BIO-INSPIRED ROUTING PROTOCOL FOR VEHICULAR ADHOC NETWORKS

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Abstract

Vehicular ad hoc networks are highly mobile wireless networks that are designed to provide vehicle safety, monitor the traffic etc. In VANET mobility of vehicles cause the communication links between the vehicles to frequently be broken. So in order to improve road safety by providing timely and accurate information to drivers various routing protocols have been implemented. We present Bio-inspired routing protocol for VANET. It is based on continuous learning paradigm in order to take consideration of dynamic environmental changes. Hybrid protocol is based on urban as well as rural scenarios which gives road safety services by transmitting packets with minimum delay and high packet delivery ratio.

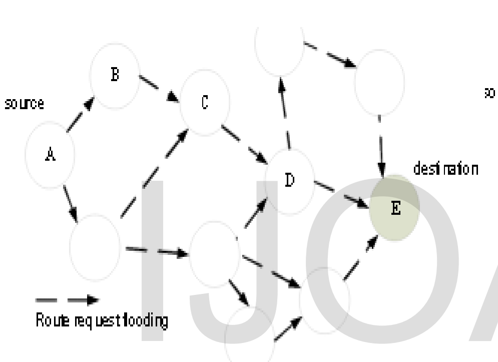
Keywords **:** Geographic information system, intelligent vehicles, Bio inspired computing, routing protocols.

1. Introduction

A Vehicular Ad-Hoc Network is a technology that uses moving vehicles as nodes in a network to create a random node movement network. VANET converts every participating vehicle into a node, allowing nodes approximately 100 to 300 metres of each other to connect and in turn create a network with a wide range. As vehicles moves out of the signal range and drop out of the network, other nodes can join in connecting vehicles to one another so that a mobile Internet is created.The primary goal of VANET is to provide road safety measures where information about vehicle's present speed, location coordinates are passed with or without the deployment of infrastructure communication. Types of vanet are Vehicle to Vehicle communication approach is most suited for short range vehicular networks. It is reliable and provides real time security. It does not required any roadside infrastructure. Vehicle to Vehicle does not have the problem of Vehicle Shadowing in which a smaller vehicle is shadowed by a larger vehicle preventing it to communicate with the Roadside infrastructure. Vehicle to Infrastructure gives solution to longer-range vehicular networks. It makes use of previous existing network infrastructure such as wireless access points. Communications between vehicles and RSUs(road side unit) are supported by Vehicle-to-Infrastructure (V2I) protocol and Vehicle-to-Roadside (V2R) protocol.

In this work we are going to use working principle of AODV as well as GPSR protocol. The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is use for both multicast and unicast routing. It is an on demand routing, meaning that it builds routes between nodes only as desired by source nodes. It keeps these routes as long as they are needed by the sources.

When a source node desires a route to a destination for which it does not already have a route, it broadcasts a route request (RREQ) packet across the network.The Nodes which are receiving this packet update their information for the source node and set up backwards pointers to the source node in the routing tables. Along with addition to the source node IP address, broadcast ID and sequence number, the Route request also contains the most newest sequence number for the destination of which the source node is known. A node receiving the Route request may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to that contained in the RREQ. If in this case, it unicasts a Route reply back to the source. As the RREP propagates back to the source, nodes set up forward pointers to the destination. If the source node receives the RREP, it may start to forward data packets to the destination. If the source receives a RREP containing a greater sequence number or contains the same sequence number with a less hop count, it may update its routing table for that destination and begin using the best route. As long as the route will active then it will continue to be maintained. A route is considered to be active as long as there are data packets periodically travelling from the source to the destination via that path. Once the source stops sending data packets i.e the communication between both node is over, the links will time out and after some time it will be deleted from the intermediate node routing tables. If a link between certain node is break occurs while the route is active, the node propagates a route error (RERR) message to the source node to inform it of the now unreachable destination. After receiving the Route error, if the source node still desires the route, it can reinitiate route discovery to transfer packets.



