vehicles. The proposed solution in the paper is a new algorithm that uses fuzzy logic and k-means clustering to improve the performance of cluster-based routing protocols in Vehicular Ad-hoc Networks (VANETs). The algorithm is designed to address the limitations of existing protocols and enhance the reliability and efficiency of communication among vehicles. In the research we conducted simulations and compared the performance of the proposed algorithm with existing algorithms to evaluate its effectiveness. The findings demonstrate that, in terms of packet delivery ratio, the suggested method performs better than the current protocols with 1.5% in this case when the number of vehicles decrease the PDR increase, Throughput increase trough time than previous paper, and network lifetime will better increase and more stability. in this paper we suggest that the proposed algorithm can significantly improve the performance of cluster-based routing protocols in VANETs and provide suggestions for future work to investigate the algorithm's impact on different network parameters, extend it for multi-hop routing, evaluate it under different traffic scenarios, and investigate its security implications.

Keywords*: Cluster, Dynamic topology, efficient Routing, Vehicular Ad hoc network*

CHAPTER ONE

INTRODUCTION

1.1. Background of the study

The most dangerous and common cause of death is a traffic accident. The biggest obstacles to reducing road accidents globally are lack of vehicle commitment, ignorance of the scope of the issue and impossibility of prevention, delayed reporting of traffic accidents, and a lack of real-time incident location.. The main goal of the VANET is to provide safety.In today's transportation system, a vehicular ad hoc network (VANET) is a sort of wireless ad hoc network used to offer communications between cars and nearby roadside equipment, enhance comfort and safety on the road, and prevent accidents and congestion(H. Singh & Singh, 2017). A mobile circuit within each car and a road circuit allow the vehicles to wirelessly connect with one another. Vehicles connect with one another and with surrounding permanent roadside equipment over a vehicular ad hoc network, a subtype of a MANET or mobile ad hoc network, to provide intelligent transportation systems and an intelligent transportation framework. Vehicle Ad hoc Network (VANET) is a dynamic topology with nodes moving quickly, having more processing, storage, and energy than handheld devices, and providing accident-ahead information. (Hamedani & Rezazadeh, 2018).

VANET can create their own wireless network using an ad hoc network as necessary. A complete path must be started to convey the packet to its destination in order to permit successful communication; this can be done by creating a productive routing protocol. As a result, the cars must have transceivers and computerized control modules in order for them to function as network nodes and interact. The primary goal of VANET is to provide comfort and safety by providing information on gas stations, weather, parking, roadblocks, and emergency alerts. Vehicle-to-vehicle, vehicle-to-infrastructure, roadside unit, and onboard side unit are the several types of VANET communications.(Mamatha & Aishwarya, 2019)

Vehicle-to-Vehicle (V2V): Is communication amongautomobiles to correspond to new Automobiles directly, the vehicles to locally connect in an ad hoc fashion and transmit network traffic to each other, it might be used to alert about crises or reach out of coverage nodes.the vehicles to locally connect in an ad hoc fashion and transmit network traffic to each other, it might be used to alert about crises or reach out of coverage nodes.

Whereas Vehicle-to-Infrastructure (V2I): is communication among automobile to correspond only through the RSU. In order to report network data, such as lane traffic, road safety, and/or congestion status, it enables communication between the vehicles and RSUs.

IT focuses on the communications between RSUs to transmit regional network data and provide globalization. Vehicular ad hoc networks provide many benefits in but still now because of the dynamic nature of the moveable nodes in the network, finding and maintaining routes is very challenging issues in VANETs Networks, Routing protocols are very important in ad hoc networks because they are responsible for starting and maintaining routes to facilitate multi-hop announcement and spread the service area of the network. However vehicular ad hoc network (VANETs) routing protocols are planned for different scenarios such as mobility of nodes, interference, and bandwidth limitations.

Message reduction and modification in vehicular ad hoc networks are examples of non-cooperative conduct that can significantly impair the message delivery ratio and compromise the safety of other vehicles. During broadcasting or flooding, a significant amount of bandwidth was lost. (Mujahid et al., 2021). It may cause overcrowding in the network, decreases throughput, and delay increases. Therefore, new mechanisms improving the performance of cluster base routing protocol inVANETs using hybrid algorithm designed to promote cooperation in VANET for packet delivery ratio, end-to-end delay, packet loss ratio, and control overheads.

1.2. Motivation of the study

The main objective of the Vehicular Ad hoc Network is to allow Intelligent Transportation Systems by enabling effective vehicle-to-vehicle communications and providing global connection to mobile users who are now connected to the outside world via other networks at home or at work. (ITS)(Phull et al., 2022). Even if Vehicular ad hoc networks provide many benefits but still now it has also many challenges such as rapid topology change, high vehicle mobility, frequent link failure, network instability and so on. Because of the dynamic nature of the mobile nodes in the network, finding and maintaining routes are a very challenging issue in Vehicular Ad hoc Networks. Even though many routing protocols for VANETs have been proposed, how to design an efficient routing in networks and how to handle dynamic topology in the VANET are still challenging issues. The aforementioned problems are the main driving forces behind this study's is to improve the performance of cluster-based routing protocol in VANETs using hybrid algorithms to provide efficient routing protocol and increase network performance.

1.3. Statement of problem

A VANET is a kind of wireless ad hoc network that enables communication between vehicles and nearby roadside equipment. It is a new technology that is evolving to integrate next-generation wireless networking capabilities into cars. The main objective of the Vehicular Ad hoc Network is to allow Intelligent Transportation Systems by enabling effective vehicle-to-vehicle communications and providing global connection to mobile users who are now connected to the outside world via other networks at home or at work. (ITS)(Phull et al., 2022). Even if Vehicular ad hoc networks provide many benefits but still now it has also many challenges such as rapid topology change, high vehicle mobility, frequent link failure, network instability and so on. Because of the dynamic nature of the mobile nodes in the network, finding and maintaining routes are a very challenging issue in Vehicular Ad hoc Networks. Even though many routing protocols for VANETs have been proposed, how to design an efficient routing in networks and how to handle dynamic topology in the VANET are still challenging issues. Due to node mobility in VANETs, there is a high possibility of node or link failures or breakage, as well as disconnection. This necessitates the development of efficient routing protocols that deal with the high mobility of vehicles while also ensuring reliable communication between them. In the end, improving the performance of cluster base routing protocols in VANETs using hybrid algorithm is proposed to increase the performance of network by using different performance evaluation metrics to show its improvement with existing ones using packet delivery ratio, end-to-end delay, packet loss ratio, and control overheads(Sindhwani et al., 2022).

1.4. Questions and /or hypotheses.

The following three research questions will be addressed based on the issue mentioned in the statement of problem.

1. How to design an Efficient and stable routing protocol in VANET?
2. How to handle dynamic topology in VANET?
3. How to improve and evaluate the performance of network?

1.5. Objectives

1.5.1. General Objectives

The general objective of this study is to improve the performance of cluster-based routing protocol in VANETs using hybrid algorithms.

1.5.2. Specific objectives

To succeed in the general objective of the study, the following specific objectives need to be accomplished.

- To designing an efficient and reliable routing protocol in networks and how to handle dynamic topology in the VANET.
- Propose a mechanism that improves the performance of the network by improving packet delivery ratio, end-to-end delay, packet loss ratio, and control overheads.
- To simulate and compare the proposed method with other methods using cluster-based method

1.6. Significance of the Study

The objective of most researches that is designed to solve a problem and give a lot of opportunities in several areas, so efficient routing protocol in VANETs is applied in the following Area:

The study on improving the performance of cluster-based routing protocols in VANETs by using fuzzy and K-means algorithms is significant for several reasons:

- VANETs are a type of ad hoc network that allows communication between vehicles and infrastructure devices. These networks are necessary to make intelligent transportation systems (ITS) possible as well as to increase traffic efficiency and road safety.
- However, VANETs face several challenges, including high mobility, frequent topology changes, and limited bandwidth, which affect the network's performance.
- Cluster-based routing protocols are commonly used in VANETs to reduce the overhead and improve network scalability. These protocols segment the network into clusters and choose a cluster head (CH) in charge of overseeing communication within each cluster. However, because of the network's high mobility and frequent topology changes, choosing an effective CH is a difficult issue.
- Fuzzy logic and K-means clustering algorithms are powerful tools for data analysis and decision-making. In this study, these algorithms are used to improve the performance of cluster-based routing protocols in VANETs. Fuzzy logic is used to determine the CH's suitability based on several criteria, including distance, speed, and direction, while K-means clustering is used to group vehicles based on their location and mobility patterns.
- The proposed approach can significantly improve the network's performance by reducing the overhead and improving the CH's selection accuracy. This leads to better

network efficiency, reduced delay, and improved packet delivery ratio. Therefore, the study is significant for improving the performanceof VANETs and enabling the development of more efficient and reliable intelligent transportation systems.

- The study can also contribute to the advancement of research in the field of fuzzy logic and clustering algorithms by demonstrating their effectiveness in optimizing cluster-based routing protocols in VANETs. The findings of the study can be used as a basis for future research in this area, leading to the development of more sophisticated algorithms and protocols for VANETs.
- In conclusion, the study on improving the performance of cluster-based routing protocols in VANETs by using fuzzy and K-means algorithms is significant for enhancing the efficiency and reliability of VANETs and advancing research in the field of fuzzy logic and clustering algorithms. The study's findings can be used to develop more efficient and reliable intelligent transportation systems, leading to improved road safety and traffic efficiency.

1.7. Expected outcome of the study

The expected outcomes of the study on improving the performance of cluster-based routing protocols in VANETs by using fuzzy and K-means algorithms are as follows:

- Improved network efficiency: The proposed approach is expected to improve the network's efficiency by reducing the overhead and improving the CH's selection accuracy. This will lead to better network performance, reduced delay, and improved packet delivery ratio.

- Better cluster formation: The K-means clustering algorithm is expected to group vehicles based on their location and mobility patterns, leading to better cluster formation and more efficient communication within clusters.

- Increased accuracy in CH selection: The fuzzy logic algorithm is expected to determine the CH's suitability based on several criteria, including distance, speed, and direction, leading to more accurate CH selection and better network performance.

- Reduced packet loss: The proposed approach is expected to reduce packet loss by improving the network's stability and reducing the number of dropped packets due to the CH's unavailability.

- Improved road safety: The improved network performance is expected to enhance road safety by enabling better communication between vehicles and infrastructure devices, leading to improved traffic flow and reduced accidents.

- Advancement in fuzzy logic and clustering algorithms: The study is expected to contribute to the advancement of research in the field of fuzzy logic and clustering algorithms by demonstrating their effectiveness in optimizing cluster-based routing protocols in VANETs.

- Overall, the expected outcomes of the study are improved network efficiency, better cluster formation, and increased accuracy in CH selection, reduced packet loss, improved road safety, and advancement in fuzzy logic and clustering algorithms. These outcomes will lead to the development of more efficient and reliable intelligent transportation systems, enhancing the performance of VANETs and improving road safety and traffic efficiency.

1.8. Scope and Limitation of The Study

1.8.1. Scope of the Study

The scope of the proposed work with a given time and resources will only focus on solving the performance of the network by using hybrid algorithms. Finally, evaluate the performance of the network by using packet delivery ratio, end to end delay, packet loss ratio and control overheads.

The scope of the study on improving the performance of cluster-based routing protocols in VANETs by using fuzzy and K-means algorithms is as follows:

The study focuses on improving the performance of cluster-based routing protocols in VANETs by optimizing the CH's selection process using fuzzy logic and K-means clustering algorithms.

The study aims to investigate the effectiveness of the proposed approach in reducing the network's overhead, improving the CH's selection accuracy, and enhancing the network's stability and efficiency.

The study will evaluate the performance of the proposed approach using metrics such as packet delivery ratio, delay, throughput, and network overhead, compared to existing cluster-based routing protocols.

The study will be conducted using simulation tools such as NS-3 or MATLAB to simulate the VANET environment and evaluate the proposed approach's performance under various scenarios.

The study will focus on the use of fuzzy logic and K-means clustering algorithms, but it may consider other algorithms or techniques that can improve the CH selection process in cluster-based routing protocols.

In summary, the scope of the study is to investigate the effectiveness of using fuzzy logic and K-means clustering algorithms to optimize the CH selection process in cluster-based routing protocols in VANETs. The study aims to evaluate the proposed approach's performance usingsimulation tools and metrics and analyze its impact on road safety and traffic efficiency. The study will contribute to the development of more efficient and reliable intelligent transportation systems and advance research in the field of fuzzy logic and clustering algorithms. The study's findings can be used to improve the performance of VANETs and enable the development of more sophisticated algorithms and protocols for VANETs.

1.9. Limitation of the study

Due to resource constraints, time constraints the proposed work does not include the following.Wewere not concerned about the security issue.

The study on improving the performance of cluster-based routing protocols in VANETs by using fuzzy and K-means algorithms may have the following limitations:

- Simulation environment: The study will be conducted using simulation tools such as NS-3 or MATLAB. The simulation environment may not accurately reflect the real-world VANET environment, which may limit the study's generalizability.
- Real-time implementation: The proposed approach may require significant computational resources, which may not be feasible to implement in real-time VANETs.
- Limited scalability: The proposed approach may face scalability issues in large-scale VANETs. The fuzzy logic algorithm's complexity may increase with the number of vehicles, leading to increased computational overhead and delays.
- Limited evaluation metrics: The performance evaluation of the study may be restricted to a few metrics, such as packet delivery ratio, delay, and throughput, which may not adequately convey the influence of the suggested approach on the performance of the network.

- Limited scope: The study's scope is limited to improving the performance of cluster-based routing protocols in VANETs by optimizing the CH selection process using fuzzy logic and K-means clustering algorithms. Other approaches or techniques that can improve the network's performance may not be considered in the study.
- Limited applicability: The proposed approach may not be applicable in all VANET scenarios. The effectiveness of the approach may depend on the network's topology, mobility patterns, and communication requirements.

In summary, the study on improving the performance of cluster-based routing protocols in VANETs by using fuzzy and K-means algorithms may have limitations related to simulation environment, real-time implementation, scalability, evaluation metrics, scope, and applicability. These limitations should be considered when interpreting the study's findings and applying them to real-world VANET environments. Future research should address these limitations and explore other approaches or techniques to improve the performance of cluster-based routing protocols in VANETs.

CHAPTER TWO

2. LITERATURE REVIEW AND RELATED WORK

2.1. Overview of Vehicular Ad hoc Networks

Vehicular ad hoc networks have recently become one of the most attractive study topics in the field of computer networking as a result of the growth of the vehicle industry globally and wireless communication technologies.

VANETs are a subclass of mobile ad hoc networks (MANETs), which provide communications between nearby vehicles as well as between vehicles and nearby roadside devices. However, due to their distinct characteristics, VANETs set themselves apart from other networks. While in motion, nodes (vehicles) in VANETs are limited to road topology. If road data is available, we can estimate a vehicle's future position; additionally, automobiles can provide considerable processing, communication, and sensing capabilities, as well as continuous transmission power, to enable these operations.(K. Singh et al., 2020).

VANETs, on the other hand, have several drawbacks, including the possibility of large-scale deployment and high mobility. Because most cars are driven quickly and regularly change positions, nodes in the vehicular environment are much more dynamic. Because of the high mobility, the network topology is dynamic, with node links connecting and disconnecting often. Additionally, VANETs have the potential to be large-scale, including many people and spanning the entire route.

Because of these separate good-looking and troublesome characteristics, VANETs may pique the interest of both industry and academia. As a result, a number of publications have sought to describe the difficulties associated with vehicle networks. Before reviewing and evaluating the performance of various routing protocols, several publications, for example, address the research issues of routing in VANETs. (Sindhwani et al., 2022)

(Hosmani, 2017)The Firefly Algorithms will be employed in this study for vehicle dispersion. Firefly strategies involve providing a set of simple rules that follow those rules and applying an iterative procedure to those rules. It is critical to ensure that the most appropriate links are used while establishing a route and improving cluster-based routing in VANET. Using the Fire Fly Algorithm, the system will improve the architecture of the Protocol for Cluster-based Routing in VANET.

2.2. VANET Architectures

The primary elements of VANETs are divided into three domains in accordance with IEEE 1471-2000 and ISO/IEC 42010 architectures: Mobile Domain, Generic Domain, and Infrastructure Domain. The mobile domain is divided into two components: the vehicle domain and the mobile device domain, Vehicles, such as cars and buses, as well as smart phones, laptops, and smart watches are all included in the mobile device domain,

The Infrastructure Domain includes the central infrastructure domain, which includes Traffic Management Centers (TMCs) and Vehicle Management Centers, as well as the roadside infrastructure domain, which includes traffic signals and cameras.The Internet and private infrastructures are part of the generic domain. The reference design of the C2C Communication System complies with the European architecture standard for VANETs and includes the following domains: Infrastructure domain, Ad-hoc domain, and in-vehicle domain. In-vehicle communication between the vehicle's OBU and its AUs is referred to as VANET communications.(Mukhtaruzzaman & Atiquzzaman, 2020)

V2V(vehicle-to-vehicle) wireless communication between automobiles using their OBUs.Bidirectional wireless communications between automobiles and infrastructure-connected RSUs are referred to as vehicle-to-infrastructure (V2I).

Infrastructure-to-Infrastructure (I2I) communications between RSUs allow the network's coverage to be expanded.

