International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Examination of Intelligent Transportation System Its Routing Protocols

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ABSTRACT

The networking procedure is evolving to make consumers more comfortable as technology is improving daily. A new adhoc network called the Vehicular Adhoc Network was created specifically for this purpose in the last few decades to give safety and comfort-based applications to the users while driving (VANET). This is a sort of networking between moving cars on the road that connects automobiles close to one another so that they may share information. Although VANETs are a particular type of MANET, routing protocols designed for MANETs cannot be easily applied to VANETs due to their unique set of limitations. Topology-based routing protocols were the sole form of routing protocol taken into consideration in earlier research on VANETs, however this type of protocol was not appropriate for VANETs, leading to the introduction of other types of routing protocols. A number of writers have categorised the routing protocols for VANET in a variety of ways, making the list of these protocols rather long. Understanding the bulk of these procedures is necessary to begin working in this sector. Therefore, before testing and certification, routing protocols created for VANETs cannot be applied directly in automobiles. As a result, simulation is utilised to examine various VANET-related metrics such as packet delivery ratio, end-to-end latency, packet loss, etc. Today's simulators come in a variety of varieties, each of which has pros and downsides. Choosing a simulator that produces outcomes as near to reality as feasible is thus required once more. Hence, keeping the aforementioned two variables in mind, the current analysis offers insight into the routing strategies employed by VANETs, their classification based on various factors, the benefits and drawbacks of VANETs, and how various methodologies are utilised to address those drawbacks.

In the current study, hybrid routing protocols in VANETs have been introduced. Hybrid approaches will be introduced and developed in VANETs, allowing for greater scalability and better service quality.

Keywords: VANET, AntHocNet, Hybrid routing protocol

1.INTRODUCTION

With time restrictions in mind, a large population has been using automobiles and other private vehicles as their primary mode of transportation for the past few decades. This has greatly increased the amount of road traffic density, which has led to the emergence of several new issues in the current, digital era. Moreover, this has led to more annual traffic accidents, gridlock, and greater energy usage.

Moreover, excessive automobile use pollutes the air and has a bad effect on the environment. All of this has spawned a brand-new area of study that is more focused on passenger safety and traffic efficiency. Vehicle-to-vehicle networks are also referred to as "vehicular ad hoc networks" (VANETs). According to several studies (Morris et al., 2000; Yousefi et al., 2006; Hartenstein and Laberteaux, 2009; Campolo et al., 2015), it is one of the most promising answers to this problem. Road Side Units (RSUs) and moving cars, which serve as nodes in a VANET, interact with one another using methods that don't need infrastructure. Some uses suggested by VANETs include enhancing traffic efficiency and safety.

The numerous communications need of ITS applications, such as latency, average delay, bandwidth, coverage, and many other performance parameters, are frequently handled via VANETs. The architecture of the VANET, several communication domains, and corresponding radio access methods are given in the next subsection.

According to [Yang and Xin, 2015; Jiang et al., 2014; Saini et al., 2014], a VANET system has three basic parts:

- On Board Unit (OBU)
- Road Side Unit (RU)

- Application Unit (AU)

Vehicle networks seek to provide apps for drivers and passengers that are both safe and non-safe while driving. Applications that focus on safety are used to both reduce the frequency of accidents on the road and to protect motorists. Applications that are not safety-related work to increase passenger comfort and enjoyment as well as traffic efficiency. For instance, an application to prevent auto accidents increases efficiency, preventing the traffic congestion brought on by the accidents. Applications based on comfort, traffic safety, and efficiency are briefly covered in the following subsections [Vegni and Loscri, 2015].

Vehicle nodes can function as mobile sensors thanks to applications that are aimed at improving traffic efficiency. These nodes themselves gather information on things like traffic density, weather, and parking information. So, based on the data gathered, these cars are able to determine the traffic situation in their neighbourhood and transmit this information to the OBUs, which in turn transmit it to the other vehicles in the area where route optimisation is being done. Research has shown a strong interest in this kind of application [Hartenstein and Laberteaux, 2009; Konstantinos et al., 2011]. According to [Toutouh, 2015], traffic efficiency applications have a number of advantages over traditional methods.

