Prediction Based Efficient Multi-hop Clustering Approach with Adaptive Relay Node Selection for VANET

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Abstract—In recent years to improve the conventional vehicular ad-hoc network performance an intelligent incorporated vehicle are introduced. Designing of prediction based multi-hop clustering approach for VANET is a major challenge due to the dynamic change of network and link capacity. Several earlier proposed models do not consider the mobility characteristics, the dynamic topology and the limited driving direction of VANET and they do not consider the energy problems. The main aim of the paper is to discuss about the routing based on link stability and to increase the coverage area of the cluster to improve the mobility characteristics and the energy efficiency of the VANET. The summarized studies about both the category are discussed in order to improve the link stability, energy efficiency, network lifetime, data aggregation, Quality of service, load balancing and multipath. A systematic comprehensive survey has been conducted for link stability and energy efficient clustering based routing protocols reported from 2012 to 2018. By the help of the survey, a technical direction is provided to the researchers about the pros and cons of the earlier studies. To fulfil the research gap, a novel methodology is introduced which is the prediction based efficient multi-hop clustering approach with adaptive relay node selection for VANET. The model consists of four layers. They are multi-hop clustering algorithm, prediction based clustering approach, adaptive link selection method and improved routing protocol.

Index Terms—VANET, Link stability, Energy efficient clustering, multi-hop, adaptive relay node selection, routing protocol.

I. Introduction

A. VANET Overview

In real world Vehicle-to-Vehicle communication, the applications of VANETs are large in numbers. It gives smart and efficient solutions for military based applications [1]. The major research issues in VANETs are increased number of road accidents due to higher dynamic mobility and lack of congestion control. In literature, various Internet based and vehicular social networks targeted to provide a solution to smart mobility for smart cities [2], [3]. Network overlapping issues are also considered as a drawback for Vehicular Ad-hoc Networks (VANETs). A novel Reliable Routing Protocol is designed with routing board [4]. VANET has very geographically varying network, huge and dynamic range, and forceful mobility; so the efficient routing is still a necessary criterion for VANET environments. This survey is classified into two categories. They are transmission strategies based and routing information based. The subsections of transmission strategies are broadcast, multi-cast and unicast. The subsections of routing information are topology based and position based. For the road safety of the connected networks, several researches are progressed. The primary factors of the research is congestion detection, congestion avoidance, node detection, location detection and so on [5], [6].

B. Clustering in VANET

Clustering is one among the major classification in energy efficient Vehicular Ad Hoc Networks (VANETs). A survey about various clustering protocols is discussed for about vehicle to vehicle and vehicle to infrastructure communication in VANET. Clustering is classified according to vehicle location, density ad mobility. The performance of those methods is calculated in terms of data handling, overhead, speed of the vehicles, geographical locations of the vehicle and mobility [7], [8]. The main research issue in urban based VANETs is the improvement of scalability and reliability. Here the author explained about the clustering based design and evaluation in new direction. The core ideas of the work are congestion detection, vehicle grouping, accident mapping, and information dissemination[9]. The research on inter vehicle communication are developed in large scale nowadays. Hence, to identify the suitable road, pattern clustering is used. The proposed literature review presented the overview about various clustering protocols

C. Motivation

The major drawback of internet of things (IoT) based VANET network is mobility management. To improve the performance and scalability of the vehicles the multi-hop clustering in vehicular a-hoc network is concentrated [10]. To develop efficient and scalable communication in vehicular ad-hoc network and also to improve the

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network lifetime prediction based mobility clustering is introduced [11]. The communication overhead is also reduced by using this method. In Vehicle to Vehicle V2V communication, to improve the network throughput, a newly developed concept called center of mass method is focused [12]. To increase the network bandwidth and to reduce the latency is the interests research in VANET. In order to address this, a novel concept called enhanced-AODV is combined with cross layer approach [13]. The protocol is enhanced by providing a promising vehicular movement as well as dynamic topology. To improve the on-road driving, experience relay node selected oriented models are developed for multi-hop broadcasting protocol in bidirectional stable communication[14]. Medium access controls protocols are also evaluated by the help of the routing protocols iAODV [15].

II. Link Stability in VANET

The objective of this research work is to find multiple shortest paths. The core idea of the work is an optimization based packet routing with flow instantiation source routing [16]-[18]. The major sections are source routing based FI scheme which includes Route valid time estimation, source route, open flow realization and path encoding are the major sections. Input Parameters are number of nodes, source nodes, destination node and set of nodes in the computed path. Output parameters are Time complexity, accuracy, end to end delay, packet delivery ratio, packet reception rate, latency and overhead. The major drawback of the works is the packet delivery ratio of the proposed method is lower than the earlier methods. End to end delay is almost equal to the earlier models. The shortest path scheme generates considerable routing overhead. But when the speed increases the link become vulnerable.

