INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Survey on Cooperative Positioning Impact In Vehicular Ad Hoc Network

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Abstract:
The concepts of Cooperative Positioning (CP) impact have been introduced to potentially improve the accuracy of vehicle information of location and the capability of CP under real world vehicular communication suppressed is largely unknown. Vehicle location information is progressively for several road safety applications. To give the impact for positioning information is the key to better forecast of such warning systems, because inaccuracy will cause failure during an emergency. This paper is totally based survey on cooperative positioning in vehicular ad hoc network which reveal that the frequent interchange of large amounts of range information data required by existing CP schemes, the collision of packet rate of the vehicular network but reduces the efficiency of the CP technique. To improve GPS positioning perfectly for Radio-ranging or rating based cooperative positioning (CP) has been considered one of the delicate promising approaches. The aim of CP is to allow nearest nodes to work together to collectively increase the accuracy of their location. The according of ad hoc of vehicular interaction makes it natural to stretch out existing CP technique into Vehicular ad hoc networks.

Key words: *Cooperative positioning (CP), vehicular ad hoc network (VANET), and range information exchange*

1. Introduction

In the automobile industry had worked on an improved crash warning system for nodes, which will use directly in wireless communication in vehicles to periodically interchange the location or speed, or any other kinematic information for predicting potential crashes. To give the impact for positioning information is the key to the good fortune of such warning systems, because inaccuracy will cause failure to warn a driver during an emergency. The primary plan to prevail positioning information in between vehicle node was to use mercantile grade Global Positioning System (GPS) receivers. However, it was afterward established that the 5–10 m approximately of mercantile GPS will not be very effective for crash warning or other safety awareness [1]. In another case the centimeter-level correctness of professional-grade receivers and transmitters, for e.g., real-time kinematic (RTK), cannot readily be applied in an urban environment [2]. This environment case has sparked development in developing solutions that can improve mercantile GPS positioning perfectness in vehicular networks.

To improve GPS positioning perfectly for Radio-ranging or rating based cooperative positioning (CP) has been considered one of the delicate promising approaches [3]. This type of CP is attractive for vehicular networks, because the sufficient rang (or the inter vehicle distance) information can readily be calculated from the periodic exchange of location information that is helps for the crash warning system. If a cluster or group of cluster vehicles can divide amongst each other their inter vehicle distance dimensions through the Dedicated Short-Range Communications (DSRC) [4] links, DSRC can then use actual CP algorithms based on multi late ration or tri-late ration technique [5] to the next improvement of their actual position estimates.

One problem arises with CP in vehicular networks is that the constant interchange of very big amounts of range method information over a shared dedicated short range communication control panel can create repeatedly packet collisions, therefore decreasing the probability of a packet, which also divides the same channel that is fortunately received. This division of channel condition will not only affect the performance of safety applications, but also decreases the effectiveness of CP algorithms. The interaction overhead of cooperative positioning may not be a problem in not heavily tight traffic scenarios, but it cannot be ignored for dense urban traffic conditions, where a big number of vehicle nodes are within their interaction ranges and can potentially interfere with each other's transmissions and receivers.

Some researchers acknowledge the issue of interaction overhead for CP in vehicular ad hoc networks [3], but a brief investigation of this problem seems not to available in the literature survey. The main orientation of this paper is to examine the impact of range data, information interchange overhead and recognize the mechanisms for minimization CP in dense vehicular networks in terms of improving the positioning absolute or relative in nature and decrease the packet collision rates. This paper contributes work following two keys.

- It is experimented that the scenario that is used by existing distributed CP algorithms are within a limit, because a distributed cooperative algorithm cannot make use of all range data information that is received by a vehicle node due to the hard clustering rule. By stretching to the existing CP framework is proposed to make more optimized use of all interchanged range information, hence improving the performance of CP technique.
- It is experimented that interchanging range information by using easy protocols that primarily collect ranging measurements within a safety interval and forwarding these measurements in the next interval succeed small correctness gains but results in higher packet collision rates. Protocol improves the proposed, which are shown not only to decrease the packet collision rate, but to improve the positioning perfectness at the same time of collision.