The goal of the current study is to offer a VANET model that will function effectively in scenarios including cities and highways. With this in mind, a hybrid routing system for VANET will be created that prioritises improving the quality route above minimising the number of hops. Because setting up and testing VANETs is expensive, the current work will be evaluated using simulators. The specific goals that follow will outline the overall objective and the stages.

- To research various VANETs routing protocols
- To create a model that differs from the current one in a few key ways.
- To contrast this model with the most recent cutting-edge ones.
- To confirm the model.

Several unresolved problems in vehicular communication need to be best resolved. Even though there has been a lot of effort done over the last few decades in the field of VANET, there are still numerous areas and various optimisation strategies that are either not applied to open issues in VANETs or are only partially used in various vehicle applications. The goal of this thesis is to offer a fresh viewpoint on how to address some of the problems that VANETs face. The goal of the current study is to propose strategies that are nature-inspired and address vehicular domain routing issues in order to contribute meaningfully to the world of today.

2.TOPOLOGY BASED ROUTING PROTOCOLS AND NATURAL COMPUTING IN VANETS

Several commonly used routing methods for use in vehicular communications are presented in this chapter. Position-based routing protocols and topology-based routing protocols are frequently used to categorise routing protocols in vehicular communications. Reactive, proactive, and hybrid routing are subcategories of the latter type of routing protocols. Only the routing protocols that are currently in use are kept by reactive protocols like AODV and DSR, but proactive routing protocols like OLSR maintain all of the available paths. The upkeep of routing paths has a significant impact on how well a network that is extremely dynamic performs. Since the position of the destination node is determined via a location service mechanism, such as in VADD, path maintenance is not necessary with position-based approaches.

Directional and non-directional positioning-based routing strategies are other subcategories. The direction that vehicle nodes are travelling is considered while routing packets in directional approaches [Gong et al., 2007; Tian et al., 2009]. Contrarily, with non-directional routing protocols, data packets are not regarded to be forwarded in the direction that the vehicle is going (Lin et al., 2010; Lochert et al., 2005).

Natural computing (NC) employs many classes of methodologies that draw their inspiration from the natural world. It integrates techniques for tackling difficult issues, such as swarm intelligence and evolutionary algorithms. Our goal in this thesis is to optimize the performance of VANETs by utilizing swarm intelligence techniques that are employed in MANETs and changing various parameters. This chapter compares ant colony optimization-based AntHocNet technology with topology-basic protocols.

Results after Evaluating Routing Protocols

This thesis' study employs an offline protocol optimization technique to assess the effectiveness of various routing algorithms. The goal of this thesis is to reduce PDR and E2E delay, hence a swarm-based technique called AntHocNet is used. By changing the node count, the simulation for the VANET scenario has been run. AntHocNet's performance is compared to that of AOMDV and AODV. AntHocNet is a swarm-based routing technology.

AODV outperforms AOMDV and AntHocNet in terms of performance. In AntHocNet, the value of PDR rises as the network's node count rises. The hybrid nature of AntHocNet and the rapidly changing network architecture of VANET may be to blame for the lower value of PDR in AntHocNet for fewer nodes. PDR still has a lower value than the suggested routing techniques.

This chapter compares AntHocNet's performance for various VANET scenarios while altering the node count. A comparison is made between the hybrid protocol AntHocNet, the reactive routing protocols AODV and AOMDV, and the proactive routing protocol AODV. The AntHocNet protocol has a lower end-to-end delay value but a higher node density. This is due to AntHocNet's hybrid nature, which can establish continuous communication across many nodes and is helpful in urban settings. Because AntHocNet is hybrid, AODV and AOMDV exceed it in terms of throughput. Although AntHocNet has the lowest PDR of the three algorithms, the for the AntHocNet routing algorithm, the PDR value increases as node density increases. PDR, on the other hand, deteriorates in AODV and is nearly constant in AOMDV. This is because AntHocNet's hybrid behaviour with increased node density improves PDR by enabling improved communication between nodes. Even if lower values of PDR and E2E are behaving differently, AntHocNet can be integrated into VANETs by further optimizing both values, which will be beneficial for networks with fewer nodes. Therefore, the model that further increases the throughput of the AntHocNet in urban scenarios and can be quite useful in multi hop wireless network will be discussed in the following chapter.