Researchers have focused on improving the VANET networks from content delivery as well as link stability in infotainment application [2], [19]. The goal is to overcome the network from interest transmission broadcast problems. The technique used is Link stability based interest forwarding for content request protocol. The basic idea is to select more stable links among vehicles. Link stability function, Defer timer function, Interest and data packet forwarding algorithm is the major parts of the model. Input Parameters are transmission power, transmission range, frequency band, bit rate, message size, life time and intervals. Output parameters are Content delivery ratio and delay. This proposed method produces reasonable delay and packet delivery ratio. But this method is not applicable for increased mobility based VANET network.

The core idea of the work is prediction of link duration to reduce the number of interest and data packets [19]-[21]. The proposed novel idea of the research is link stability based interest forwarding approach. The major subsections are link lifetime estimation, LSIF's interest packet data structure and Interest forwarding decision making process. Input Parameters are Delay mode, number of nodes, Time intervals, Transmission range, link layer estimation, metrics, forwarding strategies compared best route and multicast network. Output parameters are forwarding data packets, interest satisfaction rate, forwarding interest packets and round trip time. Drawbacks of the work are the adoption of other mobility prediction frameworks capable of taking non-linear vehicles trajectories improvement of satisfaction levels in LSIF.

The main aim is to improve the network scalability and link stability and also to work on high dynamic topology [22], [23]. The proposed idea of the research work is double head clustering algorithm. The sub divisions of the research work is vehicles states, clustering procedure, CH selection, joining a cluster, cluster maintenance and SCH selection are the main section of the technique. Input Parameters are Speed, position, direction and link stability. Output parameters are overhead, total number of cluster and lifetime. Drawbacks of the work are the method is applicable for dynamic mobility environment for limited coverage area. This method effectively works on average vehicles speed.

Reliable and timely reception of broadcast information is the two prime objectives in the development of safety alert messaging protocol [24], [25]. The technique behind the work is bi-directional stable communication (BDSC). Hello packet exchange, link quality estimation and link selection are the major sub sections of the model. Input Parameters are Road length, number of lanes, number of nodes, transmission range, transmission power, relay, packet size frequency, bandwidth, data rate and contention window. Output parameters are Relay selection optimality, hop count, end to end delay, saved broadcast, end to end communication counts and link stability ratio. Drawbacks of the work are retransmission of messages is not available in this method.

The major objective of the work is to provide optimal path for vehicular communication due to frequency disconnected network, dynamic topology and limited bandwidth. The proposed concept is multi-valued discrete particle swarm optimization [26][27][28]. Standard particle swarm optimization, discrete particle swarm optimization and multi-valued discrete particle swarm optimization are the major sub sections of the proposed model. Input Parameters are Vertices, link stability, and probability of obstacles. Output parameters are Packet delivery ratio, average throughput and routing overhead. Drawbacks of the work are this method is not suitable for the network of large city and highway scenarios. And also convergence problem will occur.

To address the issues such as inflexible routing schemata, inefficient traffic caused by network broadcast, volatility in the network [29]-[31]. The research is about the multiple unicast paths forwarding scheme. Design principles, content discovery, unicast path building and FIB selection are the major content behind the model multiple unicast path forwarding. Input Parameters are

bandwidth, packet size, coverage area, cache size. Output parameters are Transmission efficiency, response times, cache hit ratio, and network traffic. However, the work considered only a constant motion model for vehicles, but the vehicular mobile parameters are always changing.

In general, broadcast of periodic beacon messages in fixed time intervals will reduce network performance due to increased channel load and contention [32], [33]. The main objective is to address in issue. The proposed idea is an adaptive update strategy for sending beacon messages. Sending beacon based on the estimated time of link availability and sending a beacon message based on the participation of the nodes in the forwarding set. Input Parameters are forwarding set of consecutively received data packets. Output parameters are packet delivery ratio, control packets and routing overhead. The results of the proposed method are average benefit compared with the earlier models. Still the mobility model is in the initial state. It is not applicable for different mobility models.

High speed moving vehicles creates instant changes in network topology and instability in the communication routes which leads to link failure [34], [35]. To solve this issue the novel used model is multi agent system approach and particle swarm optimization. Particle swarm optimization algorithm, cluster formation process and multiple agent based approach are the method behind the proposed methodology. Input Parameters are Simulation time, Transmission rate, coverage area, transmission range, population size, number of iteration. Output parameters are Throughput, Rate of dropped packets, routing overhead and packet delivery ratio. This concept works under default mobility model. There is no vehicle direction to form the clusters. This model produces the improved results only for the network with average quality of service. If the same model is applied to the network with large quality of service then the performance will be reduced.

The main aim to create improved cluster stability using mobility metric based clustering schemes [36]-[38]. Technique used is Dynamic mobility based and stability based clustering scheme. Cluster definition, cluster state transition, cluster formation, cluster head selection, gateway node selection and cluster maintenance are the core concept of the proposed work. Input Parameters are no of vehicles, road length, acceleration rate, deceleration rate, propagation model, number of iteration and mobility model. Output parameters are average number of clusters, average cluster head duration, average state change and clustering efficiency.