Vehicle-to-broadband cloud (V2B) communications use wireless broadband technologies such as 3G/4G to connect automobiles to the broadband cloud.(Azat & Hong, 2020)

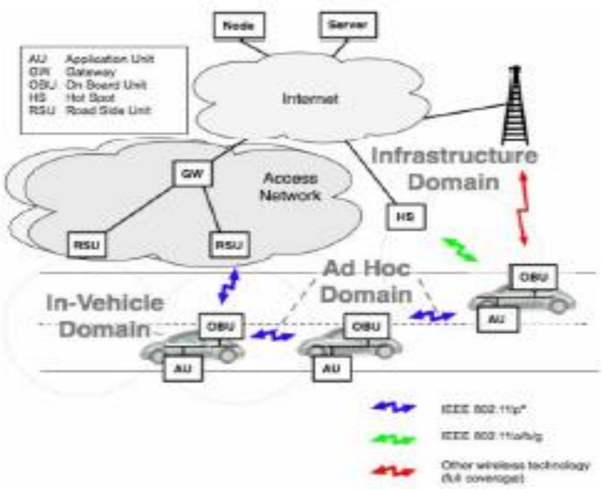

Figure 1 C2C -CC Reference Architecture

2.3. Vehicular Ad hoc Networks Application Areas

Applications in automobiles can often increase road safety, traffic efficiency, and passenger comfort. According to numerous academics, VANET applications are classed as safety, traffic efficiency, and infotainment applications. The diagram below depicts a taxonomy of VANET applications and associated use cases..(Phull et al., 2022) (Vehicular Ad Hoc Networks: Architectures, Research Issues)

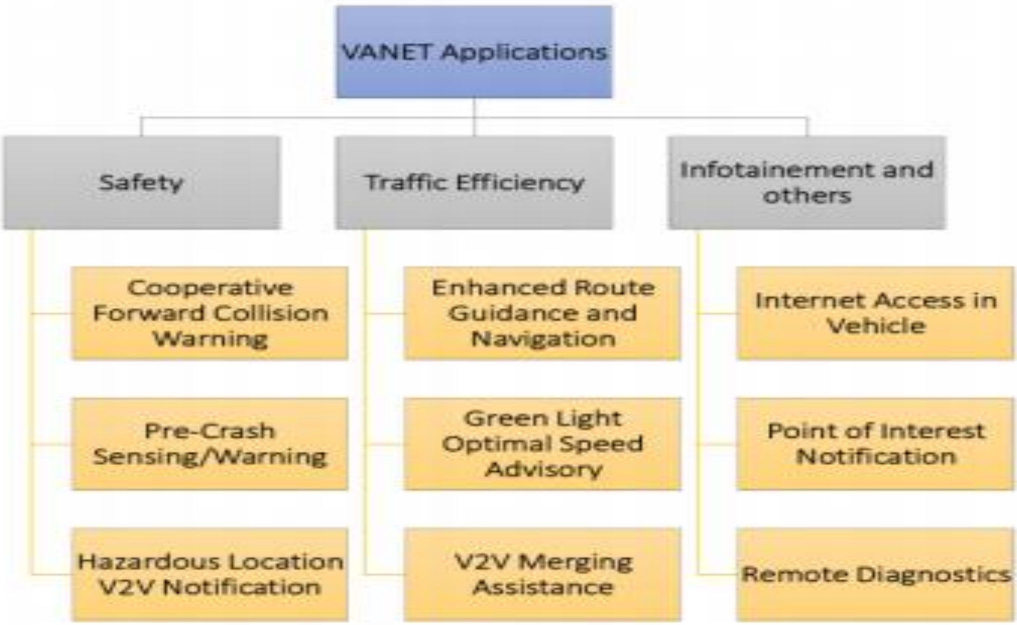

Figure 2 VANET Applications

2.4. SAFETY Applications

To improve driving safety, safety applications strive to alert drivers to harmful conditions on the road at the appropriate time. We provide a brief description of the main use cases:

Cooperative Forward Collision Warning: This use case is intended to assist drivers in avoiding rear-end collisions with other vehicles. The most prevalent causes of rear-end collisions are driver inattention or abrupt braking. Cars convey critical information such as position, speed, and direction in order to avoid a collision. When a critical condition (e.g., insufficient safety distance) is detected, the automobile alerts the driver.

Pre-Crash Sensing/Warning: Unlike the Cooperative Forward Collision Warning, this indicates that a collision is unavoidable and will occur. In such cases, the participating cars efficiently interact with nearby cars, allowing the vehicle's actuators to be used more effectively.

Hazardous Location V2V Notification: The application's purpose is to communicate relevant information about unsafe places on the roads between automobiles in a certain area.

When a vehicle detects a problematic place, it uses the information to optimize its safety systems before broadcasting it to nearby vehicles. The information is then gradually shared with other cars via V2V communications. External service providers can also offer us information about risky spots on the road, which we then convey to some vehicles within their communication ranges. Following that, vehicles that receive the information can transmit it to others via V2V connections.(Yeferny & Hamad, 2021)The article proposes three algorithms: Cluster-Based Life-Time Routing (CBLTR) protocol, Intersection Dynamic VANET Routing (IDVR) protocol, and Control Overhead Reduction Algorithm (CORA). The CBLTR protocol aims to increase route stability and average throughput in a bidirectional segment scenario. The CHs are selected based on maximum Life-Time (LT) among all vehicles located within each cluster. The IDVR protocol aims to increase route stability, average throughput, and reduce end-to-end delay in a grid topology. The ICH receives a Set of Candidate Shortest Routes (SCSR) closed to the desired destination from the Software Defined Network (SDN). The optimal route is selected based on its current location, destination location, and the maximum of the minimum average throughput of SCSR. The CORA algorithm aims to reduce the number of control overhead messages in the clusters by developing a new mechanism to calculate the optimal numbers of control overhead messages between the CMs and the CH. The article also mentions that many new vehicles now include GPS receivers and navigation systems, and car manufacturers such as Toyota, Chevrolet, and BMW have plans to include significant computing power within their automobiles.

(Mamatha & Aishwarya, 2019)(Yeferny & Hamad, 2021)Chrysler was the first vehicle maker to include Internet access in several of its 2009 auto collection, and since then, there has been a trend towards increasing the number of vehicles equipped with computer technologies and wireless network interfaces. This will lead to vehicles exchanging messages for free, enjoyable, and flexible road traffic via network protocols. Standardization for vehicle-to-vehicle communication is already underway, and a bandwidth of 75MHz has been allocated by the Federal Communications Committee (FCC) in the United States for on-road infrastructure communication using Dedicated Short-Range Communications (DSRC). The implementation of vehicle networks will enable a range of useful applications, such as automatic warnings, interactive road preparation, parking availability, audio and video file sharing between moving vehicles, and common ads, both in terms of safety and privacy. Three forms of transport connectivity are taken into consideration when delivering such systems, including cellular network, road infrastructure vehicles, and ad hoc traffic communications, with hybrids expressing the approaches mentioned above with variations.

(Mukhtaruzzaman & Atiquzzaman, 2020)This research provides a thorough analysis of the clustering-based routing protocols utilized in soft computing-aware vehicle networks. Various soft computing approaches are used for classification, including particle swarm optimization, k-means, neural networks, artificial bee colonies, genetic algorithms, fire rely algorithms, and fuzzy logic. The survey also includes a comparative examination of soft computing strategies, with an emphasis on their objectives as well as their strengths and weaknesses. This study assists researchers in selecting the appropriate soft computing technology for use in automotive networks in order to optimize metrics like as packet delivery ratio, end-to-end delay, throughput, cluster lifetime, and message overhead.(Sharma & Kaul, 2021)This paper represents about the AODV-R routing protocol outperforms in terms of reliability. This paper proposes a new clustering Ant Colony Optimization based routing protocol AODV-R for removing the congestion as well as finding shortest path selection. The proposed methodology has shown quite significant improvement over available ones.(Yeferny & Hamad, 2021)This paper provides a systematic analysis of clustering-based routing protocols used in vehicular networks that utilize soft computing techniques. The categorization is performed based on various soft computing techniques such as particle swarm optimization, k-means, neural networks, artificial bee colony, genetic algorithm, firefly algorithm, and fuzzy logic. A comparative study of these soft computing strategies is also provided in the survey, focusing on their objectives, strengths, and limitations. This survey aims to assist researchers in selecting the appropriate soft computing technique to improve metrics such as packet delivery ratio, end-to-end delay, throughput, cluster lifetime, and message overhead in vehicular networks.

2.5. Traffic efficiency applications

(Sharma & Kaul, 2021) Traffic efficiency applications aim to improve transportation system efficiency by providing traffic-related information to drivers or road operators via VANETs. This can result in shorter travel times and lower road construction and maintenance costs. The CAR-2-CAR Communication Consortium has introduced several traffic efficiencies use cases, including Enhanced Route Guidance and Navigation. This use case allows the infrastructure owner to collect traffic data for a large region, which can then be used to predict traffic congestion on roadways. The predicted data is transmitted to vehicles via RSUs, informing the driver about current and expected traffic throughout the region, expected delays to their destination, and better routes that may exist to avoid certain situations.

- **Green Light Optimal Speed Advisory:** It informs vehicles approaching a signalized intersection about the intersection's location and signal timing (i.e., when to switch the light signal), resulting in smoother driving and fewer stops. While such information is received at the right time, the car can compute the best speed to reach the intersection while the traffic light is green, and so. This will almost certainly result in an increase in traffic flow and fuel economy.
- **Infotainment and others:** This category includes use cases that are not related to safety or traffic efficiency. Some of these use cases supply drivers with amusement or information on a daily basis. Others are visible to the driver and play an essential role in improving vehicle functions.
- **Internet Access in Vehicle:** it allows drivers and eventually passengers to access the Internet via the VANET. In this case, RSUs act as internet gateways.
- **Point of Interest Notification:** It enables merchants and advertising firms to broadcast their company incentives to adjacent automobiles. To do this, an RSU transmits the advertisement information (e.g., location, hours of operation, and pricing) to the vehicles that have been contacted. Each vehicle filters the received advertisements based on the driver profile and situation, and then displays appropriate advertisements to the driver.

2.6. Characteristics of VANETs

VANETs are a special type of ad-hoc networks distinguished by the following characteristics derived from:

- **Mobility:** VANETs are mostly gathered from stationary RSUs and moving vehicles. The vehicle's speed fluctuates from extremely slow to extremely fast, posing additional communication issues. Indeed, in regions with heavy traffic, vehicles are stopped or going slowly, giving them enough opportunity to exchange messages. (Azat & Hong, 2020)However, due to the high density of vehicles, they face significant hurdles such as data collision, channel fading, message loss, and other interference issues. Vehicle speed is particularly fast in low traffic areas (e.g., highway), resulting in various communication issues such as narrow communication windows (few seconds), link failures, high end-to-end (ETE) delay, and so on.
- **Movement pattern:** Node movement in VANETs differs from that of MANETs. In MANETs, mobile nodes can move freely anywhere at any time, whereas in VANETs,

vehicles follow the topology of road networks in the geographic areas where they drive. In general, there are three situations: urban area, rural area, and highway. Urban areas have a more complex road network, denser in terms of vehicle number than rural areas, and contain more obstacles, traffic signals, and RSUs. Highways have vehicles moving in one direction over many lanes. The spatial attributes of the road network have an impact on communication efficiency and effectiveness. The figure provided in the document shows the differences in road networks between urban, rural, and highway areas.

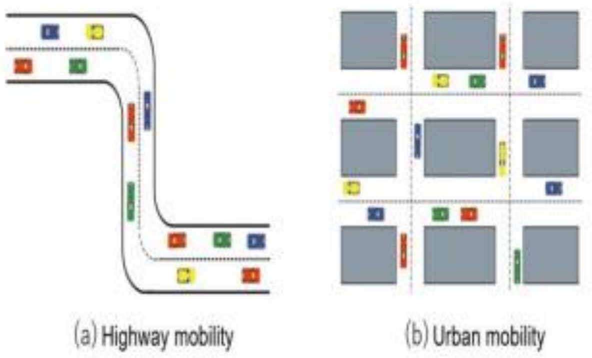

Figure 3 Vehicle Mobility

- **Traffic density:** Traffic density in VANETs varies from high to low, depending on the geographic area and time factor. High traffic density is observed in urban areas, whereas low traffic density is observed in rural areas and highways. During off-peak hours, traffic density is low, but it increases significantly during rush hours. The design of efficient VANET communication protocols faces challenges due to traffic density. In areas with very low traffic density, data dissemination protocols must deal with the network disconnection issue, whereas in areas with very high traffic density, advanced data dissemination mechanisms should be used to avoid the broadcast storm issue, especially in urban areas during rush hours.
- **Heterogeneity:** VANET nodes differ in terms of their characteristics and capabilities. Vehicles, for example, are moving nodes with varying communication ranges, sensing capabilities, and categories (for example, private, authority, and maintenance vehicles). RSUs, on the other hand, are stationary nodes positioned in strategic places and equipped with full ad-hoc capabilities.

2.7. Challenges in VANETs

VANETs require different communication paradigms, security and privacy mechanisms, and wireless communication technologies than MANETs due to their unique properties. The

following talk will describe the key issues in VANETs. Different applications are employed in Intelligent Transportation Systems (ITS), which range from traffic protection applications to infotainment applications. A group of such apps presents various protocols for vehicular communication standards.(Abuashour & Kadoch, 2017a). These needs create new challenges:
Bandwidth constraints: Because of the lack of a central controller that manages the use of limited bandwidth and comfortable activity, VANETs suffer from channel overcrowding, particularly in high-density zones. (Mujahid et al., 2021).

Delay constraints: Because VANET topology changes frequently, strict time limits apply. As a result, when designing effective vehicle transmission protocols, it is critical to account for a reasonable time delay. Vast amounts of attacks can be targeted due to the open environment of VANETs. As a result, discovering new instances connected to vehicular interaction and protecting the clustering protocols against such attacks is a difficult task.

High dynamic and unconnected topology: To deal with such conditions, a new research model called Vehicular Delay Tolerant Networks is constructed. (Husnain & Anwar, 2021).

- **Fundament Limits and Opportunities.**

From a more theoretical standpoint, nothing is understood about the underlying limitations and prospects of VANETs communication. We feel that preventing accidents and reducing resource consumption are both significant theoretical research concerns.

- **Standards.**

The original IEEE 802.11 standard falls short of the requirement for reliable network connections, and the IEEE 802.11p protocol's present MAC parameters are inefficiently designed for a potentially high number of cars.

- **Routing Protocols.**

Many researchers have presented many effective routing protocols and algorithms, such as CMV (cognitive MAC for VANET) and GyTAR (greedy traffic-aware routing). However, the critical challenge is to design good routing protocols for VANETs communication with high vehicle mobility and dynamic topology.

- **Connectivity**

The administration and control of network connections between vehicles and between vehicles and network infrastructures is the most important aspect of VANETs communication; providing appropriate delay performance within the constraints of vehicular speeds, high dynamic topological, and channel bandwidths is a fundamental difficulty in vehicular communication design..

- **Cross-Layer.**

To support real-time and multimedia applications, and the available solution is to design a cross-layer among original layers. In general, cross-layer protocols that operate in multiple layers are used to provide priorities among different flows and applications.

- **Cooperative Communication.**

The VANETs as a type of cloud called mobile computing cloud (MCC), and a broadband cloud in vehicular communication. Thus, the cooperation between vehicular clouds and Internet clouds in the context of vehicular management applications has become a critical challenge to researchers.

- **Mobility.**

Mobility that is the norm for vehicular networks makes the topology change quickly. Besides, the mobility patterns of vehicles on the same road will exhibit a strong correlation. In VANETs mobility plays a key role in vehicular protocol design and modeling.

- **Security and Privacy.**

The tradeoff of security and privacy is the biggest challenge under the requirement of efficiency.

- **Validation.**

It is necessary not only to assess the performance of VANETs in a real scenario but also to discover previously unknown and critical system properties. Besides, validation has become more and more difficult under a wider range of scenarios. The present can use field operational tests (FOTs) to solve this problem, but conducting meaning FOTs is a challenge like a large and complex system with technology components.

2.8. Clustering

It is the process of dividing a group of items into classes of similar objects, but the object that is being divided is an abstract type. The abstract denotes a lack of prior information or explanations. The data that has been clustered is also viewed as a group of data. Cluster analysis means that the data set is partitioned and then related data is allocated to labels. The fundamental advantage of clustering is that it allows for easy grouping of data and provides additional benefits.(Husnain & Anwar, 2021).

(Hosmani, 2017)This paper presents various forms of cluster-based routing protocols that can be used to achieve efficient communication. However, there are other concerns and obstacles that must be addressed, including clustering in relation to the bidirectional traffic model, data dissemination strategies, routing, QOS assurance, security, and so on. We give a study on several clustering techniques in VANETs in this manner.

(Wahid et al., 2022)The recommended schemes are categorized in this study based on the operating context. A survey of suggested routing strategies during the last eight years is presented in order to establish the design considerations and strategy used in each proposed system, as well as its flaws. This survey will help fresh scholars in this subject examine existing cutting-edge systems. The table at the end of each routing scheme gives the simulation, routing, and scenario parameters for the suggested routing strategy. This article also discusses VANET technology, its function in the intelligent transportation system, recent advancements in the sector, and the system's implementation time frame.

2.9. Clustering Concept

(a) Supervised clustering: The goal of supervised clustering is to readily discover clusters with high probability densities. Because it employs the target variable and training sets, supervised clustering provides the highest performance because it includes the variable in the cluster.

(b) Unsupervised learning: This term is most commonly used to quantify dissimilarity and similarity. It lessens the increased resemblance between inter and intra cluster. It employs a highly particular objective function.