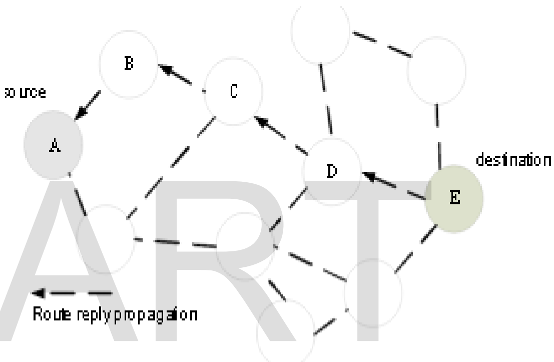
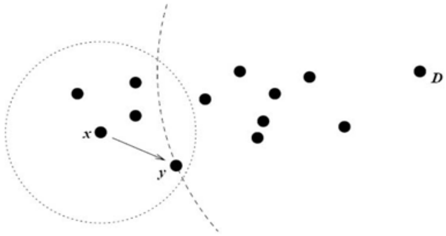


Fig 1. RREQ flooding **Fig 2.RREP propagation**

GPSR is a well known Geographic routing protocol which use the geographic position of the nodes to make their routing decisions, it assumed that every participating node known its own geographical location using global positioning systems(GPS). GPSR makes greedy forwarding decisions using only information about routers immediate node in the network topology. When a packet reaches a region where greedy forwarding is impossible the algorithm recovered by routing around the perimeter of the region by keeping state only about the local topology. GPSR uses the greedy approach to find out the immediate neighbors, which works on the principle that the optimal node is the one which is closest to the destination. An example of greedy next node explained in the figure. Here, x, want to send a packet to the destination D. x's radio range is denoted by the dotted circle, and it forward the packet to y, which is closest to destination D, the process carry on until the packet reaches to the destination. In case of greedy failure or not receiving a beacon from a neighbor for longer than time out interval T, GPSR router deletes the neighbor from its table.Greedy forwarding great advantage is its reliance only on knowledge of only forwarding node immediate neighbors.This helps VANET due to high vehicular mobility. Since each vehicle maintains only local information, these methods can scale to network with large number of vehicles. Here each vehicles are assumed to be equipped with GPS or other location services, so that they can determine their own location without incurring any overhead. The set of all neighbors and their respective locations are discovered using periodic beacon messages that are exchanged among nearby nodes. Since the vehicles do not have global knowledge of the network topology, the forwarding decisions are often locally optimal and may not be globally optimal, as a result protocol leads to dead end. To solve the dead hand problem GPSR proposed the perimeter forwarding algorithm, but it's not as efficient, especially in urban environment.



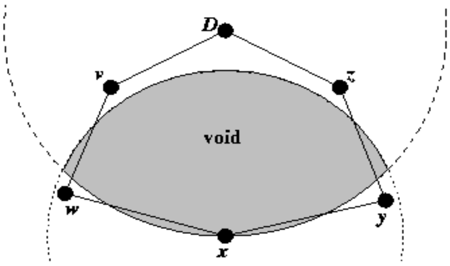


Fig4.Greedy forwarding **Fig5.Perimeter forwarding**

The problems of topology-based and geography- based routing protocols when applied to VANETs are

Topology Based routing approach has Route instability, this is because an established route consists of a set of nodes between the source and the destination that are affected by frequent broken routes in the presence of high vehicle mobility. High routing overhead shared between nodes before transmitting data. It is due to the beaconing and Hello messages used to discover routes, to confirm this discovery and to maintain the paths found. Another limitation of topology-based category is the discovery of routes with a high latency and high transmission delay especially when the network is less dense. These delays are affected by route maintenance operations and repairs when the nodes are mobile.

The geography-based routing approaches can select the longest path through the next hop in terms of geographic distance instead of the shortest one between the current node and the destination. This disadvantage is due to the lack of direct communication between two consecutive nodes due to obstacles caused by buildings, trees, etc. Another disadvantage of geography-based routing algorithms is the use of GPS device which can fail because of various reasons such as the presence of obstacles or the atmospheric conditions which could block the GPS signal. Geographic measurements with commercial GPS receivers showed errors in the reporting of GPS positions, and sometimes packets may get forwarded to the wrong direction causing higher delays or even network partitions. Furthermore, these geography-based routing protocols do not consider real-time positions of vehicles in their decision-making procedure and consider only static roadmap data. Depending on the brand of GPS, updating these static roadmaps data is expensive. This situation often leads to a wrong decision.

To address the drawbacks of topology-based and geography based routing approaches, we propose Bio inspired routing protocol for VANET. The proposed protocol is a unicast and a multipath routing protocol which uses bee routing algorithm.

2. Related work

The recently develop routing protocols are classified into two categories. One is topology-based and another is Geography based.Topology based uses network topology data to connect vehicles where as Geography-based routing uses GPS (Global Positioning System) services to route the packets.