However, recent further studies [6] suggested that the recent current vehicular positioning system enhancement, such as GPS, is not providing sufficient positioning perfectly to encourage the required reliability of vehicular safety appliances. To resolve that issue, the intention of using cooperative positioning (CP) in vehicular ad hoc network is attracting growing research interests. By going through the periodical broadcasts on DSRC, every vehicle node is able to recollect the global positioning data information of the nearer vehicle. In the time between, inter-vehicle distance can be measured by using some radio-based ranging methods [7]. Therefore, every node may leverage the GPS and distance calculations of the neighbor's node to calibrate its own relative position, by using the cooperative localization algorithm.

Various general notions and intention of applying CP in vehicular ad hoc network have been expectedly discussed in various works [2] –[4]. This research basically focuses on the localization positions algorithms of CP in VANET with the consideration of an ideal interaction framework, within every vehicle node can always detect all its neighbors' vehicle. Therefore, due to the hidden vehicle node, signal fading and interference issues, packet transmissions and receivers in vehicular communications are known to be without loss processing. However, a vehicle node may fail to capture position some of the neighbors' vehicle when packets transmitted from them are for gated. This decreased the amount of available neighborhood data, because affecting the position accuracy in CP. In [8], in these sections already discussed the implementation of packet loss on the perfection of CP. However, the characterization of CP enhancement under the unrealistic DSRC communication framework is still lacking in the literature.

This paper is organized as. In Section II we review the survey of related work of CP in VANET and the positioning bound error and localization constraints on CP performance. Section III describes the impact of cooperative positioning and analyzes the communication effect in VANETs. Section IV, concludes this paper and gives the future work.

2. Related Work

For vehicular localization CP techniques have been proposed several ranges-independent. For example Assisted Global Positioning System (A-GPS) [2] used as vehicular application. This method very much involves communications between two nodes with the vehicles and fixed or mobile reference nodes with known positions. A ground-based augmentation system (GBAS) provides reference node augmentation information such as the measured common positioning error at or near a location. Through the reference nodes with communications, a vehicle node uses information of the augmentation to overcome its own position estimate. However, these infrastructures heavily rely on the support from the range-independent CP approaches. In this condition, these techniques commonly have stringent requirements for the received GPS signal quality, low multipath wrong corrections and the visibility of multiple (at least four or five) GPS satellites, which are not viable in dense urban area's environment. Other possible paths of softer the GPS error taking by using a Kalmar filter that combines the GPS and the vehicle's kinematics information and the inertial navigation system (INS)/GPS integration coverage area. However, the perfectness to improvement that is provided by this technique is still not sufficient for disaster crash warning or other vehicular safety applications.

In a wireless sensor network (WSN) and mobile ad hoc network (MANET), the location recognition issue with range measurements is often tackled by tri-late ration and multi late ration to some fixed or mobile beacons (nodes with known location such as GPS satellites). The inter vehicle node distance is commonly calculated using radio-ranging or range-rating methods in spite of the time of arrival (TOA), time difference of arrival (TDOA), Doppler shift [9]-[10], carrier-frequency offset (CFO), received signal strength (RSS), and round-trip time (RTT) [9]. Because a vehicular ad hoc network (VANET) is a basic form of mobile ad hoc network, priority works implementation have proposed to adopt the range-based CP methods in VANETs.

Cooperative positioning was considered for positioning perfection improvement and localization environment. In some techniques such as those discussed in [8], [9] position data of the vehicles are available and accuracy development is succeed with cooperative positioning. The methods, located in [10], [11] use some GPS technique nodes for localizing the other vehicle nodes. In these considerations, some important problem such as typical ranging techniques and their pressure on the algorithm and the computational overload of centralized algorithms were not examined.