2.9.1. **Cluster-Based Routing (CBR)**

Routing algorithms for VANETs are classified into five major classes: Ad Hoc, position-based, Broadcast, Geocast, and cluster-based. Among these, cluster-based algorithms have received more attention from researchers due to their ability to maintain network performance even with a large number of mobile nodes. Cluster-Based Routing (CBR) protocol is a hybrid routing protocol that divides the network into smaller areas called clusters, and within each cluster, there is a specific routing protocol called intra-cluster routing protocol. Communication between clusters is performed via pre-selected nodes known as Cluster Heads (CHs), which are responsible for coordinating the members of the cluster and communicating between clusters using inter-cluster routing protocol.(Wahid et al., 2022).

Cluster-based routing protocols minimize control overhead and increase network scalability by selecting Cluster Heads (CHs) to find the destination route, reducing routing overhead proportional to the number of clusters rather than the number of nodes. Location information (LOCO) is used to select CHs, with nodes moving at the front of the cluster becoming CHs. CHs broadcast road safety and traffic status to cluster members and report the situation of traversed roads to RSUs for further processing and utilization, such as traffic information and accident reports. RSUs are connected through telecommunication infrastructure and are responsible for transportation control. Each RSU is attached by an address that shows its location and lane of coverage, with some managing sub-roads. RSUs use information reported by CHs to control road safety and update connected vehicles. Figure 4 below shows RSU11 and RSU12 covering left-to-right and right-to-left lanes of the road, respectively, while RSU11.1 manages a sub-road of RSU11.(Hosmani, 2017)Cluster based routing protocol have been paid much attention because of clustering have many advantages such as

- Minimizing the total transmission power
- lessening routing and topology maintenance overhead
- balancing the exhausting load among all node
- Eliminating the redundant and highly correlated data in aggregation.
- scalable for large number of nodes

(Alsabah et al., 2021)Following some guidelines, attributes nodes are grouped together. The cluster contains three types of nodes: CH, cluster CM, and gateways. Distributed and mobility adaptive clustering algorithm (DMAC), resilient mobility adaptive clustering algorithm (RMAC), adaptive service provider infrastructure (ASPIRE), and hierarchical clustering algorithm are a few examples of cluster-based routing protocols. (HCA). O-LEACH presents a high connectivity rate and a large coverage of a monitored area. The nodes which are not within reach of the CH are called orphan nodes. The authors have shown in this protocol two different scenarios. The first scenario allows a CM to act as a gateway for orphan nodes. The second scenario shows that a significant number of the nodes that are residing in an uncovered area are called orphan nodes. These nodes form a sub-cluster and select a CH based on the shortest distance of the gateway nodes(Sindhwani et al., 2022)

2.10. Related Work

In This section we have reviewed research work on the area of Improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms

(Mukhtaruzzaman & Atiquzzaman, 2020)This research attempts to improve vehicle clustering in Vehicular Ad-Hoc Networks (VANETs) by applying fuzzy logic to make the network more durable and scalable. When it comes to ensuring effective and reliable communication in VANETs, high mobility and scalability are two critical themes to address. Clustering is critical for dealing with the dynamic characteristics of VANET topologies. For highly dynamic VANET structures, many parameters related to user preferences, network conditions, and application requirements, such as mobile node speed, distance to cluster head, data rate, and signal strength, must be evaluated in the cluster head selection process, along with the direction parameter. As inputs to the proposed cluster head selection method, the prominent parameters speed, acceleration, distance, and direction information are considered. The simulation results show that the developed fuzzy logic (FL) based cluster head selection algorithm (CHSA) performs consistently in a variety of VANET settings. This research also demonstrated that the created CHSAFL meets the highly demanding criteria of both low-speed and highspeed vehicles on two-way multilane highways.

(Habelalmateen et al., 2022b)In this research, a dependable two-layer cluster-based technique for VANETs is developed to alleviate the link failure problem. When the topology does not have a consistent structure, using two-layer routing makes route maintenance and the possibility of self-organization easier. The strong link is selected at the first level of the new method, and the greedy algorithm is employed at the second level to find the optimum route. This novel approach incorporates effective parameters such as velocity, direction, ST, and position. When compared to two similar measured protocols, the proposed protocol improved network characteristics such as end-to-end delay and packet delivery ratio. When compared to previous protocols, the increased packet delivery ratio and lower end-to-end delay demonstrated improved performance.

(Sindhwani et al., 2022)Thus, in this study, a novel traffic and cluster-based network approach, Traffic-Aware Clustering based Routing Protocol (TACRP), is developed. The approach's major goal is to improve network traffic management while also lowering energy usage. A Traffic Management Unit (TMU) is included in the built network to control the total network traffic with the help of RSUs. Vehicles with comparable speeds and directions are organized into clusters to improve network stability and assist reduce network energy usage. The clustering model specifies principles for cars departing clusters, joining clusters, cluster updates, and inter-cluster communication, which improves network stability and reliability. In the proposed work, for example, the CH is chosen based on centralization, weight, distance, and energy computation. Such network configurations enable successful vehicle clustering on the road. When compared to preceding approaches such as ECHS and NRHCS, simulation experimental analysis revealed that the suggested TACRP routing protocol obtained higher results in terms of energy efficiency, throughput, packet delivery ratio, and network end-to-end delay.

(Mehta, 2016)In the proposed work, for example, the CH is chosen based on centralization, weight, distance, and energy computation. Such network configurations enable successful vehicle clustering on the road. When compared to preceding approaches such as ECHS and NRHCS, simulation experimental analysis revealed that the suggested TACRP routing protocol obtained higher results in terms of energy efficiency, throughput, packet delivery ratio, and network end-to-end delay.

(Abuashour & Kadoch, 2017a)We propose three algorithms in this article: the Cluster-Based Life-Time Routing (CBLTR) protocol, the Intersection Dynamic VANET Routing (IDVR) protocol, and the Control Overhead Reduction Algorithm (CORA). In a bidirectional segment scenario, the CBLTR protocol seeks to improve route stability and average throughput. Cluster Heads (CHs) are chosen based on the maximum Life-Time (LT) of all vehicles inside each cluster. The IDVR protocol seeks to improve route stability and average throughput while decreasing end-to-end delay in a grid architecture. The Software Defined Network (SDN) sends the elected Intersection CH (ICH) a Set of Candidate Shortest Routes (SCSR) that are close to the intended destination. The IDVR protocol chooses the best path based on its present position, destination location, and the maximum of these factors. Finally, the CORA method seeks to reduce control overhead messages in clusters by inventing a novel mechanism for calculating the appropriate number of control overhead messages between CMs and CHs. To analyze the performance of our suggested protocols, we used SUMO traffic generating simulators and MATLAB. In terms of several parameters, these protocols outperform numerous protocols listed in the literature.

(Sindhwani et al., 2022)Most ad-hoc networks have traditionally used routing algorithms such as ad-hoc on-demand vector (AODV) routing, greedy perimeter stateless routing (GPSR), direct-sequenced distance-vector (DSDV) routing, and dynamic source routing (DSR). However, it is well recognized that traditional routing methods have issues when used for the VANET. For example, the DSR cannot repair frequent link failures in the VANET. The DSDV routing protocol uses more bandwidth for message exchanges and has high overheads.

(Alowish et al., 2017)Routing methods such as ad-hoc on-demand vector (AODV) routing, greedy perimeter stateless routing (GPSR), direct-sequenced distance-vector (DSDV) routing, and dynamic source routing (DSR) have typically been employed in most ad-hoc networks. Traditional routing methods, on the other hand, are well known to have difficulties when employed for the VANET. For example, on the VANET, the DSR cannot fix frequent link failures. The DSDV routing protocol consumes more bandwidth and has high overheads.

(Mujahid et al., 2021)This paper discusses cluster-based location service schemes, which are gaining popularity due to their advantages over non-cluster-based systems. Cluster-based techniques increase network scalability, minimize communications overhead, and resolve mobility concerns inside clusters, preventing them from spreading throughout the network. As a result, this paper presents a taxonomy of existing location service schemes, examines cluster-based location services by highlighting their strengths and limitations, and compares location-based clustering to application-specific clustering such as that used in routing, information dissemination, channel access management, and security. Furthermore, present clustering strategies, problems, and future perspectives for effective cluster-based location services are explored.

(Husnain & Anwar, 2021)During clustering, this study offers a novel optimization strategy that takes transmission range, node density, speed, direction, and grid size into account. The Whale Optimization Algorithm for Clustering in Vehicular Ad hoc Networks (WOACNET) was created to select the best cluster head (CH) based on intelligence and capabilities. Initially, simulations were run, and then rigorous experiments on WOACNET were carried out. The model was tested and assessed against other well-established state-of-the-art methods, such as Gray Wolf Optimization (GWO) and Ant Lion Optimization (ALO), using a variety of performance indicators.

The results show that the created technique outperforms previous VANET methods in terms of cluster head, variable transmission ranges, grid size, and nodes. When compared to previous established approaches (11.95 and 22.50), the new method achieves an overall 46% improvement in cluster optimization and an F-value of 31.64, resulting in an increase in cluster longevity.

(Habelalmateen et al., 2022a)Thus, in this study, a novel traffic and cluster-based network approach, Traffic-Aware Clustering based Routing Protocol (TACRP), is developed. The approach's major goal is to improve network traffic management while also lowering energy usage. A Traffic Management Unit (TMU) is included in the built network to control the total network traffic with the help of RSUs. Vehicles with comparable speeds and directions are organized into clusters to improve network stability and assist reduce network energy usage. The clustering model includes concepts for cars departing clusters, joining clusters, cluster updates, and inter-cluster communication, which improves network stability and reliability. Such network configurations enable successful vehicle clustering on the road. When compared to previous techniques, such as ECHS and NRHCS, simulation experimental analysis revealed that the suggested TACRP routing protocol obtained higher results in terms of energy efficiency, throughput, packet delivery ratio, and network end-to-end delay. Routing in vehicular ad hoc networks (VANETs) is critical for data distribution in these networks. One of the major issues in these networks is the problem of vehicle link failure.

(Hamedani & Rezazadeh, 2018)In this research, a dependable two-layer cluster-based technique for VANETs is developed to alleviate the link failure problem. When the topology does not have a consistent structure, using two-layer routing makes route maintenance and the possibility of self-organization easier. The strong link is selected at the first level of the new method, and the greedy algorithm is employed at the second level to find the optimum route. This novel approach incorporates effective parameters such as velocity, direction, ST, and position. When compared to two similar measured protocols, the proposed protocol improved network characteristics such as end-to-end delay and packet delivery ratio. Improved performance was demonstrated by increased packet delivery ratio and lower end-to-end delay as compared to previous protocols.

2.11. Summary of the related work on this study

Table 1 Research-related work with their limitation and gaps

Authors	***Title***	***Algorithm used***	***contribution***	***Gaps***
(Mehta, 2016)	Design of Protocol for Cluster Based Routing In VANET Using Fire Fly Algorithm	Fire Fly Algorithm	Used the parameter of Energy, Packet delivery ratio and End to End Delay with respect to DSDV Protocol	The researcher didn't consider packet loss ratio and control overhead Fire fly algorithm can increase overhead.
(Phull et al., 2022)	Performance Improvement of Cluster-Based Routing Protocol in VANET	Propose three algorithms: Cluster-Based Life-Time Routing (CBLTR) protocol, Intersection Dynamic VANET Routing (IDVR) proto- col, and Control Overhead Reduction Algorithm (CORA).	The IDVR protocol increase the route stability and average throughput, and to reduce end-to-end delay in a grid topology.	This paper considers the evaluation method based on constant velocity but did not consider when the VANETS have different velocity. The evaluation of the IDVR algorithm focus only end-to-end delay and throughput for a grid topology but not consider other evaluation metrics.
(Alowish et al., 2017)	Performance Evaluation of a Cluster Based Routing Protocol for VANETs	cluster based routing (CBR) protocol proposed	the CBR routing protocol outperforms the AODV, GPSR, and DSR protocols in the sense of the packet delivery	The researcher evaluates based on packet delivery ratio and message overhead but did not consider throughput and packet loss.

			ratio and the message overheads	
(Mamatha & Aishwarya, 2019)	An Efficient Cluster based Routing Protocol using Hybrid FCM-Q LEACH for Vehicular Ad Hoc Networks	by using two clustering techniques Fuzzy C Means (FCM) and Quadrature-Low Energy Adaptive Cluster Hierarchy(Q-LEACH)	The performance of FCM-Q LEACH-VANET was analyzed in terms of energy consumption, network latency, total packet sends and throughput. The result showed that the throughput of the FCM-Q LEACH-VANET is more compared to the existing IDVR protocol.	The researcher did not measure how much packet is delivered from end to end and how much packet loss during traveling from one end to other end
(Habelalmateen et al., 2022b)	TACRP: TrafficAware Clustering-Based Routing Protocol for Vehicular Ad-Hoc Networks	Traffic-Aware Clustering based Routing Protocol (TACRP)	the approach is to improve traffic management in the network as well as to reduce energy consumption in it	did not consider routing/message/communication overhead and packet loss
(Hamedani & Rezazadeh, 2018)	A New Two-Level Cluster-based Routing Protocol for Vehicular Ad hoc Network (VANET)	Two-layer cluster-based algorithm has been introduced At the first level of new method, selecting the strong link and at the second	The researcher main objective is to Minimizing link failure and used increase packet delivery ratio and decrease end to end delay	The researcher did not focus on packet loss and communication overhead

		level, thegreedy algorithm is used in order to select the best route		

CHAPTER THREE

METHODOLOGY

For the investigation of explanatory research questions, we try to explain the methods that we use in the proposed solution in the performance improvement in VANET using cluster based. And then we use simulation software to see in experiments and finally, we evaluate the result. This chapter explains the improving the Performance of Cluster Based Routing Protocol in VANET by Using Hybrid Algorithms. This comprises the methods used for data collection, processing, using equipment or materials, and choosing a method. The diagram below describes the procedures or methods from the literature review to conclusion and future work. To implement the objective of this study, different methodologies will be used.

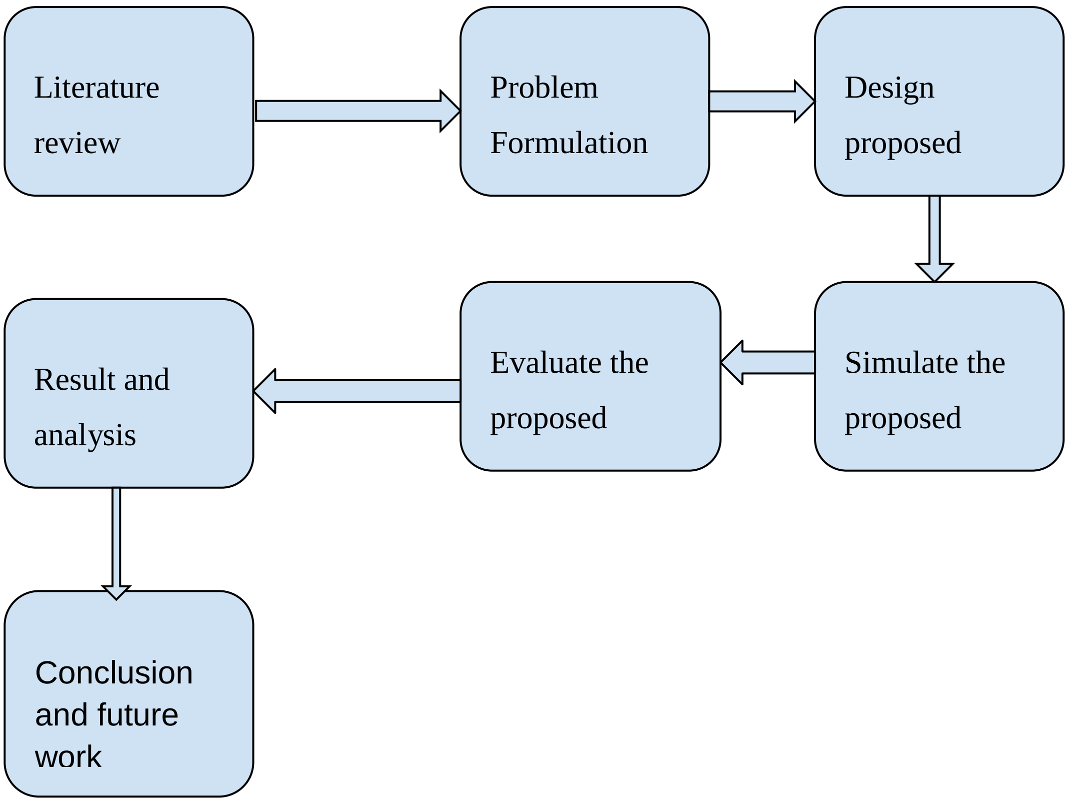

Figure 4 Procedures or methodology of the study

3.1. Literature review

To achieve the research objective, review several works such as research papers, magazines, conference papers, journal articles studied to understand the research work, to collect relevant information, to gain a deeper understanding of the research area. Different literary works that are connected to this thesis work have been reviewed, and various notions have been embraced.

3.2. Problem Formulation

After reviewing different recent articles and papers the problems are formulated, then the problem formulated was again and again reviewed. Based on the literature review we identify the problems to be solved in this thesis.

3.3. Design Proposed Solution (cluster Based routing protocol)

The new method was developed based on the cluster-based routing protocol which is used for modifying efficient routing protocol by using different parameters such as packet delivery ratio, end-to-end delay, packet loss ratio, and control overheads, to improve the performance of a network.

