Advanced greedy hybrid bio-inspired based shortest path routing algorithm for SDN controller over VANET: issues and challenges

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Abstract. VANET is used for contact between vehicles. There are two ways to do this: communication within the car and communication across stations. It has the links consistency protocol, which is utilized for node communications but isn't good at handling dynamic functions; source routing is pretty static, so it can't be optimized with proactive hop-by-hop communication; route selection isn't done well, and there are times when processing takes too long; this is why the suggested idea of a bio-inspiring algorithm is utilized to fix problems with the current algorithm. In the VANET setting, it is used to cut down on data loss and delay. A new protocol called Bioinspired Routing Protocol finds the best router as well as base station to connect the service requester to the global server. This paper suggests an Advanced Greedy Hybrid Bio-Inspired (AGHBI) routing protocol via a greedy forwarding system to make IoV work better. It uses a modified hybrid routing scheme and bee colony enhancement to choose the best quality of service route as well as keep the path with the least quantity of overflow. The simulations show that the suggested protocol works well in both vehicle-to-vehicle (V2V) as well as vehicle-to-infrastructure (V2I) settings. It also has a big effect on lowering the delay and increasing the number of delivered packets while keeping the overhead and hop count at a reasonable level for all vehicles. SDN, or software-defined networking, is utilized to keep the networking structures stable in VANET sources.

1 Introduction

VANET is the environment that links the cars on the road. For communication, mobile nodes join to form a mobile ad hoc network. If the mobile nodes are vehicles, the network is known as an automotive ad hoc network [14]. It involves creating a network, among cars using communication methods to ensure the safety of those vehicles. Bio inspired routing algorithms communicate with each other within a distributed environment established by SDN (software defined networking) providing settings [6] Vehicle Ad hoc Networks (VANETs) [9] are a subset of Mobile Ad hoc Networks (MANETs) [4] where vehicles similar, to On Board Units (OBU) could function as nodes, for transferring data. The data can vary depending on its usage, such, as checking a vehicles status online, smart navigation

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and rescue routes and preventing cyber operations [10]. V2V and V2I are the two modes of transmission, in VANET allowing vehicles to communicate with each other and, with infrastructure [2] [3]. If the wireless contact mode, between vehicles (V2V) is not accessible the units stationed at the roadside (RSUs) will be utilized instead [3] Assistants are employed to expedite the transfer procedure. The demand, for transforming VANETs into the Internet of Vehicles (IoV) is increasing, aiming to enhance the efficiency and intelligence of future transportation systems [13].This is because of problems with VANETs' accessibility, like their dynamic topology, high mobility that makes them less scalable, and signal losses. Figure 1 show how the IoV network is put together. In IoV, routing is a big problem. It requires new routing techniques that only mobile, unstable nodes can use due to increased mobility and structural changes in the network

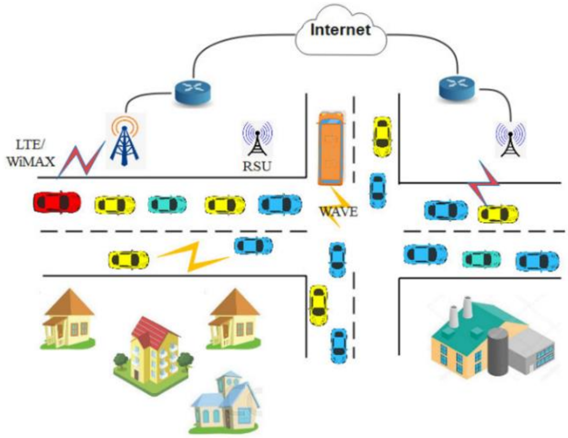

Fig.1 Structure of IoV network.[2]

According [5], Zeadally, as well as Guerrero-Ibanez (2018), the different methods for IoV can be put into four main groups: routing based on topology, routing based on position, routing based on broadcast, and routing based on multicast [12] say that topology-based routing protocols could be broken down into two groups: proactive (table-driven) as well as reactive (on-demand) routing protocols. All of the route information for all linked nodes is kept in tables and changed on a regular basis in proactive protocols [2] The advanced greedy hybrid bio-inspired routing protocol known as AGHBI, which also includes an advanced greedy forwarding system was developed, is suggested in this paper as a way to make IoV work better. The suggested procedure is made up of: 1) A selfish forwarding plan in which each car picks the nearby hop that is closest to its location. 2) The Artificial Bee Colony (ABC) method is used to find the best Quality of Service (QoS) route between cars with the least amount of delay and the highest number of packet deliveries. This is done with a modified hybrid routing scheme. 3) An effective route upkeep system is also put in place. If a link fails, a backup method is used without adding much extra work. [2]