To decrease the reflecting rays effects to the GPS positioning perfections, Drawil and Basir [11]–[12] propose a distributed cooperative method that relies on the ranging data in a target vehicle node and its neighbors. In their scenario, a vehicle recognition requiring a more perfect position estimate sends request messages to its neighbors for the communication. Every nearest vehicle responds with its GPS position result and the associated uncertainty of the calculation. The last target vehicle measures the distance calculation to all the neighbors (ranging data) upon receiving for the send back response messages. At the last, the final target vehicle's position recognition is tri late rated used by the neighbor vehicles' GPS relative estimates and range data information in an algorithm that contain the associated GPS error uncertainties. A same work is proposed in [13] to the exact position of the vehicles nodes without GPS or that knowledge outage of GPS signals. Therefore, the stress of these principles is to allow each separate vehicle to achieve most prefect or accurate positioning for a GPS signal. These principles were not produced design to improve the vehicle position accurate estimations of the neighbor vehicles at the same interval. In fast random moving vehicles on VANET environment, the safety applications for instant acquisition of positions of neighbor vehicles are very important, e.g., cooperative collision warning (CCW) [6]. For example, when an impending robust ahead is reported, CCW wants the environment vehicles' positions in an area and kinematics data information to make the decision to warn apply brake or the driver to change lane [14]. In wireless sensors [5] and ad hoc networks, there are several experiments of research, which address the issue of simultaneously position localizing a more no of nodes that form a cluster. The cluster-based that is group based CP methodology has been stretched out to VANET localization. The cluster-based CP approaches are also specifying on inter vehicle distance calculations. Every vehicle constantly measures the repeatedly distances to their nearer vehicle node using the radio-ranging methodology. Then, vehicles interchange their own states position, i.e., vehicle kinematics, GPS measurements, calculations, and inter vehicle range rate estimates evolution, in the neighborhood vehicles. On this basic information, every node compiles CP algorithms to distribute the positions for the full cluster of vehicles using popular data fusion techniques such as least mean square error (LMSE), Kalman filter, extended Kalman filter, and particle filter. Although the above mentioned works purpose various potential CP algorithms, the interaction effects of interchanging the range data that are required by CP are often ignored. In a basic previous work, we allocated the effect of packet loss on CP performance method. In this paper, our focus is to survey on comprehensively the CP efficiency with respect to realistic interaction constraints.

3. Impact of Cooperative Positioning

Cooperative Positioning was basically developed for the location determination within sensor networks and wireless ad hoc networks. Perverse to non-CP techniques, where every node specific estimates its own position or location, the aim of CP is to allow nearest nodes to work together to collectively increase the accuracy of their location. The according of ad hoc of vehicular interaction makes it natural to stretch out existing CP technique into Vehicular ad hoc networks. The famous CP technology [8] in vehicular ad hoc network is shown in Fig. 1. The CP process relies on the following two fragments of information: 1) the unknown or rough judgmental location (e.g., from the GPS) and 2) the distance calculation of the neighbor vehicles and inter vehicle distance measurements among neighbor vehicles. In general, using CP in VANETs is a three major step distributed-process, including range and vehicular information calculation, information interchange, and the final Position. In the next part, we briefly mention the essentials of using CP in vehicular interaction. Next, we derive the localizing accuracy bound of network CP using the Cramer–Rao lower bound (CRLB) [3].