3.4. Simulate the proposed solution

The hardware and software tools used to simulate the proposed solution are shown in table

Table 2 hardware and software to simulate

Software	**Hardware**
operating system: Ubuntu	RAM: 8.00GB.
processors: Intel(R)core (™)2 Duo CPU	System type:64-bi
simulation tool: integrate SUMO file with MATHLAB 2019b	Hard disk 500Gb
TraCI4Matlab version 0.9.2	
JOSM Version 17762	

3.5. Result and analysis

Showing the result and experiment for the proposed model.

3.6. Evaluation of the proposed model

The simulation's results will be validated, and performance will be evaluated. In this paper we only use end to end delay, overhead, packet loss rate, and throughput packet and delivery ratio to evaluate our proposed algorithm.

Packet Delivery Ratio

This metric measures the percentage of packets that are successfully delivered to their intended destination. High PDR indicates good network connectivity and reliability. The PDR is considered as a significant performance metric, which should always be increasing in a network. In a routing protocol, the PDR plays a major role without the network fails to improve its performance. The PDR is defined,

PDR (%) = Delivery Packets/ Sent Packet

Throughput

Throughput is defined as a number of successful messages delivered to the destination as well as this value should be high for an effective data transmission and the throughput is given by the following equation (8). Lifetime performance measurement in Vehicular Ad-hoc Networks (VANETs) can be a challenging task due to the dynamic nature of these networks. VANETs are wireless networks that enable communication between vehicles and infrastructure, and they are used to provide various services such as traffic management, safety, and entertainment.

Life Time

This metric measures the lifespan of the network, which is the time until the first node runs out of energy or fails. A longer network lifetime indicates a more sustainable and reliable network.

CHAPTER FOUR

PROPOSED CLUSTER BASED ROUTING PROTOCOL FOR VANET

4.1. Overview of Cluster based Routing protocol by using Hybrid Algorithm.

Along with benefits, VANET arises from many challenges, such as high mobility, patterned mobility, frequent network topology change, unbounded network size, and frequent link failure. The main drawback of VANET is Network instability. Because of these challenges, designing an efficient routing protocol is difficult, so we proposed Cluster based routing protocol where several vehicles join to form a group based on common features. Hybrid algorithms are proposed for VANET clustering where k-means algorithms are integrated with fuzzy logic to create efficient and stable clusters.

4.2. Taxonomy of Soft Computing Techniques Aware Clustering Based Routing Protocols in VANETs

In a dynamic and complicated environment like VANETs, soft computing provides an adaptive mechanism that generates intelligent behavior. With the rapid advancement of soft computing techniques, cluster-based routing protocols based on PSO, neural networks, firefly, fuzzy logic, ABC, and GA have gained widespread acceptance for ensuring successful clustering and routing in VANETs. Such clustering algorithms have been shown to perform well under VANET-specific conditions such as network outages, dynamic topology, and node mobility (K. Singh et al., 2020)(Sindhwani et al., 2022). In this section, we will discuss soft computing-based clustering routing protocols in VANET.

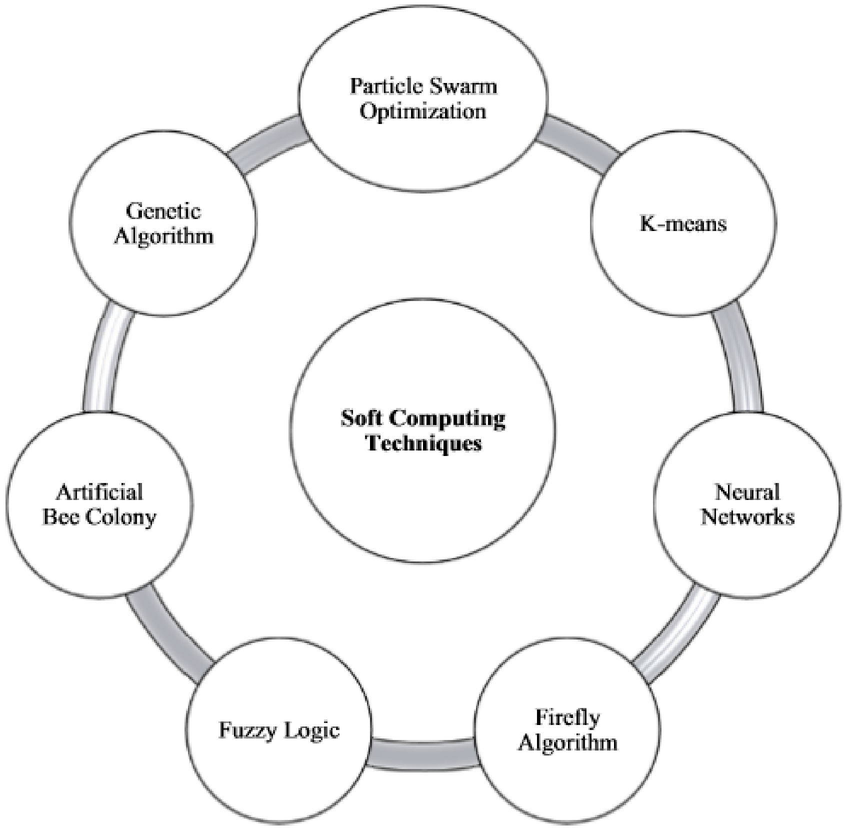

Figure 5 Soft computing techniques algorithm, in VANET

In this chapter we proposed the solution to the problem. The main role of the study is increasing the performance of routing protocol using clustering algorithm. These proposed algorithms that we used in this research are K-means algorithms and fuzzy algorithms.

4.3. Proposed Cluster based Routing protocol by using Hybrid Algorithm

In this study, hybrid methods for VANET clustering are proposed, in which k-means algorithms are combined with fuzzy logic to build efficient and stable clusters. The following steps are included in the suggested approach for increasing the performance of cluster-based routing protocols in VANETs utilizing fuzzy and K-means algorithms:

- **Cluster formation:** The VANET network is divided into clusters, with each cluster having a cluster head (CH) responsible for managing the communication within the cluster.

- **Vehicle grouping:** The K-means clustering algorithm is used to group vehicles based on their location and mobility patterns, leading to more efficient communication within clusters.

- **CH selection:** The fuzzy logic algorithm is used to determine the CH's suitability based on several criteria, including distance, speed, and direction, leading to more accurate CH selection and better network performance.

- **CH communication:** The CH communicates with other CHs and infrastructure devices to exchange information and coordinate the network's operation.

- **Data forwarding:** The CH forwards data packets to other vehicles or infrastructure devices within the cluster or to neighboring clusters.

- **Performance evaluation:** The proposed approach's performance is evaluated using metrics such as packet delivery ratio, delay, throughput, and network overhead, compared to existing cluster-based routing protocols.

The suggested technique attempts to increase network performance by lowering overhead and increasing the accuracy of CH selection. The K-means clustering method is expected to organize cars based on their location and mobility patterns, resulting in more efficient cluster formation and communication within clusters. The fuzzy logic algorithm is supposed to identify the acceptability of the CH based on a number of variables, resulting in more accurate CH selection and improved network performance. The proposed approach can greatly increase network efficiency and stability by utilizing these algorithms, resulting in greater packet delivery ratio, reduced delay, and improved network scalability.

Simulation tools such as NS-3 or MATLAB can be used to simulate the VANET environment and compare the proposed approach's performance with existing cluster-based routing protocols in order to evaluate its performance. The study should also consider the proposed approach's influence on road safety and traffic efficiency by analyzing network performance in terms of vehicle-to-vehicle and vehicle-to-infrastructure communication.

The proposed solution for improving the performance of cluster-based routing protocols in VANETs uses fuzzy and K-means algorithms, involving multiple steps such as cluster formation, vehicle grouping, CH selection, CH communication, data forwarding, and performance evaluation. The authors suggest that this approach can significantly enhance the efficiency and stability of the network and yield better packet delivery ratio, reduced delay, and improved scalability. However, the proposed solution may have limitations concerning the simulation environment, real-time implementation, scalability, evaluation metrics, scope, and applicability, which should be considered when evaluating its performance.

4.3.1. K-means based clustering algorithm

The K-means algorithm is a widely used unsupervised machine learning algorithm in VANETs. The value "K" represents the number of clusters, and the algorithm involves randomly selecting three distinct centroids as the cluster initialization. The distance between each point and the centroid is measured using Euclidean distance, and the centroids are elected as the CH. Whenever a CM joins or leaves a cluster, the mean of the cluster needs to be recalculated to reflect the change, which can result in electing a new vehicle as the CH. The velocity of the vehicles is also considered to form the clusters. However, the fixed number of clusters can be a limitation that affects v2v communication with many vehicles. The algorithm aims to reduce the number of distances between data points and the clusters by dividing an unlabeled dataset into k-number of clusters and repeating the process until no better clusters are found. The algorithm uses an iterative approach to find the best value for K center points or centroids and assigns each data point to the nearest K center, forming a cluster of data points close to a specific K center.

(Phull et al., 2022) As Vehicular Ad-hoc Networks continue to grow, many services delivery are gaining attention from the intelligent transportation system. However, the mobility characteristics of vehicular networks can cause frequent disconnection of routes, particularly during data delivery. Traffic congestion is a significant issue in both developed and developing countries, resulting in wasted time, increased driver stress, decreased productivity, and increased emissions of hazardous gases that impact public health in heavily populated areas.(Habelalmateen et al., 2022b)Clustering is an effective strategy for achieving a consistent topological structure in Vehicular Ad-hoc Networks. This research work pre-tests two algorithms for clustering. The first algorithm is a k-means clustering algorithm with dynamic grouping by k-implies that is well-suited to the dynamic topology characteristics of vehicular networks. This clustering algorithm reduces overhead and traffic management. The second algorithm is a dynamic routing protocol for inter and intra-clustering routing that improves the Packet Delivery Ratio and reduces the End-to-End latency. Compared to the cluster-based approach, the proposed protocol achieves better efficiency in terms of Throughput, Packet Delivery Ratio, and End-to-End delay parameters when considering different numbers of vehicular nodes in the network.

4.3.2. Fuzzy logic algorithms

Many clustering strategies in VANET are based on fuzzy logic algorithms. Instead of the value as true or false, the degree of certainty is considered in the fuzzy logic system (FLS).

(Habelalmateen et al., 2022b)The fuzzy logic inference system is used to learn about the driver's habits and anticipate future speed and position. The DE fuzzifier chooses the CH based on the projected speed and position. If the CH's stability factor falls below a predetermined level, a new member is chosen as the CH. This technique allows for the merging of two clusters. If the second CH reaches half of the first CH's TR, it will merge with the first CH.; (Mamatha & Aishwarya, 2019)The performance of the selection of the CH can be affected by considering only two input parameters in the fuzzy input sets. To improve the performance, acceleration is added as an input parameter along with speed and distance to create more stable clusters. To provide more stable clusters, a fuzzy logic inference system is integrated with a k-means algorithm to predict future speed and positions of the CMs. The stability of the clusters highly depends on their lifetime, and k-means algorithms cannot provide high lifetime to the clusters. If a single vehicle joins or leaves the cluster, the entire algorithm is reset, and the CH can change frequently, affecting the stability. Fuzzy logic-based solutions can provide better stability by predicting the future movement of the vehicles. CH and CM parameters such as CH duration and CM duration in hybrid architecture are generally evaluated in FL algorithms. Machine learning algorithms such as k-means are used for cluster formation to create efficient clusters, while fuzzy logic is used to select the most qualified vehicle as the CH and make the clusters more stable.Finally, in this thesis we proposed a hybrid algorithm which is K-means algorithm and fuzzy algorithm which solves the problem that discover in the literature review. In order to get better performance. These algorithms are proposed.

(Habelalmateen et al., 2022b)(Azat & Hong, 2020)This paper presents a systematic analysis of clustering-based routing protocols in vehicular networks that use soft computing techniques. The protocols are categorized based on various soft computing techniques, such as particle swarm optimization, k-means, neural networks, artificial bee colony, genetic algorithm, firefly algorithm, and fuzzy logic. The survey includes a comparative study of soft computing strategies, focusing on their objectives, strengths, and limitations. The survey aims to help researchers choose the appropriate soft computing technique to improve metrics such as packet delivery ratio, end-to-end delay, throughput, cluster lifetime, and message overhead in vehicular networks. Fuzzy Logic (FL) is a numerical tool that was developed to mimic approximate human thought. Unlike conventional set theory, which produces outputs that are either true or false, FL produces intermediate standards based on inference rules and linguistic variables. There are four main components of an FL system: fuzzification, defuzzification, a fuzzy rule base, and a fuzzy inference engine, as shown in Figure 6. The fuzzification component determines the device responses to the appropriate fuzzy sets. It assigns a membership degree to each fuzzy set, which is defined by a language word such as "high", "low", "moderate", "small", and "large".

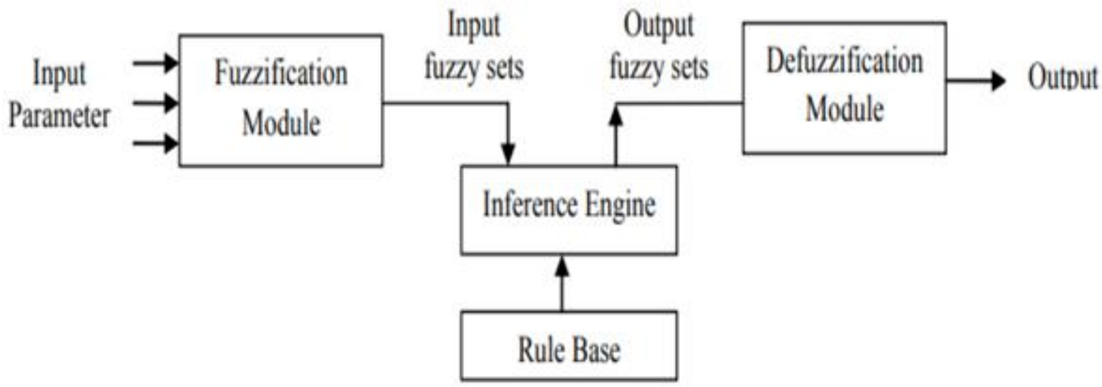

Figure 6 Fuzzy Logic Systems

The fuzzy inference engine stores if-then rule, from which the fuzzified values are transferred to linguistic output variables using the fuzzy rule. The inference scheme's results are converted into crisp values utilizing defuzzification techniques such as the averaging and centroid techniques.(H. Singh & Singh, 2017)A stable multilevel clustering routing protocol was proposed for VANETs. It is an extension of the AODV protocol at the first level, which uses fuzzy logic to establish efficient routing between members of the cluster. Tabu search was used at a higher level for routing between CHs and destinations, solving hybrid optimization problems using a cost function to choose the best solution. Node size, node velocity, node angle, and reliability were the efficient metrics used to select the optimal path. Simulation results showed an improved transmission rate of packets and reduced average End-to-End (E2E) delays compared to previous protocols, with fewer packet failures. The proposed protocol uses fuzzy logic to improve routing between cluster members, with the parameters of distance, direction, and velocity considered.

The proposed protocol uses fuzzy logic to improve the routing between the cluster members. The parameters taken for the research work are distance, direction, and velocity. However, more parameters may be considered for future work, looking toward the dynamic scenario in VANET.

(Phull et al., 2022)The study proposes a new clustering architecture comprised of two algorithms: First, a k-means clustering strategy using regional clustering approaches is proposed to reduce overhead and traffic management in VANETs. Second, a dynamic routing protocol is introduced to determine the next-hop node for inter-clustering routing, which boosts the overall PDR and minimizes the E2E latency.

(Mamatha & Aishwarya, 2019)This paper aims to improve the clustering of vehicles in Vehicular Ad-Hoc Networks (VANETs) using fuzzy logic to make the network more robust and scalable. High mobility and scalability are important considerations for providing efficient and reliable communication in VANETs. Clustering is crucial for coping with the dynamic features of VANET topologies. Parameters related to user preferences, network conditions, and application requirements such as speed of mobile nodes, distance to cluster head, data rate, and signal strength must be evaluated in the cluster head selection process, along with the direction parameter for highly dynamic VANET structures. The proposed cluster head selection algorithm takes the prominent parameters of speed, acceleration, distance.

