차량 통신망에서 Angle 우선순위를 가진 Forwarding 프로토콜

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요 약

Greedy 프로토콜은 일반적으로 VANETs에서 좋은 성능을 보인다. 그렇지만 일시적으로 거리를 비게 만드는 교통신호가 존재하는 구간이나 분리된 도로가 합류하는 지점이 없는 urban의 도로에서 지형적인 영향으로 greedy 라우팅 프로토콜은 잘못된 경로 라우팅된 경우 불필요하게 경로가 길어지거나 라우팅 실패로 나타난다. 기존의 Greedy 라우팅 프로토콜은 단순하게 목적지 노드와의 직선거리를 가지고 노드들의 우선순위를 부여하고 가장 낮은 값을 가진 노드를 중계노드로 선택한다. VANET에서는 지리적인 환경의 특성 때문에 거리뿐만 아니라 전달 방향도 중요하다. 제안된 방법에서는 하나의 노드가 패킷을 전달할 때 목적지 노드까지의 거리와 함께 전달 방향을 고려하여 다음 노드를 선정하여 보다 안정적인 경로 설정을 할 수 있고 지형 모델이 따라 변경이 가능하다. 제안된 방법의 성능은 두 가지의 이동모델을 적용한 네트워크 시뮬레이션을 통하여 검증하였고 대부분의 경우 기존 프로토콜보다 좋은 성능을 보였다.

Forwarding Protocol Along with Angle Priority in Vehicular Networks

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ABSTRACT

Greedy protocols show good performance in Vehicular Ad-hoc Networks (VANETs) environment in general. But they make longer routes causing by surroundings or turn out routing failures in some cases when there are many traffic signals which generate empty streets temporary, or there is no merge roads after a road divide into two roads. When a node selects the next node simply using the distance to the destination node, the longer route is made by traditional greedy protocols in some cases and sometimes the route ends up routing failure. Most of traditional greedy protocols just take into account the distance to the destination to select a next node. Each node needs to consider not only the distance to the destination node but also the direction to the destination while routing a packet because of geographical environment. The proposed routing scheme considers both of the distance and the direction for forwarding packets to make a stable route. And the protocol can configure as the surrounding environment. We evaluate the performance of the protocol using two mobility models and network simulations. Most of network performances are improved rather than in compared with traditional greedy protocols.

Key words : Greedy Border Superiority Routing, Adaptive Neighbor List Management, Vehicle Ad-hoc Networks

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1. Introduction

A new type of wireless access protocol is released for communications between infrastructures and mobile vehicles. That is called Dedicated Short Range Communication (DSRC)[1], and is dedicated to Vehicle-to-Vehicle (V2V) Vehicle-to-Infrastructure (V2I) communications. It supports very high mobility and low latency. The ultimate object of DSRC is to improve the overall vehicle safety. DSRC is assigned on two bands; the first is the 900MHz band, the other is the 5.9GHz spectrum. The main research focus of DSRC is centered on the 5.9GHz band.

These days, the trend of vehicular technology has been changed from mechanical performances to high technologies. Most of people expect rather high gas-mileage and better safety than high power from brand new cars. Therefore, the current design points are moved into safety, usability, and efficiency of them. When a wireless communication is available between vehicles, various new services can be introduced to the vehicular networks for vehicle safety and passenger convenience[2]. If these services are successfully applied to the real world environment, the occurrence rate of traffic accidents is significantly decreased and passengers can take various commercial/non-commercial services on their cars while travelling.

Cars on roads can form a Vehicular Ad Hoc Networks (VANETs) with DSRC devices. The VANETs have some different features with Mobile Ad Hoc Networks (MANETs)[3], since it is supposed that the networks are configured on very high mobile environment, and nodes' movement are restricted on roads. Owing to the differences, MANET protocols such as AODV [4], OLSR [5], and DSR [6], are not appropriate for VANETs. However, geo-graphical routing protocols are particularly efficient on highly dynamic environment. Using geo-location information, packets are greedily forwarded to the vehicle bringing the maximum progress toward the destination node.

Most well known geo-location routing protocol for vehicular environment is Greedy Perimeter Stateless Routing (GPSR)[7]. Packets are forwarded using a greedy forwarding in normal cases. The greedy method is known for a sub-optimal way to forward packets to a specific location [8, 9]. In some situations, a node cannot forward a packet using greedy way because the node get stuck in the local maximum [7], and then the packet is handed over an appropriate next relay not in greedy position. This is called the perimeter routing in GPSR and is a kind of recovery mode.