2 Overview of the Proposed Method

Source routing, on the other hand, is pretty rigid, so dynamic hop-by-hop communication can't be used to improve it. Also, route picking isn't done very well, and there are times when processing takes too long. The project's problem statement says that it wants to improve effective routing over the vehicle nodes. VANET is utilized for monitoring as well as communication over the networking medium, while SDN is utilized to set up the network over the media. A bio inspired protocol is a way to make routing over networks more efficient. It is based on how animals find the fastest path between a source as well as a target. It also helps with things like finding the best path and being aware of where you are.

3 Architecture diagram

The following picture shows the steps needed to understand how the modules in the VANET routing system work.

Figure 2 displays the basic setup for networking with SDN and VANET. The three unique planes—security, control, and data—each perform a different stack. The base station is in charge of handling and keeping an eye on the services above. Some of the efficiency measures it has been the error rate, the packet delivery ratio, as well as the end-toned delay. This method works very well for setting up routing over networking channels on vehicle sites.

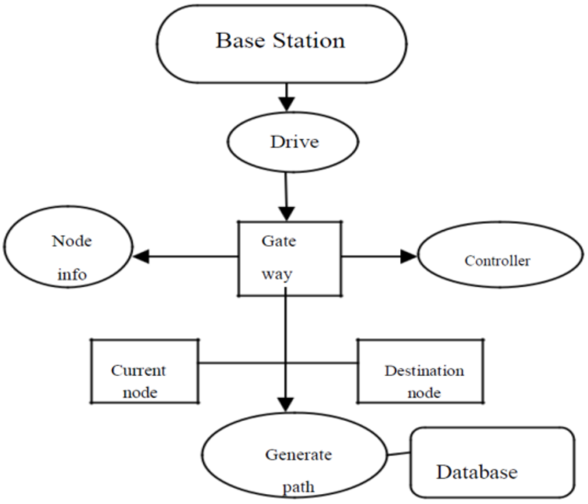

Fig. 2 block Diagram [6]

4 BIO-Inspired Protocol

It is a way of getting the best routing method over the nodes for vehicles. It finds the best way to link via the base station so that it can find the best way to get from the resource to the target. It has service in the form of methods for asking for and answering things. At its core is a normal base station (BS) that responds to service requests from users. This only happens when the car is in a covered region. If it's not in the coverage area, it sends a contact request to nearby cars and tells them how to get from the resource end to the target end. The base station controls how the networking works. The base station is in charge of giving and taking away services from the vehicular node. It has a manager that manages the process and keeps traffic out to ensure the transfer over the medium is safe. This tool is utilized to find the best fitness value over a networking means. [6]

5 Challenges of SDN controller

The controller is the network's brain as well as provides theoretically centralized control, comparable to an operating system. It is a software programmer via many parts that can handle different tasks, such as controlling the network, the flow of data, management, and so on. From a clearly centralized, abstract network view, the controller gives you the tools you need to make programming the data plane devices easier. Because of this, it serves a similar function to a regular working system. There are many technical problems that the SDN controller has to deal with [11][1]; [7]. These include controlling the flow of packets on the fly, placing controllers centralized or distributed and making sure they work together, traffic engineering via a big picture view of the network, keeping the network as well as controllers safe, handling the network's scalability as well as reliability on the fly, and setting limits on performance and latency. Basically, the manager should be able to see the whole network, including all of its assets, structure, data on resource availability, and performance traits. This way, dynamic control can be used to get the quality of service and resilience that are needed. This means that the SDN controller needs to be able to solve a number of optimization problems in polynomial time. Graph theory methods are used in a lot of the current SDN controllers to solve different problems. But speed problems are getting worse as the network gets bigger because there are more data plane devices and network apps. [1]

6 Proposed AGHBI algorithm

This part talks about the IoV routing process, which is made up of two key steps: the Hybrid Route Setup Procedure (HRSP) and the Greedy Road Selection (GRS). GRS is a spread process in which vehicles pick the next road section to travel from a list of multiple criteria that take into account the overall topology of the network. These criteria include the shortest distance as well as the number of vehicles per mile. Figure 3 shows that GRS is applied utilizing a greedy mechanism that guesses a weight value for each section and lets the vehicle choose the next junction on its own. Also, the HRSP is a distributed process that usage the ABC method to find the best way to get to the target by taking into account a number of factors, including the link's expiration time, changing direction, bandwidth, as well as delay.