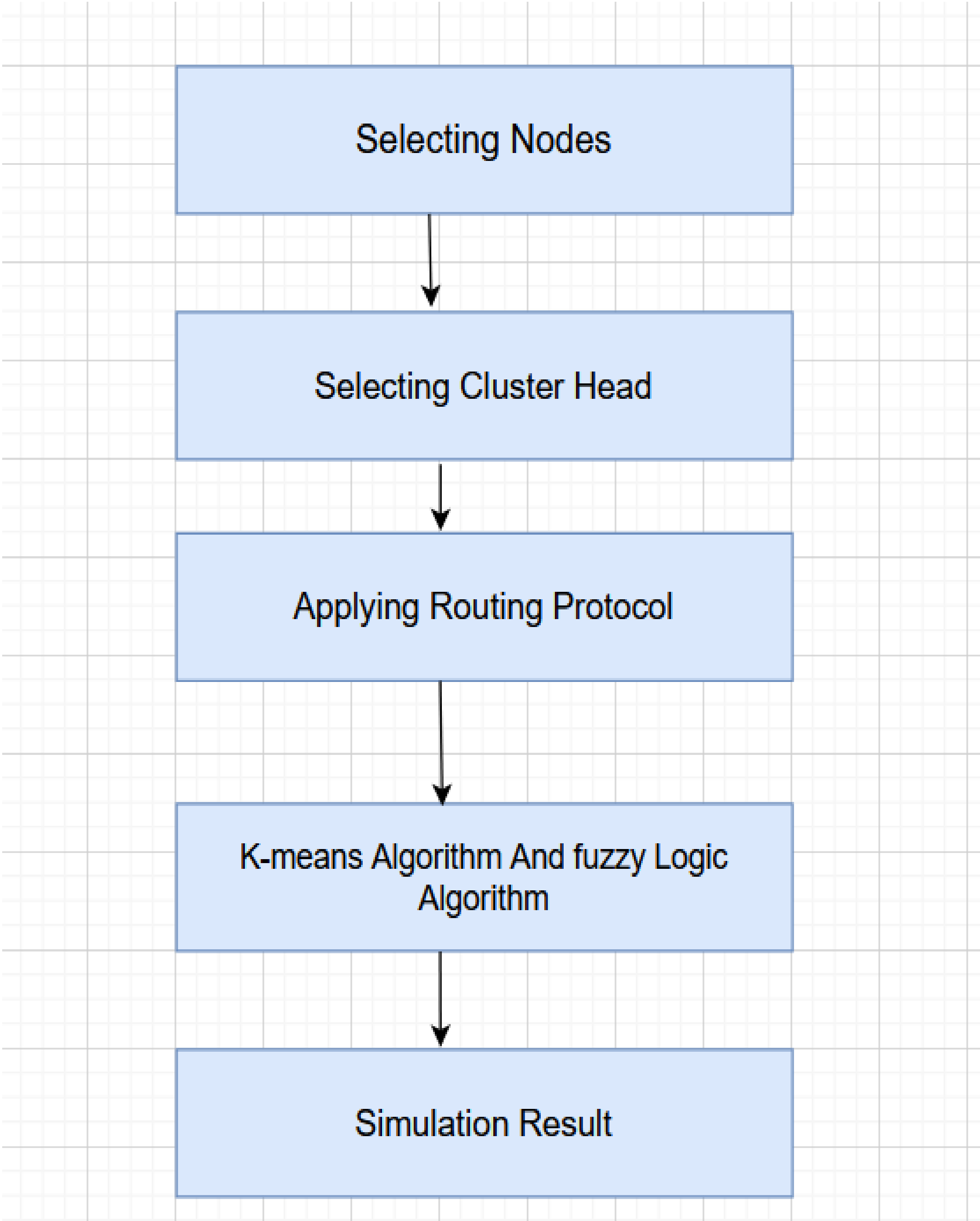

Figure 7 Proposed plan

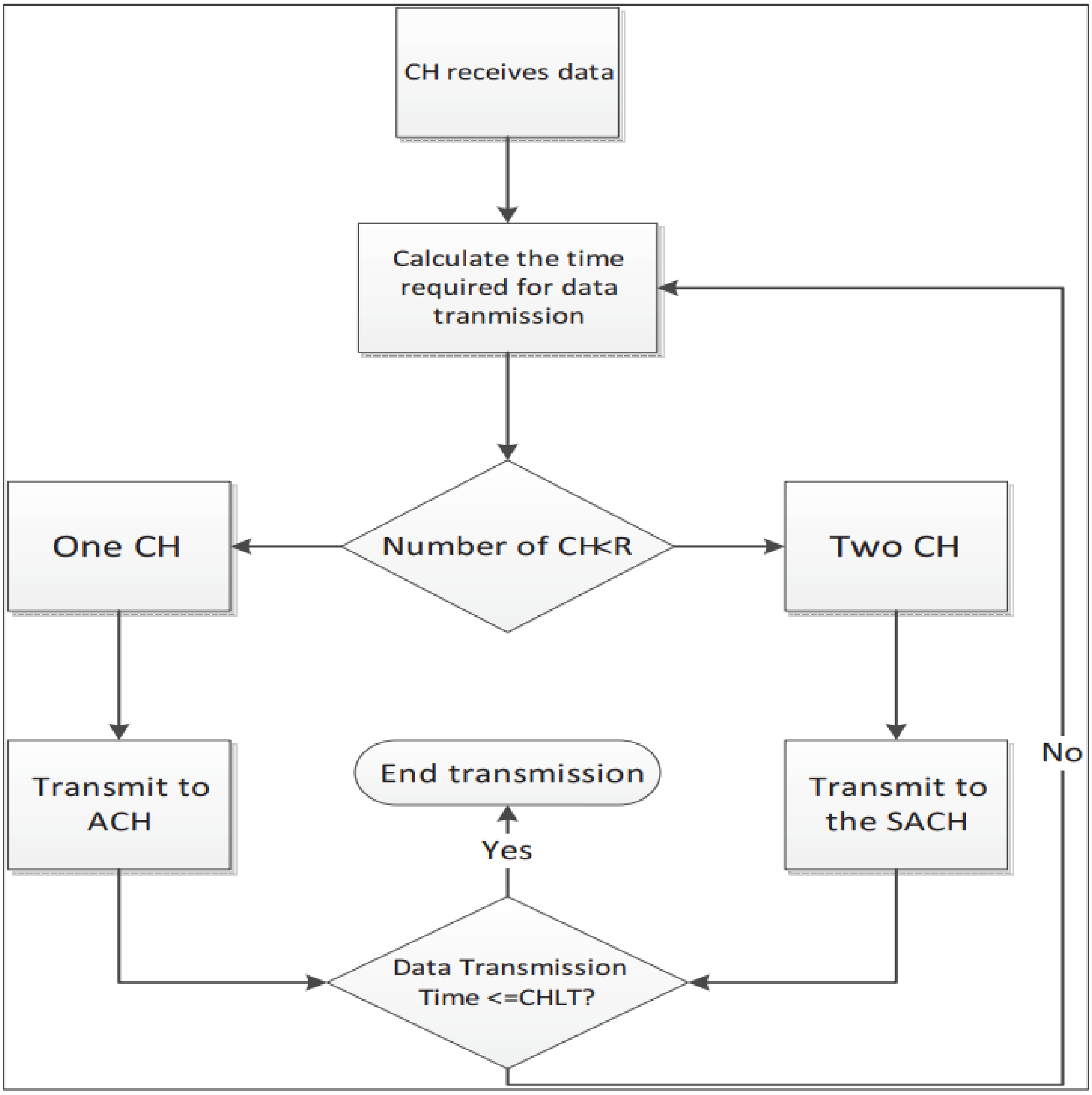

Figure 8 Flowchart of Proposed Work

The value "K" represents the number of clusters, and the algorithm involves randomly selecting three distinct centroids as the cluster initialization. The distance between each point and the centroid is measured using Euclidean distance, and the centroids are elected as the CH. Whenever a CM joins or leaves a cluster, the mean of the cluster needs to be recalculated to reflect the change, which can result in electing a new vehicle as the CH.while fuzzy logic is used to select the most qualified vehicle as the CH and make the clusters more stable.

CHAPTER FIVE

IMPLEMENTATION OF THE PROPOSED MODELS

5.1. Chapter Overview

In this section, we discussed the implementation of the proposed model that is fuzzy logic algorithm and K- means algorithm. We also discussed the configuration of the working environment in Sumo and math lab R2019B environments implantation.

The environmental setup or implementation in performance improvement cluster-based routing algorithm in VANET using fuzzy logic and K-means algorithm involves several steps:

- **Dataset Collection**: The first step is to collect the dataset that will be used to train the fuzzy logic and K-means algorithm. The dataset should contain information about the environment such as road conditions, traffic density, weather conditions, and other relevant parameters. This will be prepared by SUMO software.

- **Fuzzy Logic Implementation**: Fuzzy logic is used to model the uncertainty and imprecise nature of the environment. The fuzzy logic system takes inputs from the dataset and uses linguistic variables to describe the environment. The output of the fuzzy logic system is a set of rules that describe the behavior of the environment.

- **K-means Clustering**: The K-means algorithm is used to group the vehicles in the network into clusters based on their location and other relevant parameters. The clustering process is done based on the output of the fuzzy logic system, which provides information about the environment.

- **Cluster-based Routing Algorithm**: The cluster-based routing algorithm is designed to route the data packets between the vehicles in the network based on the clustering information obtained from the K-means algorithm. The routing algorithm considers the current location of the vehicles, the traffic conditions, and other relevant parameters to determine the optimal route for the data packets.

- **Performance Evaluation**: The performance of the cluster-based routing algorithm is evaluated by measuring the packet delivery ratio, end-to-end delay, and other relevant parameters. The evaluation process helps to determine the effectiveness of the algorithm in improving the overall performance of the network.

- **Optimization**: The algorithm can be optimized by adjusting the parameters of the fuzzy logic system, K-means clustering, and the routing algorithm. The optimization process helps to fine-tune the algorithm and improve its performance.

- **Implementation**: Finally, the algorithm can be implemented in the VANET environment using appropriate programming languages and tools. The implementation should be tested and validated to ensure that it works as expected and meets the performance requirements.

In summary, the environmental setup or implementation of the performance improvement cluster-based routing algorithm in VANET using fuzzy logic and K-means algorithm involves dataset collection, fuzzy logic implementation, K-means clustering, cluster-based routing algorithm design, performance evaluation, optimization, and implementation. These steps are important to ensure the effectiveness and efficiency of the algorithm in improving the performance of the VANET network.

5.2. Application Software and Integrated Development Environment

SUMO

Simulation of Urban Mobility is a free and open-source software package used to simulate and analyze traffic in transportation systems, including VANET (Vehicular Ad Hoc Network). SUMO provides a platform for simulating road traffic networks, including the behavior of individual vehicles, traffic flow, and traffic control systems. In VANET, SUMO is used to simulate the movement of vehicles and their interactions with the surrounding environment, including other vehicles, road infrastructure, and traffic control systems. SUMO can be used to test and evaluate various VANET applications, such as traffic management, collision avoidance, and intelligent transportation systems' is designed to be highly customizable, allowing users to create and modify simulation scenarios to suit their specific needs. SUMO provides a range of features, including support for different traffic control systems, routing algorithms, and communication technologies. SUMO can also be integrated with other software packages, such as network simulators and geographic information systems, to provide a comprehensive platform for VANET simulation and analysis.

In summary, SUMO is a software package used to simulate and analyze traffic in transportation systems, including VANET. SUMO provides a platform for simulating road traffic networks, including the behavior of individual vehicles, traffic flow, and traffic control systems. SUMO is highly customizable, allowing users to create and modify simulation scenarios to suit their specific needs. SUMO is an essential tool in VANET research and development, providing a comprehensive platform for simulating and evaluating VANET applications such as traffic management, collision avoidance, and intelligent transportation systems.

TraCI4Matlab

TraCI4Matlab is a MATLAB toolbox that provides an interface for communicating with the TraCI (Traffic Control Interface) component of the SUMO (Simulation of Urban Mobility) traffic simulation software. TraCI4Matlab allows users to programmatically control SUMO simulations from MATLAB scripts, and retrieve simulation data for analysis in MATLAB. Using TraCI4Matlab, users can set up and modify SUMO simulations, including defining road networks, vehicle routes, and traffic flow parameters. They can also retrieve real-time simulation data, such as vehicle positions and speeds, traffic densities, and emissions levels.

TraCI4Matlab is particularly useful for researchers and engineers working in the field of traffic simulation and control, as it allows them to easily integrate SUMO simulations with MATLAB-based analysis tools. It also provides a convenient way to test and validate simulation models, and to develop and evaluate new traffic control strategies. TraCI4Matlab is open-source software, and is available for download from the project's GitHub repository. The toolbox requires MATLAB R2015b or later, and the SUMO traffic simulation software must be installed separately.

JOSM

JOSM (Java Open Street Map Editor) is an open-source software program used to edit and view Open Street Map (OSM) data, which is often used as a data source for SUMO (Simulation of Urban Mobility) in VANET (Vehicular Ad Hoc Network) simulations allows users to view and edit OSM data, which includes information about road networks, buildings, and other geographic features. JOSM provides a range of tools for editing OSM data, such as adding and removing nodes, ways, and relations. Users can also add and edit attributes for OSM objects, such as road types, speed limits, and traffic signals. In the context of VANET simulations using SUMO, JOSM can be used to create and modify OSM data, which can then be used as a data source for SUMO simulations. The OSM data can be used to create a realistic virtual environment for VANET simulations, including the road network, buildings, and other geographic features. This allows researchers and developers to simulate and test various VANET applications, such as traffic management and collision avoidance, in a realistic and controlled environment.

In summary, JOSM is an open-source software program used to edit and view Open Street Map (OSM) data, which is often used as a data source for SUMO in VANET simulations. JOSM allows users to create and modify OSM data, which can be used to create a realistic virtual environment for VANET simulations using SUMO. This allows researchers and developers to simulate and test various VANET applications, such as traffic management and collision avoidance, in a realistic and controlled environment.

MATHLAB R2019B

MATLAB R2019b is a software tool that can be used in VANET (Vehicular Ad Hoc Network) research and development to perform various tasks such as data analysis, modeling, and simulation. VANETs are wireless networks that are formed by vehicles that communicate with each other and with roadside infrastructure to exchange information about traffic, road conditions, and other relevant data. MATLAB R2019b provides a powerful platform for developing and testing VANET applications and protocols. The software can be used to model and simulate various aspects of VANETs, such as communication protocols, routing algorithms, and traffic management systems. MATLAB R2019b can also be used to analyze and visualize data collected from VANET simulations, allowing researchers to draw insights and make data-driven decisions.

Some specific use cases of MATLAB R2019b in VANET include:

- Traffic Management: MATLAB R2019b can be used to develop and test traffic management systems for VANETs, such as intelligent traffic signal systems and adaptive cruise control systems.

- Performance Evaluation: MATLAB R2019b can be used to evaluate the performance of VANET applications and protocols, by analyzing the data generated from VANET simulations and testing scenarios.

- Visualization: MATLAB R2019b can be used to visualize VANET data, such as traffic flow, vehicle speed, and network topology, allowing researchers to gain insights and make data-driven decisions.

In summary, MATLAB R2019b is a software tool that can be used in VANET research and development to perform various tasks such as data analysis, modeling, and simulation. MATLAB R2019b can be used for protocol development, routing algorithm development, traffic management, performance evaluation, and visualization of VANET data. The software provides a powerful platform for researchers and developers to design and test advanced VANET applications and protocols.

5.3. Perform experiments on fuzzy logic and K-means algorithm

Performing experiments on the fuzzy c-means algorithm using SUMO and MATLAB R2019b involves designing and implementing the algorithm for VANET applications, such as vehicle clustering and traffic flow analysis. The following are the general steps involved in conducting experiments on the fuzzy c-means algorithm using SUMO and MATLAB R2019b:

- **Problem Identification**: The first step is to identify the problem or application for which the fuzzy c-means algorithm is being designed. For example, the problem could be to identify clusters of vehicles in a VANET environment.

- **Data Collection and Simulation:** The next step is to collect data about the problem or application, such as vehicle location data and other relevant data, and simulate the VANET environment using SUMO. The data will be used to develop the fuzzy c-means model.

- **Fuzzy C-Means Algorithm Design**: The fuzzy c-means algorithm is designed using the collected data and domain knowledge. The fuzzy c-means algorithm should be designed to take into account the uncertainty and imprecise nature of VANET environments.

- **Implementation:** The fuzzy c-means algorithm is then implemented in the MATLAB R2019b environment using appropriate programming languages and tools. The system should be tested and validated to ensure that it works as expected.

- **Experimentation:** The fuzzy c-means algorithm is then tested in various scenarios to evaluate its performance. Different scenarios could include varying traffic densities and vehicle speeds. The performance of the fuzzy c-means algorithm is evaluated based on various metrics, such as the number of clusters identified and the accuracy of the clustering.

- **Analysis and Optimization:** After conducting experiments, the data collected is analyzed to assess the performance of the fuzzy c-means algorithm. The analysis helps identify areas of the algorithm that need optimization or improvement. Based on the analysis, modifications can be made to the fuzzy c-means algorithm to improve its performance.

- **Validation:** The final step is to validate the performance of the optimized fuzzy c-means algorithm using additional experiments in the SUMO environment. The validation ensures that the algorithm is reliable and can be used in practical VANET applications.

In summary, performing experiments on the fuzzy c-means algorithm using SUMO and MATLAB R2019b involves collecting data and simulating the VANET environment using SUMO, designing and implementing the algorithm in MATLAB R2019b, testing it in various scenarios, analyzing the results, optimizing the algorithm, and validating its performance. The fuzzy c-means algorithm should be designed to consider the uncertainty and imprecise nature of VANET environments and should be able to provide reliable and accurate results.

5.4. Simulation Setups

The simulation is implemented by using the MATLAB R2019B (a network simulator), combining with the SUMO 0.19.0 (a road traffic simulator), TraCI4Matlab and JOSM. As shown in Fig. below, we use a real-world urban map downloaded from the OpenStreetMap for a part of Addis Ababa in Ethiopia.

In this case the proposed map covers from America gibi to Mexico and from mesholekia to urael megenaga. In this case we consider the number of vehicles taken is 50 in number in the road so the clustering considers in two four clusters.