III. Routing Based Link Stability

A. Survey Based Link Stability

Hybrid routing mechanism (HRM) based mobile adhoc network carries more challenges in the current research [39]. HRM is classified into four different categories. They are mesh, tree, zone and multipath routing. The parameters which are mainly concentrated in the output calculation are quality of service, energy efficiency, energy consumption, network reliability, message delivery ratio, latency, loss ratio and routing overhead (see Fig. 1).

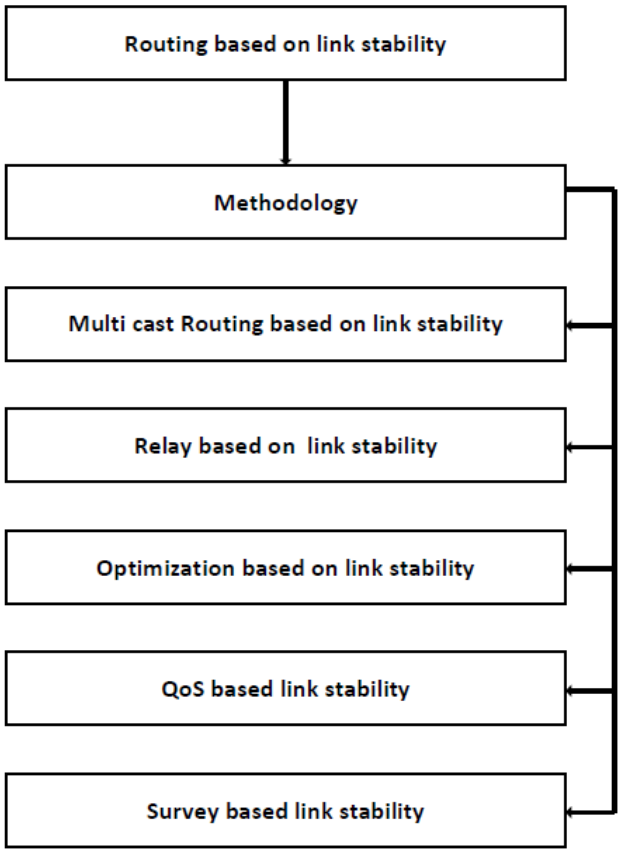

Fig. 1. Routing based on link stability

Similar to MANET and VANET, the FANET (Flying Adhoc NETwork) is also the growing subject among the researchers [58]. The major difference between the VANET among FANET it has its own characteristics in unmanned aerial vehicles research and mission based projects. Here also the dynamic nature of the mobility events makes the system more complicated to work with. In the article the survey is classified into two sections topology based routing and position based routing established a detailed report on handling the network with high mobility. The major input metrics are UAVs density, ground environment, infrastructure, obstacles effect, task duration and human operation. The measured characteristics are density, network connectivity, energy autonomy, topology variation, and scalability, quality of service, mobility models and node speed.

Improving the quality of service parameters in the wireless and mobile networks is the interesting research topic nowadays [18]. The prime issue is that the stability is not considered during the process of path estimation. It creates the curiosity in routing based link stability. The factors which are affected due to unbalanced change of path stability are overhead, energy efficiency, energy consumption, and path efficiency. MANET terminology is classified as link stability, durability, and path life. The

recent stability based routing solutions are discussed in this survey. Initially the mobility and path stability is defined in the general way then the routing protocols are classified in terms of link stability. It provides a future research direction to the researchers as final.

B. Multicast Routing Based on Link Stability

Multicast routing based link stability is the trending studies in the recent times. Random variables based mobility parameters make the multicast routing extremely hard [40]. A new model is proposed to overcome this issue in this article which is weighted multicast routing algorithm. Random variable based unknown distribution process is incorporated with mobility parameters. The multicast routing problem is primarily altered into equivalent stochastic Steiner tree problem. To address the problem a learning automata is designed and simulated to solve the equivalent stochastic Steiner tree problem. Discovering a multicast routing path a alongside with the host mobility is the major contribution of the paper. The parameters which prove the benefits of this work are message delivery ratio, energy efficiency of multicast routing, routing overhead and network latency.

By reason of mobile node character a self organizing MANET network is established it creates a way to the dynamic topology which makes the routing complicated [41]. Link stability based on RSS where presented to introduce the stable routing. Stability based multicast routing protocol is combined with multicast adhoc on-demand vector routing protocols to provide a stable routing path in terms of dynamic topology. This method is simulated in several scenarios and the results proves that the proposed work produce extremely good results in terms of network latency, message delivery ratio and communication overhead.

In general, the QoS is affected in the real time multimedia applications in terms of enlarged information rate, compact jitter as well as bandwidth availability [42]. Multicast routing with quality of service achievement in highly populated and dynamic network is an electrifying challenge in the current research. The prime concept of the paper is the creation of QoS aware routing on the base of link stability cost function. The data transmission between the sources to the destination is carried out using the node with high link stability cost function. The major subsections are stability factor calculation of the link, fixing of highest link stability cost function value, adjacent node selection, mesh network formation using stable nodes, establishment of the network with the missing nodes which are isolated. The calculated output of the following parameters proved that the performance is better than the earlier works. Those are message delivery ratio, network delay as well as routing efficiency.