3. ANTHOCNET-ETX ROUTING METHOD

This section describes research that was done using VANET simulators and compares the performance of AETX with AntHocNet. Mobility model generator for Vehicular networks is the mobility generator utilised here (MOVE). Using SUMO, this software creates traffic scenarios. Both the ns2.35 and Qualnet network simulator traffic simulation files are generated by MOVE. In this thesis study, network simulation was performed using ns2.35 software.

Problem Instance

MOVE has been used to create three alternative VANETS situations for the ns2.35 simulation. In the first scenario, N automobiles are scattered at random over a two-lane metropolis. In the second scenario, a two-lane metropolitan area is reproduced. The third VANET scenario is once again a two-lane metropolitan setting, although this one has more junctions than the others. The simulation parameters used in ns2.35 are listed in Table 3.1:

Table 3.1 describes the simulation settings for the AntHocNet and AETX routing protocols. [Source: original work]

Parameters	Values
Number of Vehicular Nodes	20-140
Transmission Range of Each Node	150-250m
Mac Layer	802.11 P
Bandwidth	2Mbps
Average Velocity	20-50km/hr
Speed Distribution	Uniform, Rayleigh

Comparison between AntHocNet and AETX

Throughput, routing overhead, and PDR are three separate metrics that are used to evaluate the two routing protocols AETX and AntHocNet in ns 2.35. Figure 4.1 makes it clear that AETX is able to increase throughput in comparison to AntHocNet. This is because it takes less transmissions overall to transfer a data packet from source to destination. Figure 4.2 plots the routing overhead rate (O) versus the number of cars (n). Here, the maximum speed of the vehicular node is maintained at 40 km/h, and the transmission range (R) of each vehicle is 250 metres. The simulation is run once again with a transmission range of 155 metres. It makes it clear that increasing the transmission range causes lower overloads. This results from the transmission range being reduced since each packet must make many hops to reach its destination. It shows how PDR behaves in relation to n. AETX's PDR has increased in value since more cars have made it easier for the company to identify and fix faulty routes, however this will result in higher routing cost. Although while AETX raises the overhead for more moving nodes, this increase is extremely negligible in comparison to the throughput boost offered by AETX.summarises AETX's advantages over AntHocNet. AETX is able to improve the throughput by 20.12%, PDR by 16.5% and routing overhead is decreased by 34% over AntHocNet.

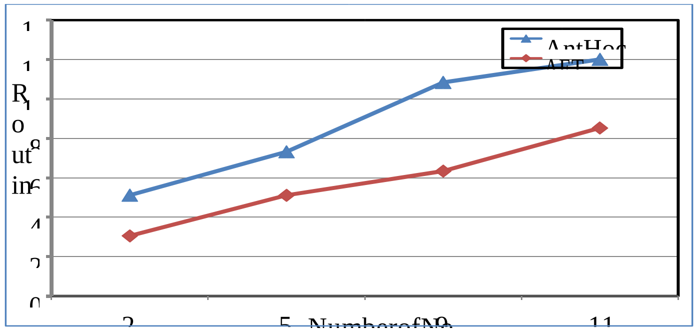

Figure 4.1: Throughput of AETX and AntHocNet routing protocol as a function of number of nodes

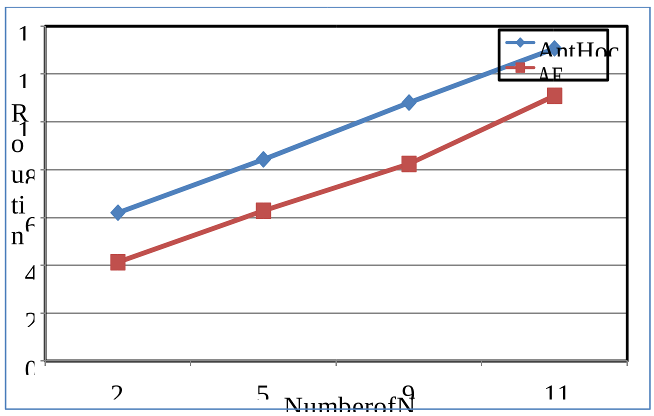

Figure 4.2: Routing overhead versus number of nodes. Transmission range=250 m.