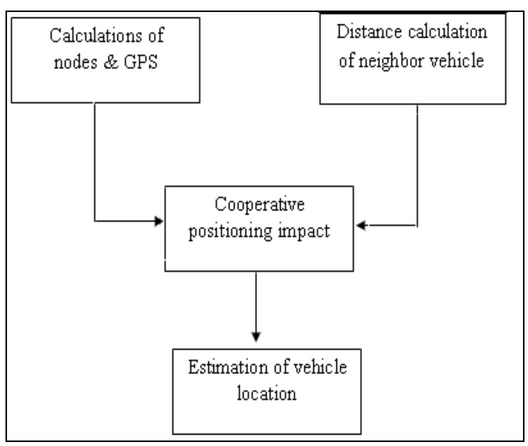

Figure 1: Framework of Cooperative Positioning

3.1. Computation Phase

The basic performance in the computation phase is for each node to assemble the following information: 1) its GPS node information and 2) distance calculation to its one-hop neighbor's vehicle. A vehicle can compute its kinematics information, as estimation of vehicle, heading, velocity and acceleration without any difficulty from the GPS or on-board kinematics sensors. For the distance calculation, range-rating techniques and the radio-ranging technique and, e.g., TDOA, RSS, TOA, Doppler shift, RTT, and CFO, can be prowess. The viability and practicability of these techniques are mentioned in [5] and [7] and are not the main task of this survey. In this survey paper, we assume that the range calculation can be made available with a suitable technique. As soon as a packet is received from a neighbor, vehicles can appraise the distance using ranging techniques as follows. We take an example, node vehicle in Fig. 2(a) estimate the distances between neighbors' and itself p, q, r and s after packets are received from them. The output of the computation phase is the vector range (RV), which consists of the accumulation of the range data to all nearest vehicle.

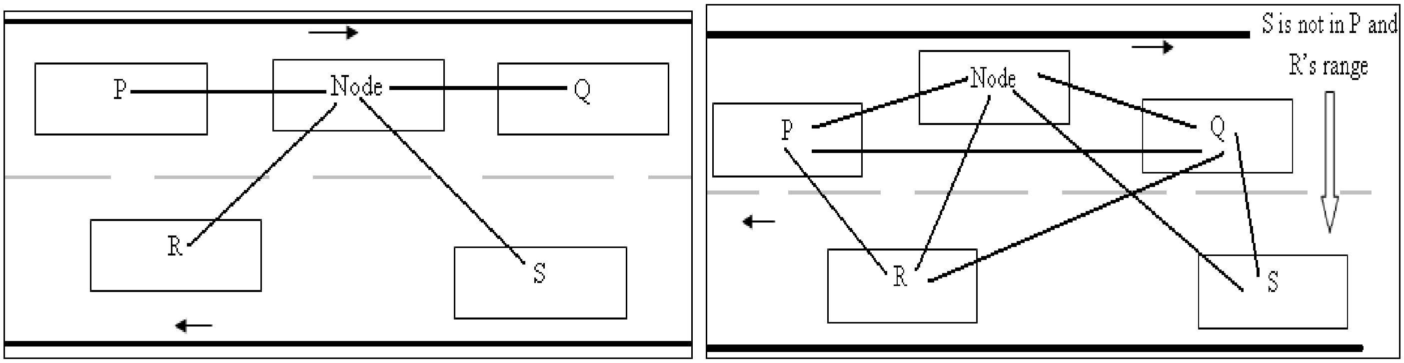

Figure 2: Computation and Exchange of Range Data
(A) Maintaining the Vector Range
(B) Creating the Matrix Range after the Vector Range Exchange

3.2. Exchange Phase

In this section, every vehicle node broadcasts its own VR and node movement information to its one-hop neighbors through Dedicated Short Range Communication (DSRC) links. The local kinematics movement information is congenital embedded in the periodic safety data broadcast. For sharing information regarding the range in the neighborhood, each vehicle broadcasts its VR regularly. These received VRs and vehicle movement information acts as an input to the Position process.

3.3. Position Phase

In the position phase, a distributed CP algorithm [1] is employed to generate more perfect Location estimates of neighbor vehicles within the aggregation. A set of vehicles forms an aggregation; aggregation contains all the distance calculations between the vehicles. And from the received VRs individual vehicle learns its own aggregation. In the example, Fig. 2(b) shows an exemplary example of the aggregation. Consider that vehicles q, r, s and node are within each other's transmission range rating. While the computation phase is going on, individual vehicle gains distance between it and other vehicles. So, node receives all VRs from each one of the neighbors' own aggregation of vehicles when the exchange phase is done. Because entire range computation between q, r, s and node are known to node, it identifies the aggregation of four vehicle nodes. Similarly, q, r, and s can identify the same four-vehicle aggregation. Enlist that, in this example, although node can receive the VR from the extra vehicle which is not in aggregation s, s is not in node's aggregation, because s is outside the transmission ranges of vehicles q and r. For s, the aggregation that is explored only consists of the following three vehicle nodes: 1) s; 2) r; and node. As soon as the aggregation luster is determined, the range matrix is formed by the range computations within the aggregation of vehicles.