Multicast routing faces lot of issues in case of link stability and connectivity. To protect the network from such facts mesh based multicast routing is used to locate the firm multicast path between the source and the receiver [43]. This reliable multicast routing ensures that it will produce high packet delivery ratio, lower network latency as well as to decrease the overhead. The key factor of the process is maintenance of link stability database, route request, route reply and multicast routing information. The major parameters which are taken for the link stability computation are neighbour node distance, received power then mainly link quality. The output parameters are message success rate, low latency and lower communication overhead.

C. Relay Based Link Stability

In homogeneous cooperative communication based network link stability issues will occur [44]. The essential factor is the relay node selection in cooperative communication which results in attaining high SNR ratio and reduced energy consumption. The considered parameters are path length, clustering coefficient and residual energy.

Broadcast protocols in VANET have the strong foundation in the improvement of traffic safety, accidents avoidance as well as messy traffic condition [24], [14] The primary concept which must be concentrated for the road safety is reliability and the timely reception of message broadcast. The author introduced a novel concept which is the sender oriented broadcasting scheme on behalf of alert message. The major protocol used for this working model is bi-directional stable communication protocol. The core idea of the proposed work is link quality estimation protocol, BDSC protocol with improved relay node selection based multi-hop network. The result produces high reliability, high link stability, improvement in traffic control and reduced network congestion.

The author protocol a novel system for the setup of stable path between the MANET networks [45]. The subsections of the work are path selection, degree of mobility calculation for neighbour node selection. The routing protocol applied to this concept is optimized link state routing protocol for stable path selection and discovering the new topology which is perfectly suitable to this condition. The output produces high quality of service, low latency, reduced packet loss ratio as well as response time.

Improved quality of service in the network provides and effective way to reduce the energy consumption and improve the energy efficiency [46]. The newer method which is used to this process is mobile sink based coverage optimization as well as link stability estimation protocol for optimal path selection and link stability improvement. The addressed problems of this research is coverage restoration, improve the energy efficiency and lifetime.

D. Optimization Based Link Stability

The proposed system talks about the optimal path fixing to improve the overall performance of the VANET network [47], [48]. Ant colony optimization in incorporated with adhoc on-demand vector routing

protocol to address this problem. The simulation results improved the link stability, packet delivery ratio, higher the vehicle speed as well as increases the quality of service parameters of the network.

In cluster based VANET communication, the network suffers overburdening of cluster head issue [34][49]. To overcome this multi cluster head selection is proposed in this paper. The major subsections of the work are hybrid fuzzy multi criteria decision making protocol, fuzzy analytic hierarchy protocol, and TOPSIS. The secondary issue which is discussed in this paper is Intrusion detection. The major subsections of this process are support vector machine, dolphin swarm optimization. The performance metrics includes false positive rate, detection time and rate.

E. QoS Based Link Stability

For WBSN network, clustering based methods are introduced to improve the quality of service parameters [50]. This survey provides a detailed report about the routing protocols and methods which is present in WBSN network. The routing protocols classified in terms of temperature aware, delay aware, energy aware, Quality of Service QoS aware, privacy aware, cluster head selection oriented, cross layer approach based as well as posture based protocols.

Maximization of quality of service parameters is the primary target of Internet of things based sensor network[50]. The network with high QoS results in reduced energy consumption and improved energy efficiency. Link quality estimation routing with integration is the proposed work of the paper. The subsections are energy consuming model, link quality estimation, stability based link quality estimation metric. The results provide high link stability and QoS (see Fig. 2).

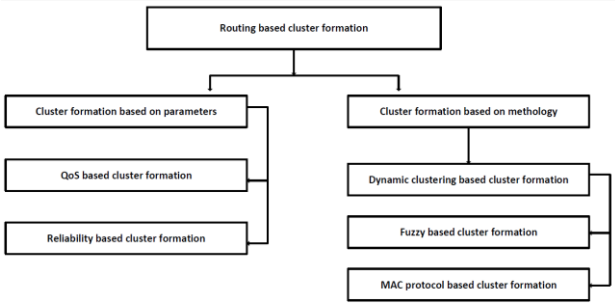

Fig. 2. Routing based cluster formation

IV. Routing Based on Cluster Formation

A. Cluster Formation Based on Parameter

1) QoS based cluster formation

In general, VANET works under several clustering algorithms. Quality of service (QoS) is considered as the important requirement for VANET based multimedia services [35]. The proposed method presents one of the ways to improve the QoS in the VANET network. It concentrates on high speed mobility constraints. The main aim is to create a stable cluster, maintain stability during transportation, and to reduce link failures. The main phases of the model is included high mobility metrics during QoS computation, MRP selection and recovery based on Ant Colony Optimization which maintains the network to stay connected during link failure. According to the proposed model, the methods are evaluated through the parameter such as stability of the network, end to end delay, and message delivery ratio and routing overhead.