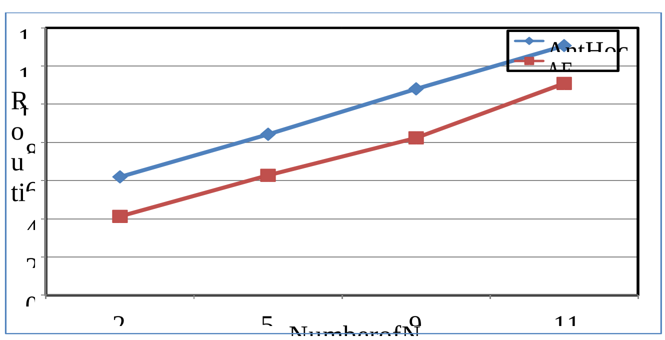

Figure 4.3: Routing overhead versus number of nodes. Transmission range=155 m.

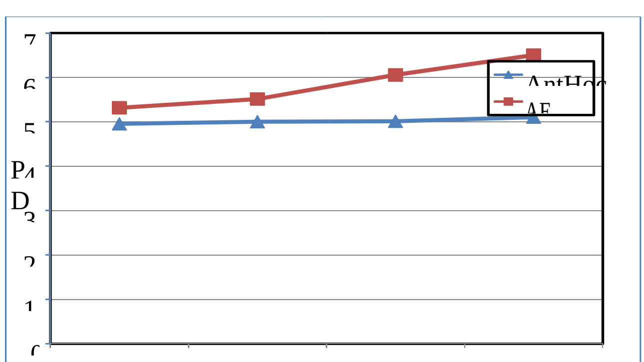

Figure 4.4: Packet delivery ratio versus number of nodes

Table 3.2 AETX improvement over AntHocNet [Source: own creation]

Parameters	Avg.± Std.	Improvement (%)
Throughput	1913.185±909.81	20
Routing Overhead	5.7575±2.29	34
PDR	58.4725±5.37	16

An updated AETX routing algorithm built on the AntHocNet routing protocol is presented in this chapter. This AETX algorithm uses ETX metric characteristics to reduce AntHocnet routing overhead. AntHocNet's integration of ETX not only lowers cost, but also offers a scalable routing solution in many VANET applications. Findings obtained in terms of PDR and E2E latency show poor performance of AntHocnet's minimal hop count and confirm that adding ETX improves performance; nevertheless, as the network gets larger, overhead increases, necessitating optimisation of the outcomes. AETX will be more beneficial for long paths, though, as it may increase throughput. The chapter's discussion of the AETX routing protocol, an improvement on AntHocNet, offers a workable alternative.

4. ADVANCED-ANTHOCNET (AAHN) ROUTING PROTOCOL FOR VANET

Being a hybrid routing technology, AntHocNet has a greater E2E delay for fewer nodes. For the majority of VANET cases, the PDR routing protocol also doesn't produce good results. Because AntHocNet does not employ the idea of traffic density to determine a route, this issue arises. The first route created by estimating the pheromone is saved and used once more, however in the case of a VANET scenario, that route or link will be regarded as a dead link as it's possible that no vehicle or mobile vehicle exists on the dead road/dead link. Figure 5.1 can be used to quickly visualise this issue

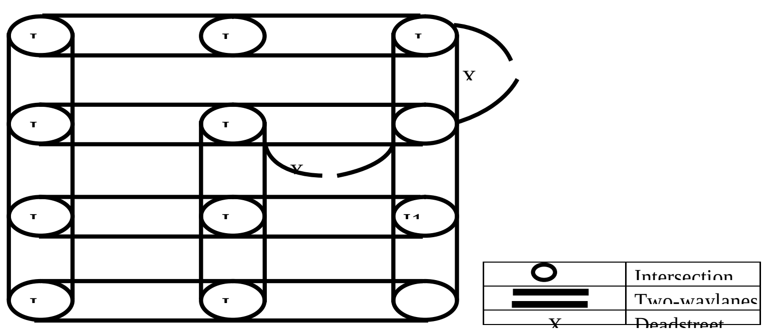

Figure 4.1: A VANET scenario having 12 intersections/junctions [Source: Redrawn from Abbasi et al, 2018]