The Range matrix as well as the reported vehicles' kinematics then act as inputs to the CP mechanism. The conception is to increase the location estimates of each vehicle node using these inputs based on multi alteration or tri- alteration principles [2]. Many more such CP mechanisms' have been proposed in the literature [1], [6], [8–[9].

3.4. Discussion

In vehicular networks the concept of the CP is especially attractive, as the efficiency of location/positioning of vehicle is normally expected to increase as the density of the vehicle increases [14]. Notwithstanding, the high-speed kinematics movement of vehicles creates a challenging environment for CP mechanism. The very dynamic environment overcomes to rapid progress in topology evolution, frequent network fragmentation and short link life wireless. Therefore, by using the CP techniques to track the updated progress network topology in real time, range information needs to frequently be interchanged among the nearest vehicles. The intensity range, rating data information to interchange over the shared DSRC control channel line not artificially introduces significant communication overhead into the vehicular ad hoc network. In this case unavoidable contaminate the congested conditions and impacts the reliability of the interchange of safety packets that are transferred over the shared control channel line. In these circumstances can performance of safety, vehicular applications and ultimately adversely affect the reliability of vehicles [6]. However, when the wireless channel line is congested, the VR packets are also used to loss. This concept potentially reduces the aggregation size and leads to degraded CP algorithm accuracy. In the literature survey most work is based on simulation, simulation study would also show that frequency range, rating information, data interchange has a significant impact on not only the reliability of safety communications but as well as on the CP performance.

By taking some information, the absolute aggregation based CP algorithms depend on the full range matrix, where all pairwise information data in between vehicles within an aggregation range is captured. The range information data are simply discarded from the calculations where vehicles that do not belong to the cluster. In the example, Fig. 2(b), the VR from s is out of range by node, because s is not consisting in the aggregation of vehicles. In this condition, node misses the potential favorable time to further increase the localizing accuracy by leveraging the extra range information data that is available from s. In the literature, they will find how using the extra range information data can effectively improve the CP performance accuracy in vehicular networks.

3.5. CP For Positioning Accuracy Bounds In Vehicular Networks

The errors from GPS position and inter vehicle ranging basically edict the accuracy of CP. The CP efficiency can also get affected due to the technique for estimating the position in CP. For evaluating the accuracy of CP the standard approach used is to calculate the CRLB in ad hoc network. The CRLB represents the lower bound for the deviation of any unbiased estimations and is the inverse of the Fisher information matrix (FIM). So, for appraising the CP performance the CRLB can be used as the benchmark disregarding of the position estimation technique that is used. To evaluate the CP performance in VANETs we develop a CRLB model.

In this section we discussed about the accuracy of positioning, here assume a simple zero value mean normal distribution for GPS-based localizing and errors of radio ranging information [14]. The normality consideration on GPS error is practical in the cases of highway and opens space scenarios implementations which are totally base on simulation setup. We acknowledge that this consideration may not be always applicable in urban areas due to the location and time varying multipath, interference, refraction and dilution of precision (DOP) effects on the GPS signal [11]. Some researchers say that, the real world distribution of location error in urban area scenarios may be better preferable modeled as a Gaussian mixture model (GMM). In that CP technique will be implemented fusing low level GPS data which is done in low range. So in our future work we increase the range of GPS positioning by communicating the vehicles to each other.

In summary, we gave a survey on cooperative positioning with the help of GPS and CP is to help a nearest optimal localizing accuracy, which cannot be suitable for low range under ideal communication channels, with minimal overhead by exploiting proper improvement of the techniques.

4. Conclusion

We have surveyed the impact of CP communication overhead in vehicular wireless networks. We have found that, unless we find efficient ways of interchanging large amounts of range information over the urban areas are not suitable for a large range because of range attenuation vehicular communication channels; CP may not provide a viable option to increase positioning accuracy in large range. In our CRLB model the normal GPS error distribution with a constant standard deviation.

In our future work, we plan to extend the range of positioning accuracy in large range using nearest vehicle node and CRLB model and by communicating the vehicles using more advanced realistic GPS error models that are more appropriate for urban scenarios.

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