Vehicle location service scheme based on road map in Vehicular Sensor Networks

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A B S T R A C T

Vehicular Sensor Networks (VSNs) are merging for supporting communications between roadside sensor nodes and vehicles on for notifying environment events on roads to drivers and passengers. Geographic routing has been considered as an efficient and scalable approach to send sensing data from sensor nodes to vehicles. Fundamentally, geographic routing requires sensor nodes to be aware of the location information of vehicles. Since sensor nodes are deployed around roads and vehicles move on the roads, this field property of VSNs brings about a challenging issue to provide location service of vehicles. In this paper, we propose a quorum-based location service scheme to provide sensor nodes with the location information of vehicles in VSNs. For providing the location service, the proposed scheme exploits a crossing point between a quadrangular path quorum of a location update and a line path quorum of a location query by using the road map information. Then, the proposed scheme is extended to accommodate several considerations such as voids, multiple vehicles and sources, and energy depletion. The effectiveness of the proposed scheme is analyzed and validated by extensive numerical and simulation results.

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1. Introduction

Nowadays, vehicles have been demanded a lot of information about roads around them for their safety and convenience, and a great number of sensor nodes have been developed to detect events around them. According to this situation, Vehicular Sensor Networks (VSNs) are recently merging for supporting communications between roadside sensor nodes and vehicles on roads [1,2]. In VSNs, roadside sensor nodes detect environmental events on roads and send reporting data to vehicles which are interested in such events. A lot of applications from emergency warning to road monitoring have been introduced for VSNs [3]. For example, in a damaged road detection application, sensor nodes detect the damaged roads and send the information such as the location of the damaged roads to road management vehicles.

In VSNs, data communication patterns are from sensor nodes to vehicles [2,4,5]. Until now, a great number of routing protocols have been proposed in wireless sensor networks and vehicular ad hoc networks [6]. Such routing protocols are generally categorized into a topology-based routing approach and a geo-

graphic routing approach. The topology-based routing is known to be efficient in a small and static network due to the management overhead of the network topology to find routing paths. In VSNs which consist of a number of sensor nodes and mobile vehicles, the geographic routing has been considered as an efficient, simple, and scalable routing approach since it exploits pure local location information instead of global topology information to route data packets from sources to destinations [7,23]. Fundamentally, the geographic routing in VSNs requires sensor nodes to be aware of the location information of vehicles which are intended as destinations.

Many researches have been studied to provide source nodes with the location information of destinations in ad hoc and sensor networks [8]. They can be categorized into a flooding-based location service approach, a hash-based approach, and a quorum-based approach. Especially, a quorum-based approach [9–12] has been proposed for (1) solving the large control overhead of flooding-based approach, (2) solving the hash function and server management overhead of hash-based approach, and (3) providing the location service in the network of irregular shape. The quorum-based approach exploits crossing points between a location update quorum and a location query quorum for providing location service. However, the existing quorum-based location service schemes have problems and limitations in VSNs because they ex-