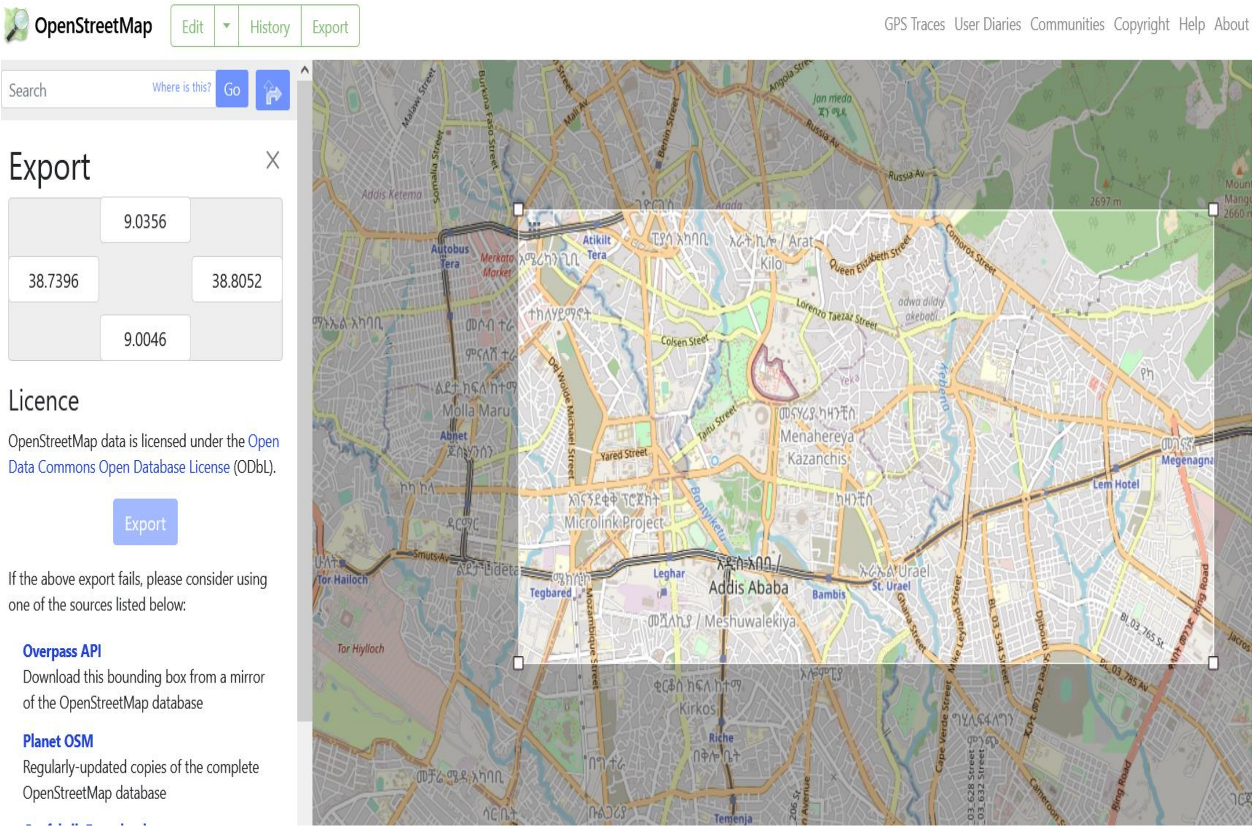

Figure 9 The Selection of Specific Area Using Open Street Map From Addis Ababa Live Map

So, in the figure above we select the area that we want for the simulation. This simulation takes place in the open street live map. In our case our selection is in Addis Ababa Ethiopia which cover or select specific area as we can see in the figure,

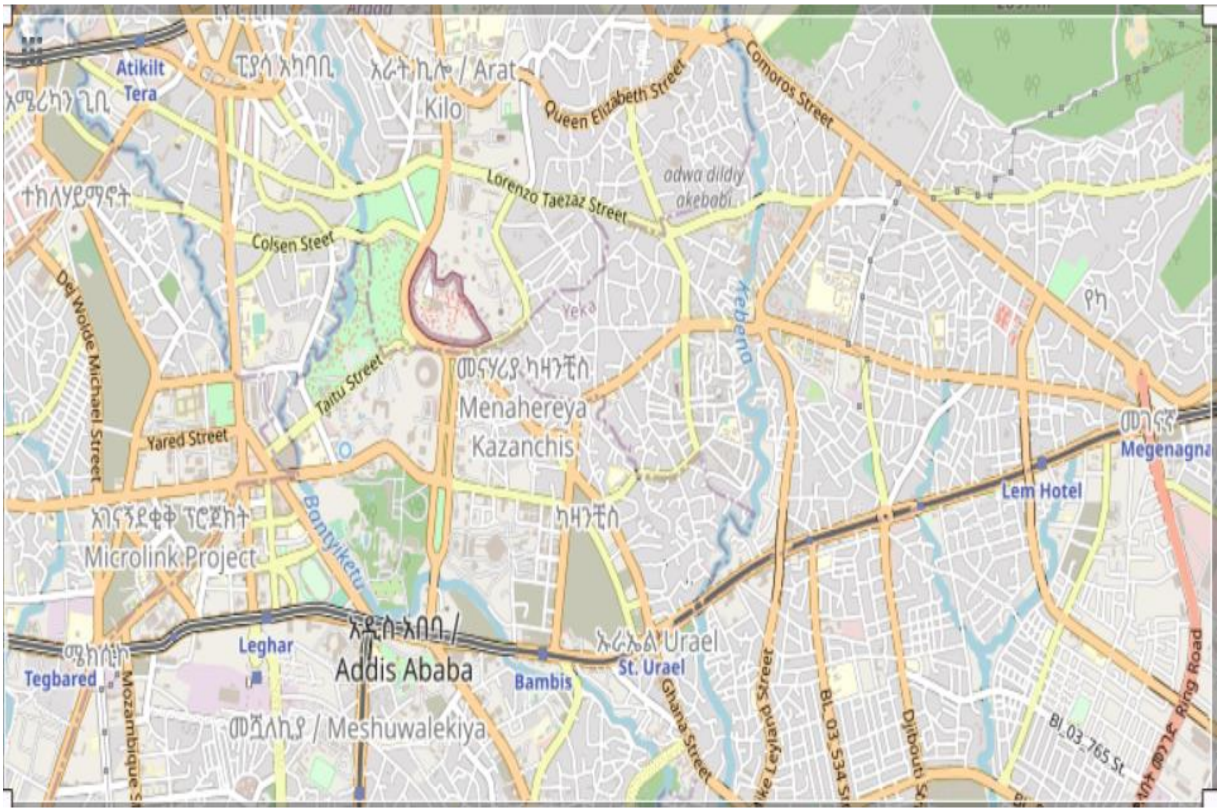

Figure 10 The Selected Specific Area

As we see from the above figure the area selection in Addis Ababa covers from Mexico to megenagna and from America gibi to Commerce Street. So, our simulation focuses the vehicles movement in this specific area. The next step is to edit the unwanted areas that means remove some unnecessary points from the selected area using JOSM.

Figure 11 The Selected Data Which Enters To the JOSM For Edited

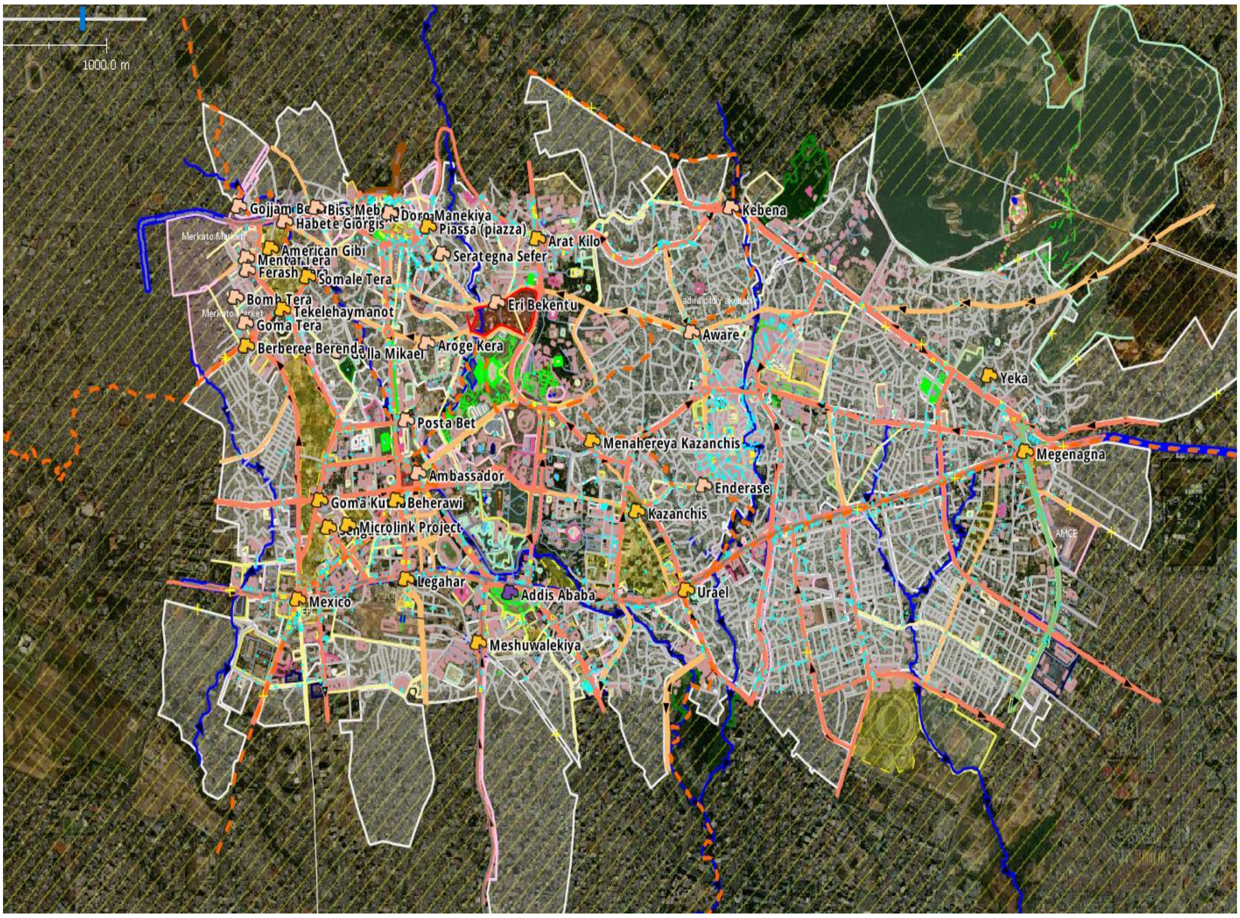

Figure 12 OSM Data Files

```
rl=100; %road length
rw=40;   % road width
road=zeros(rl,rw); % creation of empty road

%%%%%generating 50 vehicles randomly on the road%%%%
xpos= randi([1 100],1,50);
ypos= randi([1 40],1,50);

for i=1:50
  road(xpos(i),ypos(i))=1;  %%% indication of presence of vehicle
end

```

Figure 13 Generating 50 Vehicles Randomly On the Road

In this we define the road length and width then next we create an empty road that randomly distribute or generate 50 vehicles on the road.

In the figure 12 we divide the road vehicles in to four clusters which is C1, C2, C3 and C4 respectively. Then we calculate the number of vehicles in each cluster that means we indicate the number of vehicles in each cluster. Then finally we find the position of each vehicle in each cluster.

```

%%%%% Dividing segment into clusters %%%%%%

c1=road(1:25,1:40);   cn1=transpose(c1); %creation of first cluster
c2=road(26:50,1:40);  cn2=transpose(c2); %creation of second cluster
c3=road(51:75,1:40);  cn3=transpose(c3); %creation of third cluster
c4=road(76:100,1:40); cn4=transpose(c4); %creation of fourth  cluster

[col1,row1] = find(c1==1);    % finding the position of vehicle in first cluster
pos1 = horzcat(row1,col1);
MCID1=length(col1);          % Indicates No. of members in cluster 1

[col2,row2] = find(c2==1); % finding the position of vehicle in second cluster
col2=col2+25;
pos2 = horzcat(row2,col2);
MCID2=length(col2);          % Indicates No. of members in cluster 2

[col3,row3] = find(c3==1);  % finding the position of vehicle in third  cluster
col3=col3+50;
pos3 = horzcat(row3,col3);
MCID3=length(col3);          % Indicates No. of members in cluster 3

[col4,row4] = find(c4==1);  % finding the position of vehicle in fourth  cluster
col4=col4+75;
pos4 = horzcat(row4,col4);
MCID4=length(col4);          % Indicates No. of members in cluster 4

```

Figure 14 Dividing the Segments In to Clusters

```
%%%%%%%%%%Intialization of variables for code%%%%%%%%%%%%%%%%%
row1=transpose(row1);row2=transpose(row2);row3=transpose(row3);row4=transpose(row4);
col1=transpose(col1);col2=transpose(col2);col3=transpose(col3);col4=transpose(col4);
columnn=[col1,col2,col3,col4];
roww=[row1,row2,row3,row4]
MCID=[MCID1 MCID2 MCID3 MCID4];
x1=MCID(1);x2=MCID(2);x3=MCID(3);x4=MCID(4);
v=1;p=1;k=0;
g2=0; g4=0; g6=0; g8=0;
coln1=col1;coln2=col2;coln3=col3;coln4=col4;
MCIDn(1)=MCID(1);MCIDn(2)=MCID(2);MCIDn(3)=MCID(3);MCIDn(4)=MCID(4);
ma=0;mb=0;mc=0;md=0;
```

Figure 15 Initialization of Variables for Code

In this implementation we consider that vehicles are moving in different speeds.

```
    %%%%%%%%%%vehicles moving with different speeds%%%%%%%%%%%

           if (MCID(1)~=0)
                for i=1:MCID(1)

                    g1=randi(3);
                    g(i)=g1;
                    coln1(i)=coln1(i)+g1;
                   % vehicle(i)=[row1(i),coln1(i)];

                    if g1>=g2
                      ma=g1;
                      g2=g1;
                    else
                      ma=g2;
                    end
                end
           else
               ma=0;
               g=0;
           end


          if(MCID(2)~=0)
            for i=1:MCID(2)
```

Figure 16 Vehicles Moving With Different Speeds

```
%%%%%%%%%%thresoldpoint and thresold distance calculation%%%%%

         dth1=25-ma;dth2=50-mb;dth3=75-mc;dth4=100-md;

          columnn=[coln1,coln2,coln3,coln4];
           column_new=[coln1,coln2,coln3,coln4]
           MCID

         th_point=[dth1 dth2 dth3 dth4];

         speed=[g h j q];
         speed(speed==0)=[];


  % th_distance=[];

  for n=1:4

           for VID=k+1:k+MCID(v)

               D(VID)=abs(th_point(p)-columnn(VID));
               LT(VID)=D(VID)/speed(VID);
               %th_distance=[th_distance,D];
           end
           k=k+MCID(v);
           p=p+1;
           v=v+1;

```

Figure 17 Threshold Point and Threshold Distance Calculation

In the figure above, we calculate the threshold point and threshold distance calculation. Threshold point and threshold distance calculations are used in clustering algorithms in VANETs to group vehicles into clusters based on their life time. This approach can improve the efficiency and reliability of communication, reduce network congestion, and adapt to the changing network conditions.

```
%%%%%life time calculation and cluster head election%%%%%%%%%%%%%%%%%%%%%%%

% for i=1:10
    % LT(i)=th_distance(i)/speed(i);
% end

  LT1=0;LT2=0;LT3=0;LT4=0;

 for i=1:MCID(1)
    LT1=max(LT1,LT(i));
 end

for i=MCID(1)+1:MCID(1)+MCID(2)
     LT2=max(LT2,LT(i));
 end

 for i=MCID(1)+MCID(2)+1:MCID(1)+MCID(2)+MCID(3)
     LT3=max(LT3,LT(i));
 end

 for i=MCID(1)+MCID(2)+MCID(3)+1:MCID(1)+MCID(2)+MCID(3)+MCID(4)
     LT4=max(LT4,LT(i));
 end

 CH_pos1=find(LT(1:MCID(1))==LT1);
 CH_pos2=find(LT(MCID(1)+1:MCID(1)+MCID(2))==LT2);
 CH_pos3=find(LT(MCID(1)+MCID(2)+1:MCID(1)+MCID(2)+MCID(3))==LT3);
 CH_pos4=find(LT(MCID(1)+MCID(2)+MCID(3)+1:MCID(1)+MCID(2)+MCID(3)+MCID(4))==LT4);
```

Figure 18 Life Time Calculation and Cluster Head Selection

Lifetime calculation and cluster head selection are crucial tasks in clustering algorithms to improve the efficiency and scalability of communication. In VANETs, vehicles are typically powered by batteries with limited energy resources. Lifetime calculation can be used to estimate the remaining energy of each vehicle and determine its expected lifetime. This information can be used to select cluster heads that have sufficient energy to perform their tasks efficiently. By selecting energy-efficient cluster heads, the network can reduce the energy consumption and prolong the lifetime of the network.

In VANETs, the number of vehicles can be very large, and communication among all vehicles can be inefficient and impractical. Cluster head selection can be used to group vehicles into clusters and select a representative node (cluster head) for each cluster. The cluster heads can perform tasks such as data aggregation, routing, and group communication on behalf of the other vehicles in the cluster. By reducing the number of nodes involved in communication, the network can improve its scalability and reduce the network overhead.

In VANETs, the topology of the network can change rapidly due to the high mobility of vehicles.So, in this paper Cluster head selection used to select the most stable and reliable nodes as cluster heads. Stable nodes are less likely to move out of the cluster or lose connectivity, which can improve the reliability of communication and reduce the chance of data loss and network congestion. Cluster heads can also perform tasks such as data redundancy and error correction to ensure reliable data delivery.