Let's say the vehicle at Junction J1 is the source vehicle sending the data packet to the vehicle at Junction J11. Using the prior knowledge of the phenomenon value, the AntHocNet algorithm will choose J5-J9-J10-J11 as the shortest path. As the AntHocNet routing protocol lacks any mechanism to establish a dynamic routing path based on rich traffic density and also takes into account multiple streets and junctions when calculating the shortest path, if streets J9-J10 eventually become dead due to the nature of vehicle movement or the traffic density charges, it will increase E2E delay and reduce PDR. The data packets are also forwarded by AntHocNetutilising the one hop neighbour approach. When compared to one hop neighbour information, the usage of two hop neighbour information produces better results. The two-hop approach increases the effectiveness of routing while also cutting down on E2E delay. A new routing protocol called Advanced AntHocnet (AAHN) is introduced in this chapter to address the aforementioned issues. AAHN is intended to enhance AntHocNet's performance for urban environments in VANETs.

Advanced-AntHocNet (AAHN) Routing Protocol

In section 5.1, in relation to Figure 5.1, the problem with AntHocnet during the path startup and maintenance procedure was already covered. Therefore, a routing protocol that has the capability of dynamically choosing routing junctions and pathways depending on directional density is required. In order to address the problem, a routing protocol called advanced-AntHocNet (AAHN) is presented in this section. It aims to optimise data packet forwarding by choosing optimal junctions and intersections, hence increasing packet delivery ratio.

Calculation of Traffic Density in AAHN

Data packets are routed via AAHN, which chooses the best possible shortest path while taking vehicle density into account. Various approaches have been put forth to calculate data on road traffic density. Table 5.1 lists the approaches taken to determine traffic density up to this point.

Name	Reference
Opposite Stream Vehicle Communication Approach	ziliaskopoulous et al., 2003
Self-Organizing Traffic Information System (SOTIS)	Wischhof et al., 2003
Traffic View	Nadeem et al., 2004
E-road	Tyagi, 2012
Video Processing Technique	Sen et al., 2013
Infrastructure free traffic information system(IFTIS)	Jerbi et al., 2007
Enhanced IFTIS	Bilal et al., 2011
Road Oriented Traffic Information System (ROTIS)	Bilal et al., 2014

5.CONCLUSIONS

A swarm-based approach is described in this thesis to address issues with the vehicular network. These ant-based algorithms offer a challenging algorithm for bettering VANET behaviour. Since VANET has recently gained a lot of attention, there are now more options for resolving the issue because successfully implementing VANET could alter how society looks.

The primary characteristics of VANETs, vehicular communication mechanisms, the architecture of VANETs, and the various application categories offered by the VANET—safety-based applications and non-safety-based applications—are first discussed. The disparity between VANET and MANET is also explored, as well as how routing protocol in MANETs cannot be deployed in a VANETs scenario.

The next step was to examine the current state of the various routing protocols designed to address the various problems presented by VANET. There is also discussion of various communication patterns that will aid in packet reception by nodes. At the international level, various nations are working on their own unique programmes to successfully integrate vehicle ad hoc networks. The top three countries for research on various VANET situations are Japan, the USA, and the EU. It was also explained how various writers classified the routing protocol using various taxonomies. In a thorough interactive review, several difficulties in vehicular communication are addressed through routing methods.

By using traffic density data in AntHocNet's multiple junction method, this issue has been resolved. It has been proposed that a new routing algorithm called Advance-AntHocNet (AAHN) replace AntHocNet by including link traffic density data. The ROTIS method is also used to divide the road segment into cells. According to the length of the route, the size of cells and transmission range of the vehicles were dynamically modified. More so than AETX, AAHN increased the network's throughput. Additionally, a statistical study has been done. Friedman rank testing was done since the data obtained from simulation violated the normality assumption. The two other algorithms that were taken into consideration, AETX and AntHocNet, were assessed as being second and third best, respectively. AAHN's throughput increased by 35.6% compared to AntHocNet and by 11.63% compared to AETX. In terms of PDR, AAHN has outperformed AETX and AntHocNet by percentage improvements of 8.01% and 40.24%, respectively. AAHN's routing overhead has risen by 32.6% in comparison to AETX. AAHN's routing overhead has decreased by 5.82% compared to AntHocNet.

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