An analytical based performance evaluation for clustered VANET network is discussed in this paper [51]. The major parameters which are chosen for the evaluation process are network throughput, end to end delay and message delivery ratio. Several scenarios for simulations are created and the performance is evaluated.

VANET works under high velocity which creates link breakage frequently. To overcome this drawback, a new model is created a new model is created namely clustering based reliable low-latency multipath routing [67]. Ant Colony Optimization algorithm is used to find the optimal path to transfer the data from the source to the destination. Cluster heads are created using the maximum link stability. The considered evaluation parameters are QoS, network reliability, delay, energy efficiency and network throughput.

2) Reliability based cluster formation

The objective of the work is to improvise the VANET stability by cluster based topology. Because of the extremely high mobility of the vehicles the frequent change in topology occur which results in the increase of routing overhead on topology updating [52]. Clustering is the most effective way to manage and stabilize the network. In this survey several classifications of clustering algorithms are discussed which are beacon based, density based, direction based, efficient clustering, stable based, and cluster based multiple channel. This stable clustering method results in the reduction of routing overhead which increases the reliability of the network.

The paper is focused on the concept of Cluster-Based Beacon Dissemination Process which investigates the proximity map of the vehicle vicinity [53], [54]. The major objectives are providing an accurate and detailed mapping, coordination based vehicle mapping and those are solved by the concept of clustering. This beacon based cluster dissemination process provides a proximity map based on topology optimization.

B. Cluster Formation Based on Methodologies

1) Dynamic clustering based methodologies

This paper presented an investigation on intelligent transport system (ITS) which reduces the number of accidents and provides a managed traffic for VANET [55]. The incorporation of ITS in VANET makes the network accident free. VANET communication is classified into two general section, they are vehicle to vehicle (V2V) and vehicle to infrastructure (V2I)

communication. Inter vehicle communication method is created to enhance the road traffic safety. On behalf of large number of message generation in the vehicles at critical areas the network produces high overhead which reduces the network stability. To overcome this drawback a new cluster based algorithm is proposed which merge dynamic clustering and passive data dissemination method. This method is the effective way to increase the stability by reducing the communication overhead in the network.

The author produces a new approach for vehicular network stability improvement [36]. Clustering mechanism is used for this purpose and due to dynamically changing topologies the performance of clustering is affected which makes the cluster stability maintenance is the demanding issue in VANET communication. The proposed approach uses several metrics which are received signal strength (RSS) and identifier number metrics. To perform the advanced clustering operation, dynamic mobility and stability based clustering approach is formed for several road side scenarios. The primary parameters are vehicles direction, position and lifetime estimation. The wide ranging simulation shows better performance on vehicle stability.

Communication failure is the major drawback in vehicular adhoc network hence it is essential to create a network which high reliability [56]. A hybrid dynamic cluster method is assisted by the author to create a reliable communication. Building of cluster based stable dynamic topology with agent technology is the core concept of the proposed model. The main metrics are the time taken for cluster formation and cluster head selection then the overall lifetime of the cluster.

2) Fuzzy based clustering methodologies

In general, the two main classifications of VANET communication is V2V and V2I and maximum of the networks are works under the concept of clustering which suffers from several performance issues [49]. In cluster communication, the cluster heads are burdened by extra overhead in the dense network scenarios. The prime part of the paper is to reduce the over burdening of the cluster head. Which open the way for multi cluster head scheme there each cluster consist several cluster heads. For the process of stable cluster head selection fuzzy based decision making approach is used and the core concept of this approach is fuzzy analytic hierarchy process (AHP) and TOPSIS methods.

Vehicular Ad-hoc Networks and opportunistic networks are investigated for the large scale internet of Things Applications. Security and trustworthy condition is essential [64]. To make it happen Fuzzy based cluster management system (FCMS) is proposed in this paper which consists of two scenarios which are FCMS1 and FCMS2 for VANET vehicle clustering process. The input metrics of the first scheme is vehicle relative speed, degree of centrality and security of the vehicle. The main input metrics of the second scheme is trust worthiness. The result evaluates highest possibility of cluster maintenance with high relative speed, high degree of centrality and high security with trustworthiness.

3) MAC protocol based methodologies

In order to reduce the road accidents and death rate the evergreen field of technology is VANET. By this reason, large number of protocols is proposed in the earlier days to improve the message safety, message priority [57]. MAC is a certain area where no more exposure in literature. Here the author proposed a new lane model for VANET to reduce the latency by introducing priority cluster based packet forwarding scheme. Cooperative clustering is used for cluster selection which helps to broadcast safety messages and leads to the latency reduction during the emergency time period. The transmission structure of this work is that the cluster member node in the cluster acts as a cooperative node to transfer the emergency packets from the sender to the receiver.