Then in this simulation finding cluster length and finding the position of moving vehicles is very important for our simulation

```
%%%%%% finding Cluster length and position of already moved vechicles%%%%

        for i=1:x1

         if (coln1(i)>25) & (coln1(i)<50) & (x1~=0)
             coln2(MCID(2)+1)=coln1(i);
             row2(MCID(2)+1)=row1(i);
             MCID(2)=MCID(2)+1;
             MCID(1)=MCID(1)-1;
              coln1(i)=0;row1(i)=0;
               MCIDn(2)=MCIDn(2)+1;
               MCIDn(1)=MCIDn(1)-1;


         %elseif(coln1(i)>50)&(x1~=0)
             %coln3(MCID(3)+1)=coln1(i);
             %MCID(3)=MCID(3)+1;
             %coln1(i)=0;
             %MCIDn(3)=MCIDn(3)+1;
             %MCIDn(1)=MCIDn(1)-1;

         end

        end
           coln1(coln1==0)=[];
           row1(row1==0)=[];
```

Figure 19 Finding Cluster Length and Position of Already Moved Vehicles

```
%%%%%%%%%%%%%%%%%%vehicles are in motion%%%%%%%%%%%%%%%%%%%%%


         road=circshift(road,1);
         roadn=transpose(road);


    imagesc(roadn)



        t1=sprintf('time = %f sec',time);
        title(t1);

        pause(1);
        g=[];h=[];j=[];q=[];

        T1=D(CH_pos1)/speed(CH_pos1);
        T2=D(CH_pos2)/speed(CH_pos2);
        T3=D(CH_pos3)/speed(CH_pos3);
        T4=D(CH_pos4)/speed(CH_pos4);
        Tavg=(T1+T2+T3+T4)/4;
        nitk=Tavg/(Tavg+1);
        s1=1;

        average_throughput(time)=(s1)*((nitk)^10)

```

Figure 20 Vehicles are in Motion Which Represent How All Vehicles are Moved

CHAPTER SIX

6. RESULT, EVALUATION, AND DISCUSSION

6.1. Result of the experiment

In this chapter, the result, and discussion of the proposed algorithm for improving the performance of cluster-based routing protocol in VANET by using fuzzy logic and k-means algorithm. The performance of cluster-based routing protocol improved using hybrid algorithm will be discussed. In this case we propose fuzzy logic and k means algorithm. And here based on the result we compare our proposed algorithm with other related work of researcher's algorithm. And finally, we show the result by comparing the proposed algorithm with the other researcher's related algorithms we chose to compare.

Table 3 Simulation environment

Parameter	Value
Number of Vehicles randomly	50
Road Area (Length x width)	(100 x 40) km
Number of Simulation Iteration	25
Clustering Protocol	Fuzzy and K-means clustering algorithm
Packet size	512 byte
Message Size	200bits
Environment	Highway
Vehicles Speed	10 -60 kmph
Simulation Time	100 second
Data sending rate	2mbps
Number of clusters	4
Vehicle movement	With different direction

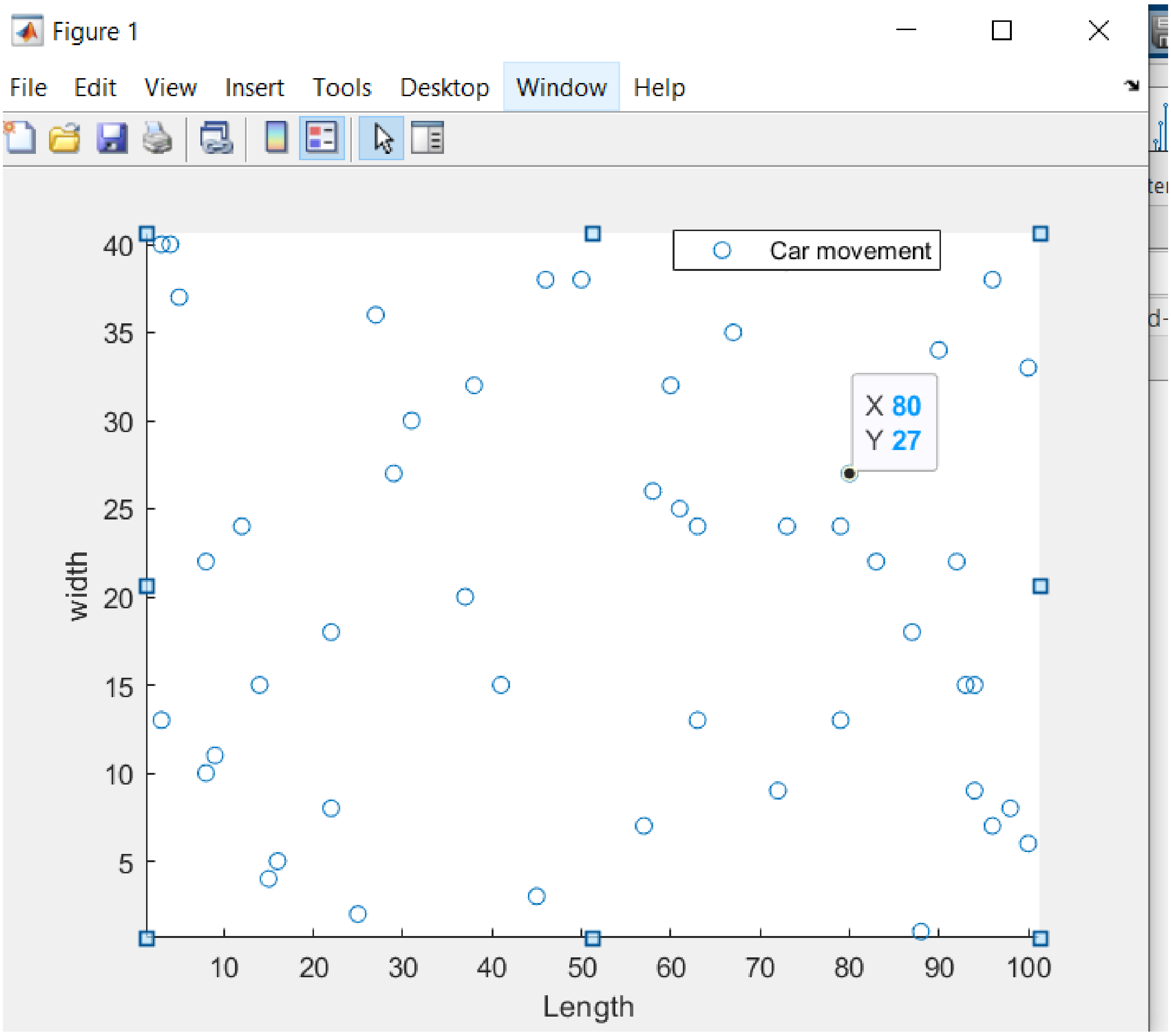

Figure 21 Represents the Vehicle Movement with 100 and 40 Km Area

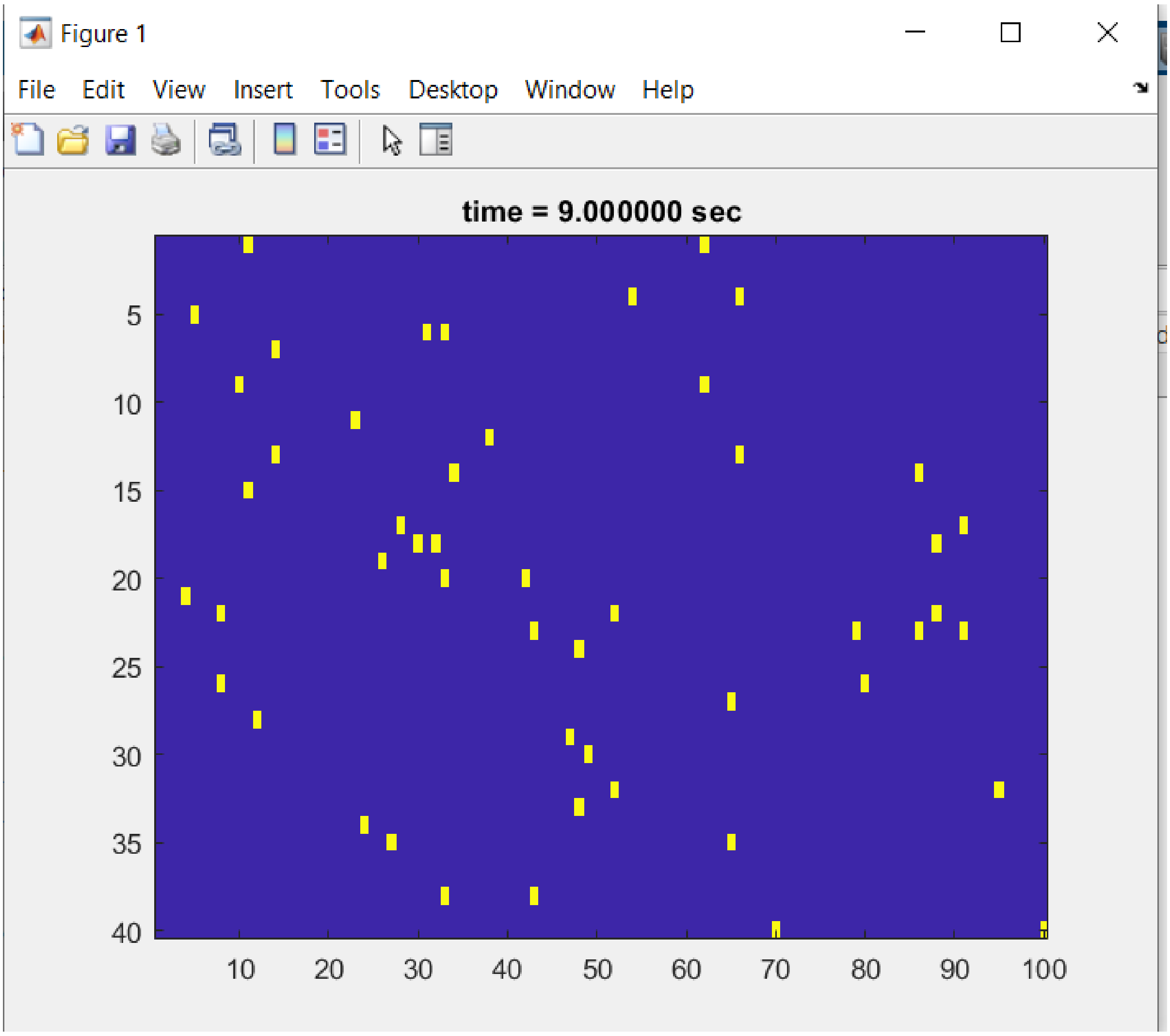

Figure 22 The Randomly Movement of Vehicles

The number of time vs the number of car indicates in the graph. In the experiment we generate 50 number of Number of Vehicles randomly and the speed of each Vehicle is different. So, the above graph indicates the movement of Vehicles and they are going on to divide in to four clusters and thy select the cluster head based of the life time.

Command Window

```
    24      4


cluster_head2 =

    30     31


cluster_head3 =

     8     53


cluster_head4 =

    38     84
```

Figure 23 Cluster Head Selection Using Life Time

In this case as indicate in the graph grouping or clustering is going on in the implementation case. And then clustering two four clustering is setting. The clustering is based on the life time of the vehicle. Higher energy life time will be elected as cluster head and this node allows the communication of the member cluster to the other clusters by using cluster head.

Location		Life_time2
4	51	3
15	47	0.5
10	47	1
22	45	3
24	51	1.5
11	43	5
37	44	4
40	44	2
13	44	4
6	45	1.5
40	40	4
33	39	4.5
7	40	8
8	38	10
38	36	12
15	39	4.5

Figure 24 Life Time for the Second Cluster Head Selection Process

```
average_throughput =

  Columns 1 through 7

    0.3062    0.2512    0.3942    0.1672    0.2572    0.2119    0.2012

  Columns 8 through 14

    0.2370    0.2183    0.1615    0.2842    0.2431    0.2329    0.2012

  Columns 15 through 21

    0.0505    0.3355    0.3234    0.1164    0.2391    0.4862    0.4221

  Column 22

    0.4491
```

```
column_new =

  Columns 1 through 11

    21    20    12    11     7     7     6    48    49    47    45

  Columns 12 through 22

    45    46    46    47    42    41    42    39    38    41    37

  Columns 23 through 33

    35    33    32    34    33    29    31    27    29    72    70

  Columns 34 through 44

    69    62    64    60    61    56    54    55    53    52   100

  Columns 45 through 50

    98   100    97    90    85    81
```

Figure 25 Average Throughput for Each Column

```
Lifetime =

  Columns 1 through 7

    1.0000    1.0000   10.0000   11.0000   15.0000    7.5000    8.0000

  Columns 8 through 14

         0    0.5000    0.5000    1.5000    3.0000    1.0000    1.0000

  Columns 15 through 21

    0.5000    3.0000    3.5000    3.0000    9.0000    5.0000    3.5000

  Columns 22 through 28

    5.5000    6.5000   15.0000   16.0000    7.0000    7.5000   19.0000

  Columns 29 through 35

   17.0000   21.0000   19.0000    1.0000    3.0000    2.0000   11.0000

  Columns 36 through 42

    4.5000    6.5000    6.0000    8.5000   19.0000    9.0000   10.0000

  Columns 43 through 49

   21.0000    3.0000    0.5000    1.5000         0    3.5000   12.0000

  Column 50

   16.0000
```

Figure 26 The Life Time for Each Column

In this case we divide the experiment in to 8 columns and we got life time value that describe the life time of each node needed. This metric measures the lifespan of the network, which is the time until the first node runs out of energy or fails. A longer network lifetime indicates a more sustainable and reliable network. Lifetime performance measurement in Vehicular Ad-hoc Networks (VANETs) can be a challenging task due to the dynamic nature of these networks. VANETs are wireless networks that enable communication between vehicles and infrastructure, and they are used to provide various services such as traffic management, safety, and entertainment.

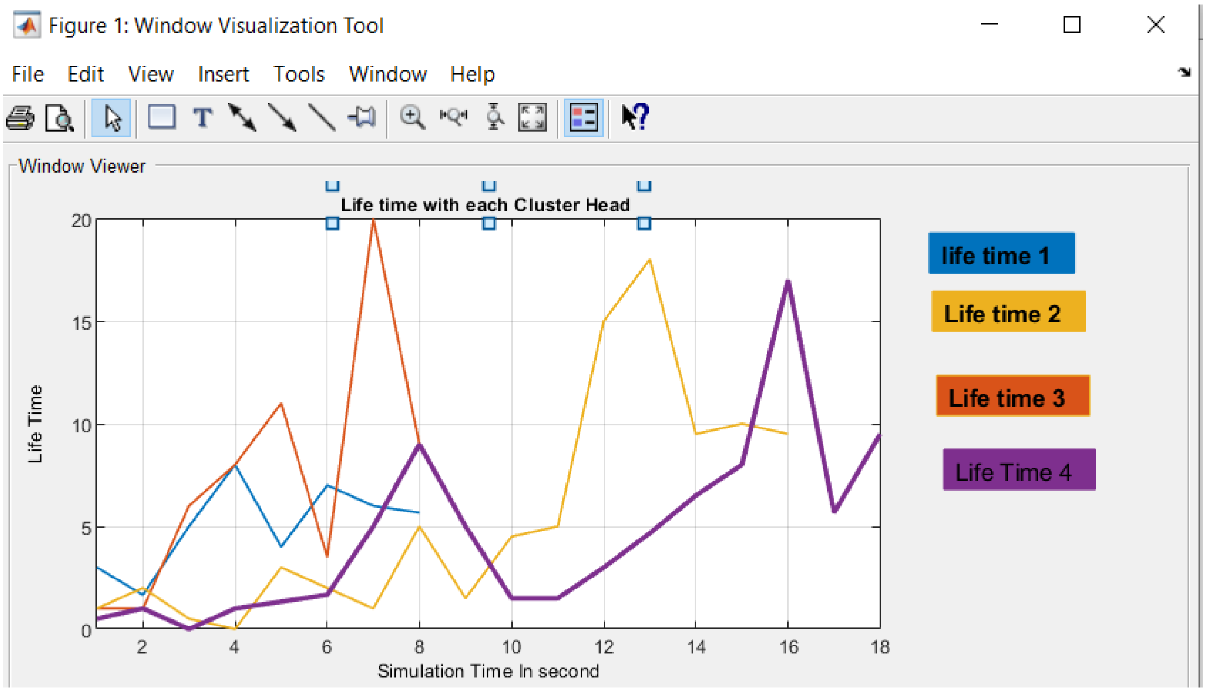

Figure 27 Life Time with Each Cluster Head

In the experiment above we divide the vehicles in to four clusters. This is because to increase the performance of the clustering algorithm. So in this case the cluster head is selected based on the energy life time of the vehicle the higher life time will be the cluster head. So the above figure represents the life time of each cluster head. In life time one represents the energy life time for cluster head 1 and life time 2, 3 and 4 represents the life time of to each four cluster heads.