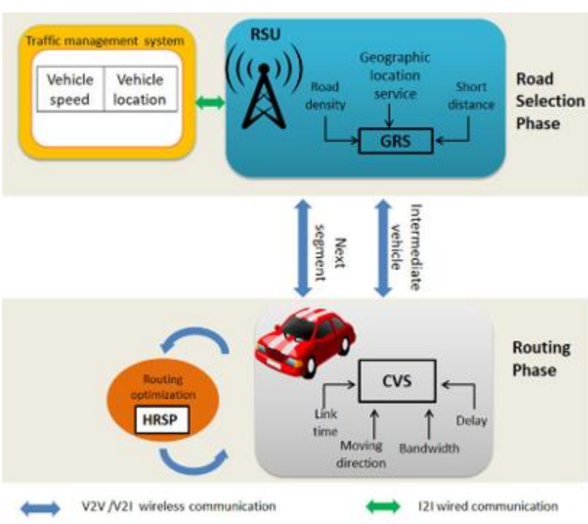

Fig. 3 The general architecture of the proposed AGHBI protocol. [2]

6.1 AGHBI Algorithm Design

When a car node wants to send a data packet, it does the following: Step 1: First, it makes sure that the destination is on the same road segment as the car. If it is, it starts the HRSP process to find the best route to the destination. If it is not, it starts to measure the range to the nearest heading junction (Dh). Step 2: The car uses the HRSP method to find the best route to the next junction if (Dh > ±). If not, it sends a request packet to the nearest heading junction to change the routing process. Step 3: Once the heading junction has switched, it chooses the nearest junction that is closest to the target, just like in Algorithm 1. It then starts HRDP all over again by sending the data packet to the cars in the middle of the road.
These steps are done again and again until the data packet gets where it needs to go.