In this paper the alternating channel access mechanism is discussed and the major classifications of synchronization intervals are control and service channel intervals [58]. The control information data are communicated in between the control channels and the service information data are communicated in between the service channels. The core idea is the creation of cluster based TDMA mechanism in MAC protocol to improve the message delivery ratio and the throughput of the network.

A new emerging technology which is adopted for VANET is wireless access in vehicular environment [58]. Distributed coordination function based medium access control is the central part of the process which is the reason for the low performance and high rate of collision. To reduce the contention window and link failures many clustering approaches are analyzed in the earlier models. This survey detailed about the major classifications of cluster based multi channel MAC protocol (see Fig. 3).

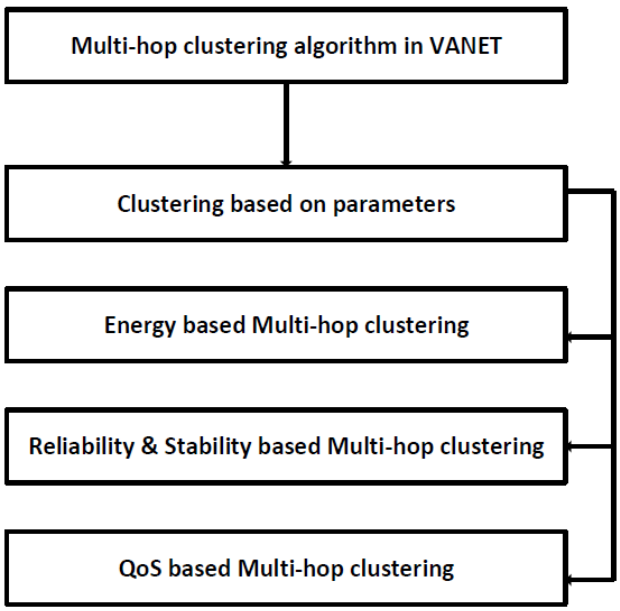

Fig. 3. Multi-hop clustering algorithm in VANET

V. Multi-Hop Clustering VANET

A. Clustering Based on Parameters

1) Energy based multi-hop clustering

Multi-hop heterogeneous network faces critical drawbacks in term of energy efficiency in the complicated road side scenarios [59]. In order to overcome this clustering tree topology control algorithm is proposed to increase the energy efficiency of the network and load balancing. The main metrics are link quality and packet loss rate. According to this cost function and the distance factor is considered to elect the cluster head. The child node selects the cluster head through residual energy, distance and link quality. Some relay nodes are also selected and those are declared as non-cluster heads, which help for multi-hop communication to reduce the load of the cluster head. By this process the lifetime of the network is increased. This concept is applied to several scenarios are the performance is analyzed. The results prove that it prolong the lifetime in better way when compared with the earlier methods.

The major disadvantage in the multi hop network is it produces high delay which reduces the scalability of the network. This survey describes about various protocols and algorithms under three categories which are centralized, distributed and hybrid [60]. After analyzing the issues, a new clustering model is introduced to prevail over the prior negative aspect. The comparative study of existing clustering algorithm based multi-hop routing and dynamic network topology is discussed. This proposed system makes a few sub sections for energy efficient clustering and extend the network lifetime. The subsections is network area, homogeneous nodes, stationary BS and nodes, the two-hop intra-cluster communication and multi-hop inter-cluster communication (see Fig. 4).

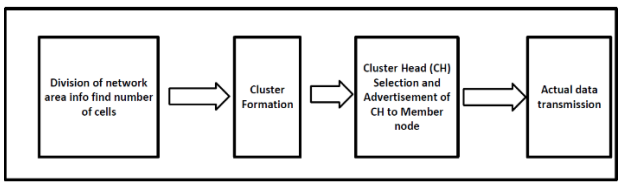

Fig. 4. Multi-hop dynamic cluster head selection

The two layered heterogeneous networks currently work in clustering based multi-hop concept. Mainly to improve the energy efficiency and to reduce the energy consumption, clustering concept is initiated [61]. In general, cluster head node consumes more power, which leads to increase the overall energy consumption of the network. To overcome this drawback and to achieve better scalability, a novel model for clustering algorithm is introduced, which is collision free polling based multi-hop cluster formation. Here, polling points are used to collect the information from the nodes to the cluster head whereas the cluster head energy consumption is reduced.

2) Reliability and scalability based multi-hop clustering

VANET network has several architectural models where clustering method is employed mainly in hierarchical network architecture by node grouping [62]. The earlier works discussed about the mobility model for CH voting. Due to wide range of communication rapid movements are taken part which makes the network less reliable. This problem is addressed by introducing PMC algorithm (passive multi-hop clustering). PMC provide a default coverage and stability to the cluster which leads to maintain the reliability of the cluster. Priority based neighbor selection is the main subsection of passive multi-hop clustering algorithm.