The greedy protocols show good performance in downtown areas in big cities where there are many nodes on roads. But the protocols are not fit for urban areas in which few cars only are moving around since nodes meet the local maximum frequently. In order to carry out a greedy strategy successfully in the areas, greedy protocols need to be modified to adapt to the environment. When a node make a decision for forwarding a packet, the node takes into account the direction of the direct line between its location and the destination location. Packets are forwarded toward converged direction to the destination-direction.

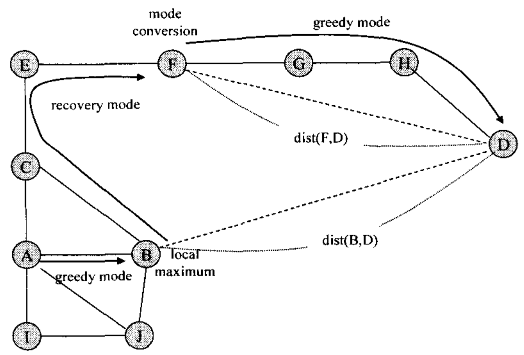
In this paper, we propose an angle priority based greedy routing protocol for VANETs. The proposed protocol chooses the next node taking into account both of the distance to the destination and the direction to the destination. The forwarding route made by the proposed method is drawn along the direct line between the source node and destination node. We measure the performance of the protocol by using network simulations and two patterns of vehicular mobility.

The rest of this paper is organized as follows : Section 2 provides related work, and addresses about the problem of traditional protocols, specifically GPSR. Section 3 present our main idea of greedy forwarding protocol along with angle priority. Section 4 explains mobility models and simulation parameters, and provides simulation results. Finally, we conclude this work in the Section 5.

2. Related Work

GPSR [7] algorithm is a kind of position-based routing, where a routing node forwards a packet to one of its neighbor node which is geographically closer to the destination node among the neighboring nodes. That is called greedy forwarding. In order to select a next relay node among the neighbor nodes, each node makes use of location information on the neighbor list. To do this, it assumes that each node needs to be aware of its own location, the location of neighbors. A node obtains its location from a location device such as, GPS device, and acquires the locations of neighboring nodes by means of HELLO beacons. It also assumes that a source node obtains the location of the destination node from a global location service [10] which supports a location registration and lookup service that maps node addresses to locations. The scope of GPSR is limited to geo-graphic routing. For developing our protocol, we use the same assumptions as the GPSR protocol.

The GPSR protocol which make a routing decision depending on local information include a recovery mode in order to escape from the local maximum situation [7]. In other words, a node holding a packet to forward cannot find a proper forwarder being closer to the destination than itself. In order to recover from this local maximum, this protocol forwards the packet to backward with respect to its distance to the destination node. The packet will be continuously detoured until it reaches a node whose distance to the destination node is closer than the former recovery node. When the packet reaches the node, the mode of the packet may be resumed to the greedy mode. (Figure 1) describes the brief operations of GPSR. Node *A* forwards a packet to Node *B* through the greedy mode. But the packet gets stuck in the local maximum on Node *B*. In order to escape from the local maximum, Node *B* forwards the packet to Node *C* which is a backward node after writing its location in the packet header. Nodes receiving the packet extract



(Figure 1) GPSR routing modes in a local maximum the location of the former recovery node and the destination node from the packet header, and compare the distances. When the packet arrives at Node *F*, the distance *dist (F, D)* is shorter than *dist (B, D)* and then the packet's mode is changed into the greedy mode again.

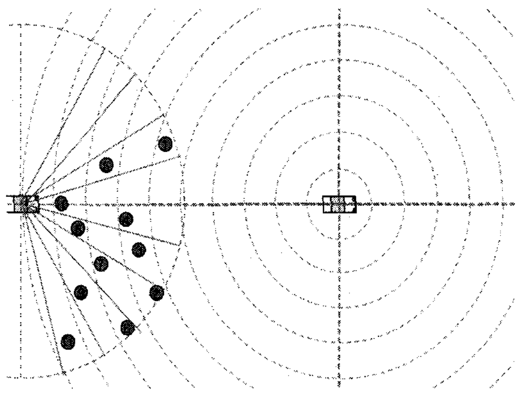
Many recovery algorithms [7, 11, 12] have been proposed to solve this problem. GPSR recovers from the local maximum by means of a perimeter mode. In the perimeter mode, a node makes a planar network graph, which is a neighboring node topology graph without crossing links. To get the planar network graph, GPSR employs either Relative Neighborhood Graph algorithm (RNG) [13] or Gabriel Graph algorithm (GG) [14]. The node selects a vertex from the graph using a right-hand rule. This rule states that when a node first enters into the recovery mode, its next forwarding hop is the node that is the minimum included angle toward counterclockwise to the destination node. Afterwards, the next hop is sequentially counterclockwise to the previous node until the packet reaches a mode conversion node. Whenever a node has a packet to forward in the recovery mode, the generating of planar graphs is performed at the each node and involves much processing cost.