A] Topology Based Routing

Topology-based routing protocols have been applied to VANETs with the IEEE 802.11p standard which allows the transmission range upto 300 m at least in order to make the network more stable.Also, the routes used

to disseminate data between vehicles have a short time of life compared with routes used by MANET nodes. This situation conducts to vehicular network partitioning. Consequently, discovering routes in this case of topology-based routing, the setup of topological end-to-end paths between a source and a destination before sending the packets is the fundamental step. These topology-based routing protocols can be reactive or proactive.
The most common MANET routing protocol that has been applied to VANET is the Ad hoc On-demand Distance Vector (AODV)protocol. The route discovery method of AODV is based on routing tables which store the routes toward multiple destinations. Each destination is indicated using only the next hop node to reach this destination. The source disseminates a Route REQuest (RREQ) to its neighbors which in turn sends the same packet to their neighbors and so on, until the final destination is reached. Once the route request reaches the destination or an intermediate node which knows the path toward the destination, a Route REPlay (RREP) is sent back to the source node through the reverse route. AODV uses a sequence number to discover fresh paths and to prevent routing loops.

In [1]author states that multihop data delivery through vehicular ad hoc networks is complicated by the fact that vehicular networks are highly mobile and frequently disconnected. To address this issue, they used the idea of carry and forward, where a moving vehicle carries a packet until a new vehicle moves into its vicinity and forwards the packet. Being different from existing carry and forward solutions, they make use of predictable vehicle mobility, which is limited by traffic pattern and road layout. Based on the existing traffic pattern, a vehicle can find the next road to forward the packet to reduce the delay.The author propose several vehicle-assisted data delivery (VADD) protocols to forward the packet to the best road with the lowest data-delivery delay. The results show that the proposed VADD protocols outperform existing solutions in terms of packet-delivery ratio, data packet delay, and protocol overhead.

Salim Bitam[2] a topology-based bee swarm protocol
called Quality of Service Bee swarm routing protocol for VANET (QoS Bee VANET) was proposed. It is a reactive, multipath, QoS routing protocol designed for VANETs. Its main idea was inspired by the biological paradigm of communication between bees when searching for food. This protocol searches routes from the source to the destination using a request route packet called forward scout. This control packet is created and cloned by the source node to be launched to a limited number of nodes in the neighborhood (transmission range area) of the transmitter. In other words, only a percentage of source neighbors received the forward scout. this protocol guarantees QoS requirements such as end-to-end delay, throughput, and the packet delivery ratio. However, QoS Bee VANET can flood the network by control packets especially if any link fails.

In Al-Rabayah and Malaney [2], the authors proposed a new routing protocol called Hybrid Location-based Ad-hoc Routing(HLAR) protocol that combines a modified AODV protocol with a greedy-forwarding geographic routing protocol. HLAR is a reactive protocol in which the source includes its location coordinates and those of the destination vehicle in a Route REQuest (RREQ) as in AODV. If the RREQ packet reaches the destination vehicle, the destination replies with a Route REPly (RREP). The intermediate vehicles are allowed to locally repair broken routes through a Route RePair (RRP) packet instead of just reporting a broken route to the source vehicle. RRP packet repairs link failures caused by vehicle mobility potentially leading to an increase in the routing overhead and degradation in network scalability. The simulation results obtained with HLAR demonstrated good scalability and optimal overhead even in the presence of high location errors. However, HLAR is very close to AODV and the geographic aspect can be better exploited to reduce the average end-to-end delay.

B] Geography-based routing

Geography-based routing protocols have also been applied to VANET. They are also called position-based routing protocols in which the node positions are used to route data between vehicles. They perform a recovery strategy to overcome the void case when there is no routing progress based on nodes' position data. A strong feature of these protocols is that the packets are routed to the destination without the knowledge of the network topology or a prior route discovery. In contrast, the source should determine its own position in addition to the position of the destination.

Josiane Nzouonta[5]in this paper presents a class of routing protocols called road-based using vehicular traffic (RBVT) routing, which outperforms existing routing protocols in city-based vehicular ad hoc networks (VANETs). RBVT protocols leverage real-time vehicular traffic information to create road-based paths consisting of successions of road intersections that have, with high probability, network connectivity among them. Geographical forwarding is used to transfer packets between intersections on the path, reducing the path's sensitivity to individual node movements. For dense networks with high contention, we optimize the forwarding using a distributed receiver-based election of next hops based
on a multi criterion prioritization function that takes nonuniform radio propagation into account. Author designed and implemented a reactive protocol RBVT-R and a proactive protocol RBVT-P and compared them with protocols representative of mobile ad hoc networks and VANETs. The results in urban settings show that RBVT-R performs best in terms of average delivery rate, with up to a 40% increase compared with some existing protocols. In terms of average delay, RBVT-P performs best, with as much as an 85% decrease compared with the other protocols.