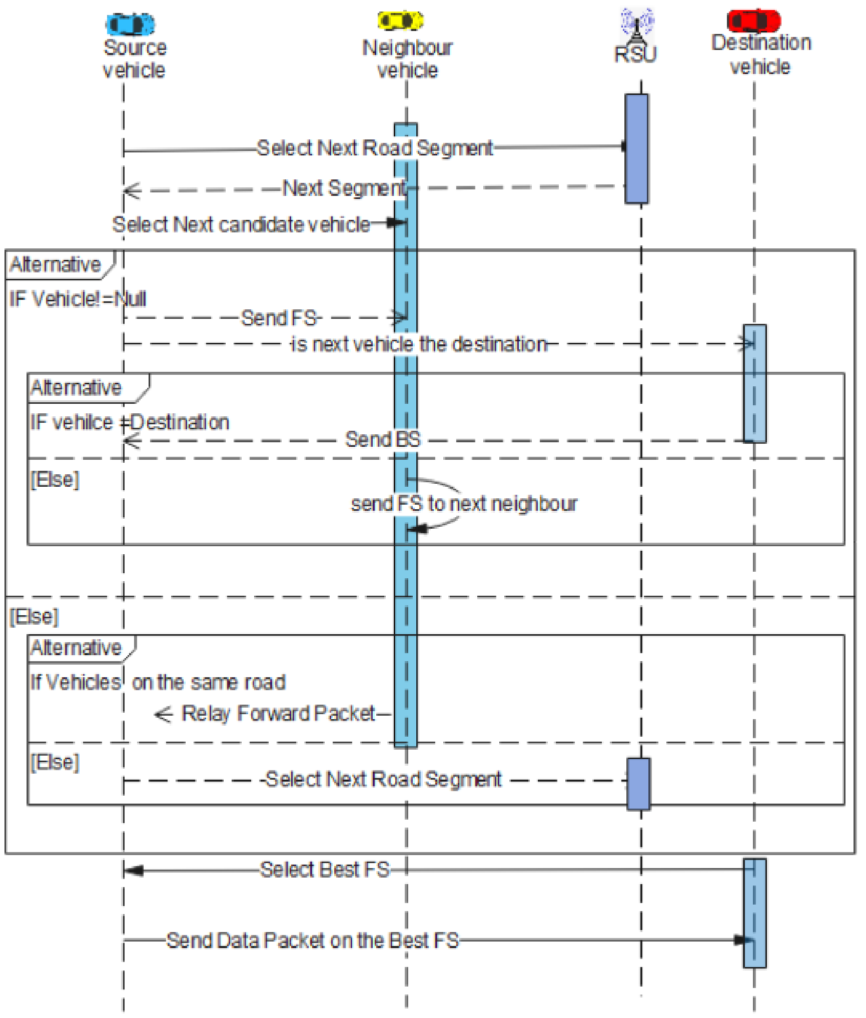

Fig. 4 Structure of the suggested framework for IoV network [2]

7 Performance comparison via difference schemes

This part compares the AGHBI protocol to three other main protocols. The first is AODV [2]. This is a topology-based protocol. When a source node wants to send a packet, it checks the routing table for a route to the destination. If one doesn't exist, it broadcasts a route request packet, and nodes that receive it rebroadcast it until it reaches its destination. The GPSR protocol [15] is based on geography. It works like this: a source or an intermediate node sends the packet in a greedy mode, where the next hop is the closest geographic neighbor to the destination. This process is repeated until the packet gets to its destination. The VSIM protocol [8] is a distributed-based protocol that models routing as a collection of multiple factors using a fuzzy inference system. It has two main processes: selecting road segments and selecting relay vehicles. The road selection process's job is to pick several junctions in a row so that the packets can be sent to their target. The relay selection process's job is to pick relay cars from the chosen road segment. The results were found by changing three evaluation conditions: the scalability scenario (number of vehicles), the mobility scenario (distance between vehicles), and the traffic scenario (speed of data transfer). Each of these is described in more detail below. The given result is the average of 1000 separate runs of the same experiment set up in the same way.

7.1 Performance scalability scenario

Two different sets of protocols are tried with different numbers of cars. The number of vehicles ranges from 200 to 500, and the number of sources is set to 50. Source vehicle picks a target that is a different distance away at random, and every two seconds, each vehicle sends two sets of packets. Figure 5(a) shows that the AGHBI protocol delivers more packets than other protocols. This is because it uses an opportunistic routing method that lets cars choose the next hop without sending too many packets through the network. Once a certain range is reached, the delivery rate starts to drop. This is because a lot of packets are sent at once, which causes network collisions and the loss of many packets. The reason GPSR doesn't work as well as other protocols is thought to be that it only uses the greedy way, which doesn't work well at urban crossings and causes a lot of packets to drop. When compared to the VSIM, AODV, and GPER protocols, the AGHBI protocol increases the number of delivered packets by 7.7%, 13.9%, and 29.7%, respectively. Figure 5 (b) shows that AGHBI has a 39%, 72%, and 61% lower delay than VSIM, AODV, and GPER, in that order. This is because the ABC optimization method used in AGHBI makes the whole way between the sender and receiver takes very little time. The delay goes down as the population goes up because AGHBI always chooses the road parts with the most connections and the shorts distance. When there is low density in VSIM, packets are dropped, which makes the carry – and – forward times longer, which makes the delay longer. The delay for AODV and GPSR gets longer as the density goes up because of the high overhead. In Fig.5(c), the overhead goes up as the number of vehicles goes up. When the network is dense, VSIM's speed goes down because more control packets are sent during the neighbor finding process. With GPSR, the extra cost goes up because hello markers have to be traded to keep track of where cars are at all times.