3. Greedy Forwarding Protocol along with Angle-Priority

The most important point of greedy routing protocols is that the current node selects the most suitable next node among its neighboring nodes. The proposed method makes use of both of the distance to the destination node *D* from a neighboring node *N*, *dist (D, N)*, and the deflection angle toward node *D* from node *N*, *angle (D, N)*. The forwarding priority value *val(N)* is calculated by below Equation 1, where D means the destination node *D*, *N* means each neighboring node of the current node, the value a satisfies $0 \leq a \leq 1$. A node which has the minimum *val(N)* is selected as the next forwarding node.

$$val(N) = a \times dist(D, N) + (1-a) \times angle(D, N) \quad (1)$$

In order to implement the protocol we apply the different a values for downtown area and urban area. The α is larger than 0.5 in downtown areas where there are many nodes and detour roads is less than 0.5 in urban areas where the direction is the most important information in order to mitigate the influence from the distance. We make use of 0.75 in downtown area and 0.25 in urban area for a. We call our protocol as Greedy Forwarding Protocol along with Angle Priority (GPAP), since the proposed scheme utilizes both of the distance and angle priority.



(Figure 2) Nodes' distances and angle priorities

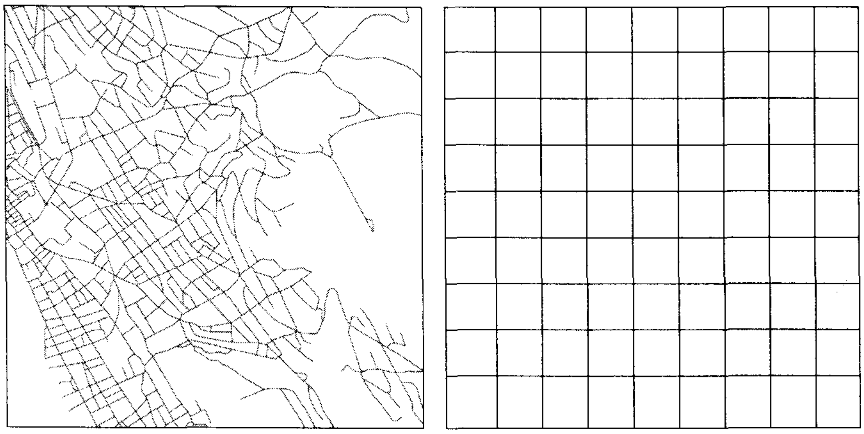
(Figure 2) shows the selecting order of the current node to the destination node. The neighboring nodes are assigned a number from 1 to 11 by the distance to the destination. The number 2 is not better than number 4 even though the number 4 is farther than number 2 when we compare the number 4 node with the number 2 node. If the vehicles are in an urban area, the number 1 node is not the best next node because the node is located on a little bit away from the direct line between the current node and the destination node. Packets are apt to be forwarded wrong route in this case. We can change the a value for configuring sensitivity of the distance and angle priority as changing environment.

4. Performance Evaluation

4.1 Mobility Models and Network Simulation Parameters

The simulations are implemented using the NS-2 (version 2.33) simulator [15]. We simulate both GIS and Manhattan mobility model to evaluate the protocols. To get real mobility patterns, Generic Mobility Simulation Framework (GMSF) [16, 17] is applied for our research. The area size of both mobility models is 3000m×3000m. (Figure 3) shows the road topologies used for generating the mobility traces. The map for the GIS model is located in the downtown area of Zurich, Switzerland.