In[4] paper author proposes a new position-based routing protocol for such metropolitan bus networks, which makes use of street information like street map and bus route information to identify a stable geographic route with high connectivity for data delivery. Furthermore, the proposed protocol can cope with partitioned networks and route messages across partition boundaries. The simulation result shows that it achieves significant performance improvement compared other similar routing approaches.

3. Biological computing

Biologically inspired (biologically-inspired) computing is a field of study that loosely knits together subfields related to the topics of social behaviour,emergence and connectionism. It is also closely related to the field of AI(artificial intellegence), as many of its performance can be linked to machine learning. It depends heavily on the fields of biology, computer science and mathematics. It is the use of computers to design nature, and simultaneously the study of that network to improve the usage of computers. Bio inspired computing is a major subset of natural computation. Some areas of bio inspired computing and their biological counterparts:

- genetic algorithms:-evolution
- emergent systems:-ants, bees
- artificial immune systems:- immune system

Bio-inspired computing is based on decentralised approach; bio-inspired computing often involve the method of specifying a set of simple organisms, a set of simple rules which adhere to those rules and a method of iteratively applying those rules. There After several generations of rule application it is usually the case that some forms of complex behaviour occour.The complexity gets built upon complexity until the end result is something markedly complex and quite often completely counter intuitive from what the original rules would be expected to produce.For designing of this protocol we consider swarm intelligence concept i.e bee swarm routing.

Swarm Intelligence is the property of a system whereby the collective behaviors of agents interacting locally with their environment cause coherent functional global patterns to combined Individual insects function much like simple computing devices – they execute simple procedures based upon the input, causing them to obtained some output at any given time, an individual insect is merely reacting to stimuli in its immediate surroundings. Global cooperation emerges as a result of two phenomena. First one is each species is genetically pre-programmed to perform an identical set of procedures given the same stimuli set. Second, by performing these procedures implicitly modify their environment, creating new stimulation for themselves and those which are around them. This phenomenon via changes to the environment is called stigmergy

Bee routing protocol

A honey bee colony has many features like efficient allocation of foraging force to multiple food sources, foragers evaluate the quality of food sources visited and then recruit optimum number of foragers for their food source by dancing on a dance floor inside the hive, they have no central control, they make decision without global knowledge of the environment. They perform two type of dances. They are "Round Dance" **-** When food source is < 50 meters from hive and "Waggle Dance" **-** When food source is > 50 meters away. Consider each node in the network as a hive. There are three types of agents: packers, scouts, foragers.

Packers: Packers mimic the task of a food-storer bee. They always reside inside the node, receive and store the data packets from the transport layer.

Scouts : Scouts discover new routes from their source node to their destination node. A scout is transmitted using the broadcasting principle to all the neighbors of a node with an expanding time to live timer (TTL), which controls the number of times a scout could be re-broadcasted. Each scout is seperately identified with a key based on its id and source node.

Foragers: It receives the data packets from packers and then transport them to their destination. Each forager has a special type: delay or lifetime. The delay foragers collect the delay information from the network while the lifetime foragers collect the remaining battery capacity of the nodes that they visit.

4.Proposed system

When communication end-points are not within their respective radio transmission range, how is it possible to obtained communication between two vehicles or between a vehicle and a roadside base station which satisfies the constraints imposed by road safety applications? To address this challenge, we propose Bio-inspired routing protocol. It is a protocol that combines geographic routing based on Global Positioning System (GPS) to establish routes, with topology-based routing which discovers paths using network topology data.

In order to overcome the drawbacks of topology-based and geography based routing approaches, we propose the design protocol called Bio-inspired routing protocol for VANET. Our protocol is a unicast and a multipath routing protocol which guarantees requirements of VANET safety applications, placed as stringent requirements such as end-to-end delay, packet delivery ratio. This protocol will provide stable and reliable routes between the source node and the destination node with an reduced delay, increased packet delivery ratio and low routing over The biologically inspired algorithms have its applications in various fields for optimisation. The idea is to design a system to efficiently route packets in VANETs to distant locations . Our objective is to optimize the system by using the features of the biologically inspired optimization algorithms.heads. such as end-to-end delay, packet delivery ratio .

5.Conclusion

This paper gives brief idea about VANET and its existing protocols in topology-based and geography-based networkAccording to the drawbacks of these protocols we propose a hybrid routing protocol which can be more suitable for urban as well as rural scenario.It gives the ideas of using the biologically inspired algorithm in vanet.

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