Distributed multi-hop clustering algorithm (DMCNF) is the emerging idea of the VANET technology with main input metrics location, speed, position and direction [63]. One hop neighbor selection is used in this algorithm which waits for the acknowledgement during the communication which uncertainly increases the network delay. To tackle this subject the new protocol Enhanced-DMCNF is investigated. Here the communication between the RSU and the stable cluster in handled by a new vehicle which reduces the cluster overhead.

The control overhead and congestion problems of the VANET network is discussed in the paper which leads to propose a new model namely optimal adaptive data dissemination protocol (OADDP) [64]. The two main subsections namely, optimal clustering and control overhead reduction algorithm. For optimal clustering whale optimization algorithm (WOA) is used and for control overhead reduction prediction based decision making (PDM) algorithm is used. The simulation is done and the results are compared with the earlier adaptive data dissemination protocol and the performance shows that the proposed method performed well in terms of success rate and data dissemination efficiency.

Applicability and commercial values gathered tremendous attention to the VANET. The main challenges in the VANET network is due to fast moving capability the reliability of the network is reduced [65]. To achieve probability broadcasting a novel data dissemination scheme is proposed. Proper transfer duration is provided to the vehicle to exchange the information to the cluster. Data distribution among the vehicles is handled by probabilistic forwarding concept. The concept is simulated and the result show that the message delivery ratio and the coverage information are improved and the latency is reduced when compared with the earlier works.

Nowadays maximum of the VANET technology is works in clustering theory [54]. High mobility makes the network trickier and frequent disconnection occurred which leads to reduce the overall Quality of service. This issue is address by introducing the hybrid approach, the election of trustworthy CH by the combination of trust factor and stability is the core plan. This model is

separated from the earlier works by introducing the newer parameters as the metrics namely reports events and static trust function. The increase network traffic in clustering is controlled by introducing the timer approach. As final the cluster stability is improved compared with the earlier methods.

Due to the rapid moving character of the mobile nodes in VANET instability is increased. Clustering is the universal solution to get the better of this issue [66]. The earlier presented works make huge number of CH which despoiled the performance. To resolve this difficulty grey wolf optimization is embedded with the clustering algorithm. The natural hunting behaviour of the grey wolf is used to generate the efficient clusters which lead to receive the optimized numbers of clusters. The simulation results provides communication quality, reliable delivery ratio of the information in VANET.

3) QoS based multi-hop clustering

Various researches are proposed in terms of quality of service in multi-hop clustering based vehicular communication [67], [68], [35]. The key factor of the researches is cellular technology, wide range communication, network with reduced latency, constructing stable clusters, reducing communication overhead, high mobility matrices, and optimizations based algorithms and routing recovery. The calculated results are cluster head selection numbers, vehicles mobility rate, collision detection rate, network latency, message delivery ratio and communication overhead.

VI. Improved AODV

The cutting edge of the AODV protocol depends upon the major criteria such as the minimum delay path for the selection of the route [86]. The selection of the route does not depend upon the load path nodes and its size and it is most important in the real time requirements is the routing in case of the network transmission than the amount of information. The main bottleneck in this protocol is the residency of the route longer the case. It leads to delays or even data loss and create many critical problems. The series issues in AODV routing protocol is a web-based time delay. The AODV protocol is used in congestion with the random selection algorithm and the traffic in conformity with the principles of ADM allocated to different paths. The collaboration of the protocol minimizes the network congestion and minimize network latency and enhance the network QOS.

To transmit the constrained data from the leaf nodes (LLN) to the boarder router the proactive based RPL is utilized and it is the network layer routing protocol [69]. The conventional wired or wireless network is framed to transmit the application data, the non-constrained networks is used to transmit the data from the LLN boarder router (LBR) to the destination. The flexibility nature of the wireless networks is used to transmit the application data from LBR to non-constrained network. The paper is designed to discover the channel route from the LBR to the destination by using the directional antennas and the protocol is the channel based cognitive AODV routing protocol. The networks are connected by means of the Cognitive Radio Networks. The implementation results reveals that the projected cognitive AODV protocol with directional antennas is out-rich the results with compared with the conventional structured based wireless networks.

The network is infrastructure-less network and the network is the MANET and it is abbreviated as Mobile ad hoc network the network has the capacity to configure itself. The geographical structure of the network changes dynamically [70], [71]. The wireless mobile nodes communicate each other without any centralized hub. The network does not consist of centralized administration. The MANET routing protocols are been differentiated with various routing protocols they are reactive, proactive and hybrid routing protocols [72]. The performance metrics is compared between the routing protocols AODV and DSDV protocols the QOS parameters are overhead, packet delivery ratio, throughput and end to end delay. The metrics proves that the AODV is better than DSDV. The metrics is due to the performance of the end to end delay in which the proactive routing protocol is less compared to the AODV protocol. The author enriched that the performance diminish due to the black hole attack. The above drawbacks are overcome to enhance the AODV protocol.