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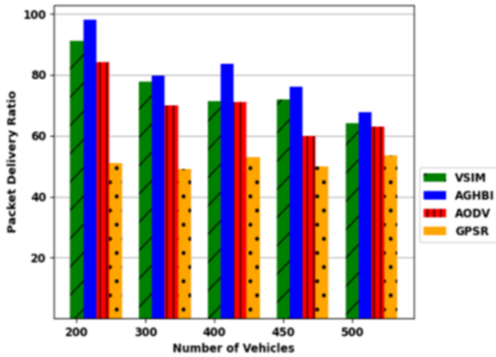
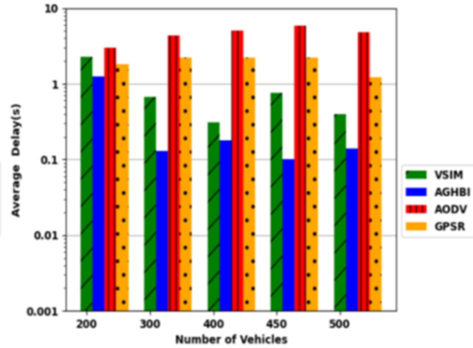
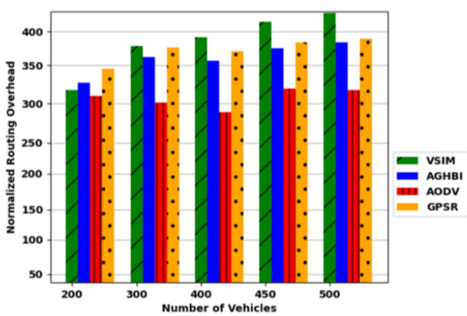


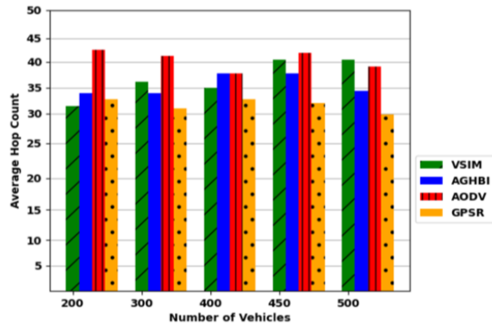
(a) Packet Delivery Ratio 90



(b) Average Delay



(c) Normalized Routing Overhead



(d) Average Hope Count

Fig. 5 AGHBI Protocol [2]

However, AGHBI does better than VSIM and GPSR because it has a better route repair system that uses backups when data links fail. The low number of control bits in the AODV means it uses less overhead. Compared to VSIM and GPSR, AGHBI cuts the cost by 48% on average and 19.8% on average. Figure 5(d) shows that as the number of cars goes up, so does the number of hops. This is because the AODV doesn't have a world view, so it doesn't work as well as the others. The fuzzy method in VSIM slows it down because it chooses many hops to get to its target while still making sure there is a solid communication link. In AGHBI via low density, the number of hops goes up to make sure transmission is stable. Nevertheless, after a certain number of vehicles, the number of hops goes down. This is due to AGHBI chooses links with the fewest number of hops, which also increases the number of packets delivered. The GPSR uses fewer hops than other protocols because it finds the fastest way to send packets to their target by using a greedy method. To sum up, AGHBI lowers the number of hops by 14% compared to VSIM and 39% compared to AODV. [2].

Table 1. List of BIO-Inspired algorithms and applications to SDN Controller [1]

Bio-inspired algorithms	SDN Controller Problems
Ant Colony Optimization / Variants, Bee Colony Optimization, Smell Detection Agent based algorithm	Shortest path among source as well as destination, Disjoint paths from source to destination, Routing, Traffic Engineering, etc.
Particle Swarm Optimization / variants	Controller Placement at optimal position, Link Congestion Management
Firefly synchronization	Distributed SDN Controller synchronisation, Obtaining consensus between data plane instruments as well as network applications
Artificial Bee Colony / variants	Distributed controllers via specific Controller functions, as the network scales

8 Conclusion

An Advanced Greedy Hybrid Bio-Inspired Routing Scheme (AGHBI) is put forward in this work. AGHBI uses two main steps to find the best route for sending data in an IoV environment. First, it uses a greedy forwarding scheme to find the segment that is closest to the destination. Next, It employs a modified hybrid routing strategy as well as an ABC optimization technique to identify the highest quality of service route while avoiding overflow. In simulations, it was shown that the AGHBI protocol works well in large cities and highways. It outperforms VSIM, AODV, and GPSR by approximately 7%, 13.9 percent, and 29.7 percent in terms of packet delivery ratio and 39 percent, 72 percent, and 61 percent in terms of delay, respectively. It also has a lower hop count by about 14% and 39% compared to VSIM as well as AODV, and its overhead is about 48% and 19.8% lower. It involves the ideas of SDN as well as VANET that make use of parts that mimic networking. In later versions, it turns out to be very useful for setting up networking models with the newest apps and technologies.

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