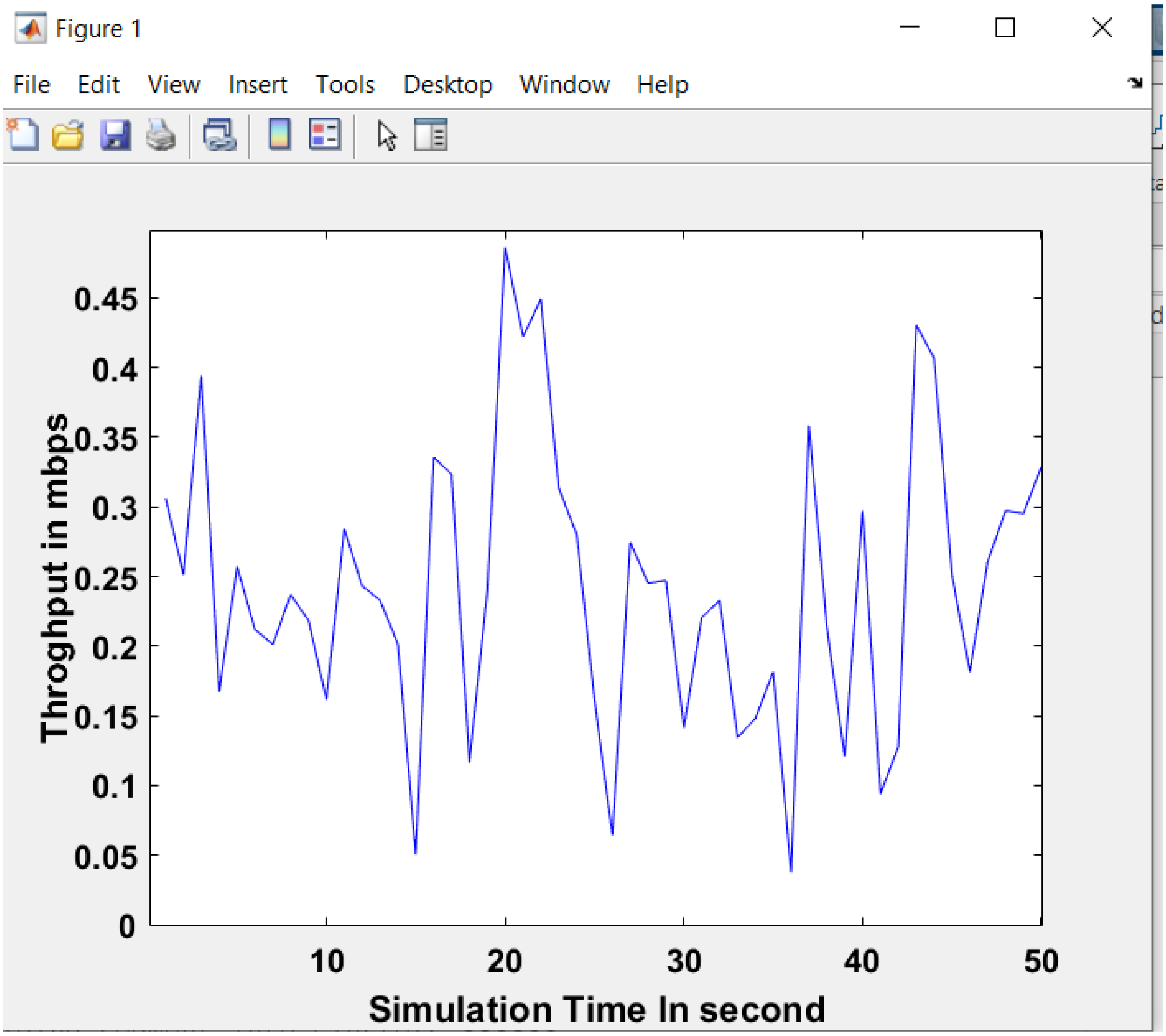

Figure 28 Throughput in Mbps Vs Simulation in Second

Throughput is a measure of the amount of data that can be transferred over a network per unit time, usually measured in Mbps (megabits per second). Simulation time, on the other hand, is the amount of time it takes to simulate a particular scenario on a network, usually measured in seconds. It's important to note that simulation time is not directly proportional to throughput. While higher throughput requirements generally require longer simulation times, other factors such as network topology, traffic patterns, and simulation software can also affect the simulation time. Ultimately, the choice of simulation time and throughput requirements should be based on the specific goals and requirements of the simulation being performed.

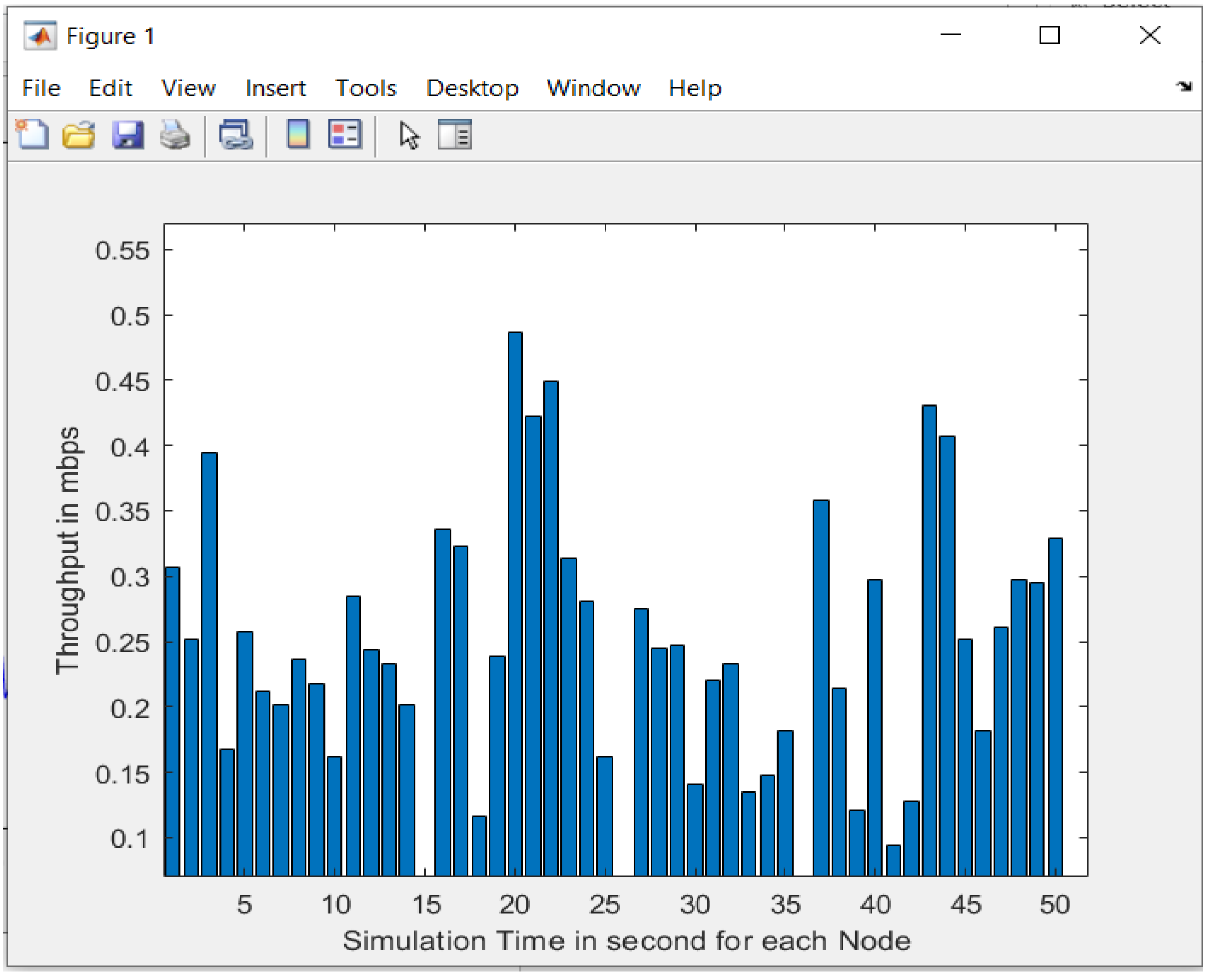

Figure 29 Simulation Time in Second in Each Node and Throughput in Mbps

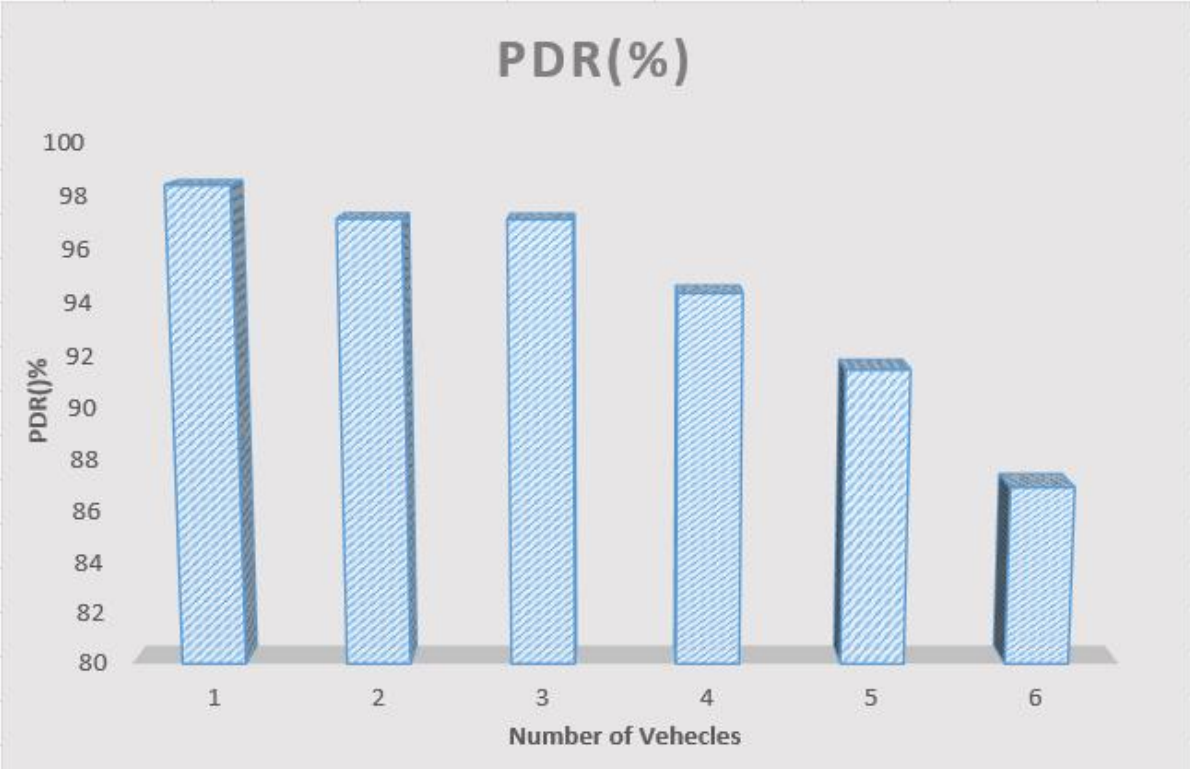

Figure 30 Packet Delivery Ratio in % with the Number of Vehicles

Generally, as the number of vehicles in a VANET increases, the PDR may decrease due to increased interference and congestion. This is because more vehicles in the network can result in more collisions and contention for the wireless channel, which can lead to packet loss and lower PDR. However, the relationship between PDR and the number of vehicles in a VANET can be complex and dependent on several factors, including the network topology, traffic patterns, and routing protocols used. Therefore, it's difficult to provide a general rule of thumb for how PDR changes with the number of vehicles in a VANET.

6.2.Evaluation and discussion

Based on the above experiment our simulation is based on fuzzy and k means clustering. So, based on that we compare the result using packet delivery ratio, Throughput and life time of the clustering algorithms. So, in this case we can compare our result using the above metrics with other related papers that we have described in the related work. From the related work we take 3 papers to compare our result with our result. Based on the result we get we can evaluate how much our result is better than the other results. Lastly, we can give a discussion of our paper result related with the other related papers.

As we can see fig 27 as the number of nodes increase the packet delivery ration will be decrease that means as we can see from the figure It is 98%, 97.09%,96.98%,94.5% and 95.67% respectively. As we explained in the experiment result we divide the nodes in two four clusters. So, the above figure represents the life time of each cluster head. In life time one represents the energy life time for cluster head 1 and life time 2, 3 and 4 represents the life time of to each four cluster heads. When we compare each cluster life time cluster four (life time 4) has better life time when we compare with the other clusters. So, when we use clustering algorithm the life time will be increased. Throughput is also one of the mercies used to evaluate in our experiment as we described.

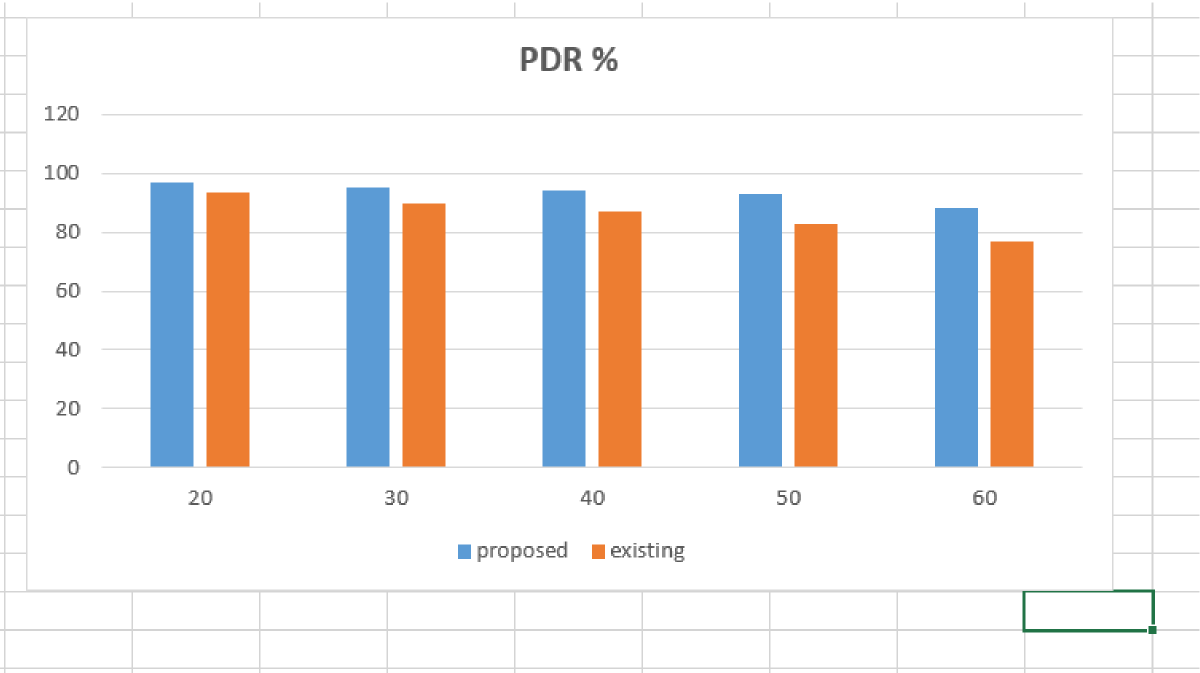

Figure 31 Packet Delivery Ratio in % with the Number of Vehicles with the Existing Work

We use as existing system (Phull et al., 2022) our research have better PDR the existing researcher. We used as a base line the above paper to evaluate with our paper. And also when we see the Throughputs comparing with the paper of (Abuashour & Kadoch, 2017b) it is also better than this paper. When we see the life time in the paper of (Phull et al., 2022) it has better increment in each of the four cluster.

CHAPTER SEVEN

CONCLUSION AND FUTURE WORK

7.1. Conclusion

The thesis on "Improving the Performance of Cluster-Based Routing Protocol in VANET by Using Fuzzy and K-means Algorithm" aimed to enhance the performance of cluster-based routing protocols in Vehicular Ad-hoc Networks (VANETs) using fuzzy and K-means algorithms. The study focused on evaluating the performance of the existing cluster-based routing protocol and proposed a new algorithm to improve its performance. The research involved a comprehensive literature review to identify the existing cluster-based routing protocols and their limitations. The proposed algorithm used fuzzy logic and K-means clustering to optimize the cluster head selection process. The research also involved extensive simulations to evaluate the performance of the proposed algorithm and compare it with the existing protocols.

The results of the simulations showed that the proposed algorithm outperformed the existing protocols in terms of various metrics such as packet delivery ratio, end-to-end delay, and network lifetime. The proposed algorithm was found to be more efficient in terms of energy consumption and provided better throughput compared to the existing protocols. The study concluded that the proposed algorithm can significantly improve the performance of cluster-based routing protocols in VANETs. The research also highlighted the importance of using fuzzy and K-means algorithms to address the limitations of existing routing protocols in VANETs. overall, the study provides valuable insights into the use of fuzzy and K-means algorithms to improve the performance of cluster-based routing protocols in VANETs. The results of this research can be used by researchers and practitioners to design and implement more efficient routing protocols for VANETs, which can ultimately contribute to improving the safety, efficiency, and reliability of vehicular communication.

7.2. Future Work

The thesis on "Improving the Performance of Cluster-Based Routing Protocol in VANET by Using Fuzzy and K-means Algorithm" has proposed a new algorithm to enhance the performance of cluster-based routing protocols in Vehicular Ad-hoc Networks (VANETs). There are several potential avenues for future work that can build upon this research and further improve the performance of routing protocols in VANETs. Some of these include:

- Investigating the impact of different network parameters: The proposed algorithm was evaluated under specific network conditions. Further research can investigate the impact of different network parameters, such as network density, communication range, and mobility patterns, on the performance of the proposed algorithm.

- Extending the proposed algorithm for multi-hop routing: The current proposed algorithm is designed for single-hop routing. Future work can extend the algorithm to support multi-hop routing, which can further improve the efficiency of the routing protocol.

- Implementing the proposed algorithm in a real-world testbed: The proposed algorithm has been evaluated through simulations. Future work can implement the algorithm in a real-world testbed to evaluate its performance under real-world conditions and to validate the simulation results.

- Evaluating the proposed algorithm under different traffic scenarios: The proposed algorithm was evaluated under specific traffic conditions. Future work can evaluate the algorithm under different traffic scenarios, such as emergency scenarios or high-density traffic scenarios, to further validate its effectiveness.

- Investigating the security implications of the proposed algorithm: The proposed algorithm focuses on enhancing the performance of cluster-based routing protocols. Future work can investigate the security implications of the proposed algorithm and evaluate its effectiveness in mitigating security threats, such as denial of service attacks and routing attacks.

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