The researchers consistently worked to enrich the stable routes in a high congested mobility area and this lead to a novelty to build the new reactive routing protocol [30], [73]. In new reactive routing extension protocol both Ad-hoc On-demand Distance Vector (AODV) and Mobility and Direction Aware AODV (MDA-AODV) prior routing protocols are used. The routing protocols are renamed as Mobility Aware and Dual Phase Ad-hoc On-demand Distance Vector with Adaptive Hello Messages (MA-DP-AODV-AHM).

Several protocols are optimized in order to increase the performance. They are DSR, TORA, ABR, and AODV [74], [75]. To provide the best path from source to destination B-AODV based on the shortest path is proposed in the work. To improve the QoS of the network, the developed new models are QAODV (QoS-AODV), (RA-AODV) and Energy based AODV protocol (EN-AODV) [76]-[78]. To protect the routing protocols from Black hole attack, AODV protocol is enhanced in several ways [79], [80].

VII. Challenges From the Earlier Study

1) Links are short lived and thus the capacity of a links is the function of time.
2) Wireless channel access imposes limitation on continuous packet transmission.
3) Combinational patterns of wired and wireless links make it hard to accurately estimate the packet arrival time.

4) Optimal path problem is one of the key issues in efficient data dissemination in VANET.
5) Establishing and maintaining stable clusters is becoming one of big challenging issue in VANETs.
6) Earlier method focused only on one hop clustering, here the communication between the cluster member and cluster head occurs with one hop distance the most. It reduces the coverage area and increases the number of cluster heads. It affects the overall performance of the network and increases the overlapping between the clusters.
7) Several proposed models do not consider the mobility characteristics, the dynamic topology and the limited driving direction of VANET and they do not consider energy problems.
8) The earlier mobility based clustering methods are based on the broadcast of control messages, which results in overloading of the network and leads to increase the collision rate of the network.

VIII. Predictions Based Efficient Multi-Hop Clustering Approach with Adaptive Relay Node Selection for VANET

A novel multi-hop clustering method is introduced and compared with earlier one hop communication based clustering methodologies. The main idea of the proposed method is to increase the coverage area of the cluster head, reduce the number of clusters in the network, reduce energy consumption, increase the energy efficiency and reduce the control overhead. Predictive model based efficient clustering is incorporated to increase the stability of the cluster for VANET with minimum clustering cost. Improved AODV protocol is introduced to improve the vehicles mobility and it is a stable model for rapidly changing topology based network. This protocol increases the link stability of the network.

A. *Energy Efficient Multi-hop Clustering*

In this section, we discussed about a new model an energy efficient multi-hop clustering approach for improvise the VANET performance. The core concept of the work is to connect the vehicles to Gateway-RSU (Road side unit) using the internet access. It provides the way to the multi-hop neighbours to share the information and form the clusters. The parameters which employees in this section are connectivity between the nodes, link stability, distance among the nodes and relative velocity. The Master cluster head is elected and the primary criteria are it should have the lowest mobility rate. Secondly, the election of slave cluster head is the reason for the cluster stability. And the major layers are node registration, neighbour selection, MCH selection, SCH selection and maintenance. The results parameters are cluster numbers, clustering overhead, Latency and message delivery ratio.

B. *Prediction Based Clustering Approach*

In the previous section we discussed about the parameters for the selection of master cluster head. Likely the parameters for the election slave cluster head is mentioned, they are vehicle residual longevity, vehicle cost and vehicle lifetime value which helps to create the efficient cluster network.

C. *Adaptive Link Selection with Improved AODV Protocol*

Adaptive relay nodes selection includes the periodic hello packet transmission, link quality estimation and selection of available relay nodes in the necessary conditions. The improved AODV protocol aims to find the best reliable path from the source to the destination. The error message section is improvised to quickly rectify the link failures with alternative link with good quality.

IX. Conclusions

In this survey the earlier works contains several classifications. Those are link stability in VANET, routing based link stability, routing based cluster formation, multi-hop clustering algorithm and improved AODV protocol. The results are discussed according to both methodologies and parameters. The main input metrics of the entire study is topology changes, vehicle mobility, cluster head selection and cluster formation. The main output metrics are end to end delay, latency, message delivery ratio, throughput, communication overhead and loss. Several drawbacks are analyzed and to overcome this issue a novel future work is presented with this paper which is Predictions Based Efficient Multi-hop Clustering Approach with Adaptive Relay Node Selection for VANET. Multi-hop clustering is used to increase the network stability, energy efficiency and to reduce the energy consumption during the transmission of the data. Predictive model is incorporated here to increase the input data rate of the network. To analysis the stable path and also to reduce the link failure adaptive relay node selection is used in advanced AODV model. By combining all the models, we can get a positively high results compared with the earlier models. Another direction of research is to build predictive models based on defining new metrics. Such metrics can indicate to clustering stability beyond link life time by exploiting the mobility model of the vehicles and linking that to the topology of the network.

Conflict of Interest

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Sami Abduljabbar Rashid, Lukman Audah Have prepared and analyzed the data; Mustafa Maad Hamdi has reviewed the research and modified the paper organization and outline ; Sameer Alani has proofread the english language. All authors had approved the final version.

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