The GIS mobility model applies the car-following model where cars do not overtake front cars and the traffic light model where cars follow traffic signal at intersections, and utilizes the real map. It includes both macro- and micro-mobility features. Each node either accelerates or decelerates as its situation. The node follows the speed limitation of each road segment. The Manhattan mobility model applies the car-following model and the stop-sign model in order to include both macro- and micro-mobility features. Each node stops at the intersection for a while and either accelerates or decelerates as its situation too. The



(Figure 3) GIS city and Manhattan mobility model maximum speed of nodes limits by 15m/s (54km/h). If a node reaches a border line, then the node returns to the area in the both mobility models. So, the number of nodes is not changed during simulations.

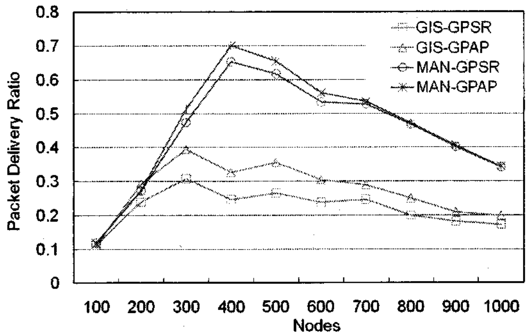
〈Table 1〉 Network simulation parameters

Parameter	Value
The number of vehicles	100~1000 nodes
The network traffic loads	10% of CBR source Interval 200ms
The packet size	512 byte
MAC protocol	IEEE 802.11 MAC
MAC transmission rate	2 Mbps
Transmission range	300m
HELLO beacon interval	1 second
Simulation time	300 seconds

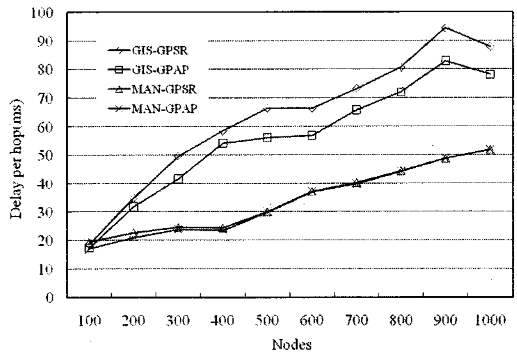
The parameters for the network simulation are listed in <Table 1>. 10% nodes are randomly selected as Constant Bitrate(CBR) source nodes and each source node generated a 512 byte packet every 200ms until the simulation was finish. Every experiment makes use of the same mobility model and different network traffic models. We get the average values after simulating 5 times with different network traffic models. The prefix (MAN- and GIS-) of protocols means the mobility model used for the simulations in the results.

4.2 Experiment Results

Because GIS and Manhattan mobility models are quite different, the packet delivery rates of each model are showed separately. Packet deliver failures were mostly occurred by packet collisions, especially with HELLO beacons. Sometimes routing protocol dropped packets due to TTL when the node density was relatively low. (Figure 4) shows the packet delivery ratio of both GIS model and Manhattan model. In Manhattan mobility model, two protocols showed a little difference because most packets forwarded with the greedy mode. In GIS mobility model, there were a lot of recovery modes. Because GPAP shows better performance in recovery mode, GPAP got better performance than GPSR in GIS model.



(Figure 4) The end-to-end packet delivery rate



(Figure 5) The delay time per hop

(Figure 5) shows the average delay time per hop. The hop delay of GIS model was higher than Manhattan model because of frequent retransmissions along with frequent packet collisions. Many nodes were intensively distributed in some area in the GIS model. Although the delay performances of both GPAP and GPSR protocols were almost the same in Manhattan model, the delay of the GPAP protocol in GIS model achieves lower than the GPSR protocols as 5~10ms. Because the recovery modes were not broke out frequently, the delay performance showed similar in Manhattan model.

5. Conclusion

In this paper, we have presented a new scheme for greedy routing which takes into account angle priority to improve routing performance both of Manhattan model and City model. When a node selects the next node simply using the distance to the destination node, the longer route is made by the protocol in some cases and sometimes the route ends up routing failure. Each node considers not only the distance to the destination node but also the direction to the destination while routing a packet. It turns out more stable routes. The proposed routing scheme improves the end-to-end packet delivery rate while other performances are kept similar. With GBSR, routing protocols could get a higher packet delivery ratio, lower delay as shown in the simulation results.

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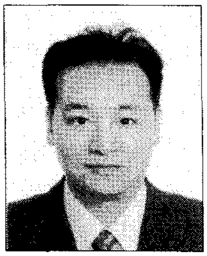

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