Extended Abstract: Improved Data Dissemination Techniques for Vehicular Communication

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***Abstract* — With the rapid development of urbanization, the tendency of road accidents is also highly increasing due to heavy traffic. Most of the victims give up their lives because of the insufficient infrastructure of emergency information distribution to the proper authorities and lack of critical care on urgent basis. Therefore, it becomes very essential to configure a mechanism for delivery of emergency messages timely across the network to a specific end user in order to deal with such kind of disasters efficiently. Research goal in this doctoral program address the improvement of data dissemination techniques for Vehicular Ad-hoc Networks.**

Keywords—RSU placement, Obstacles, Vehicle-to-roadside communication, Forwarding node, Delaunay Triangulation, Intelligent Transportation Systems.

I. Introduction & Motivation

Vehicle communication has presently been an admired research issue. As vehicular ad hoc networks are acquiring popularity day by day, a large number of researchers are exploring in this area. By taking advantages of these networks a large number of vehicles can take right decision by utilizing the information they have. The main basis of Vehicular Ad-hoc Networks (VANet) is to develop intelligent transportation system (ITS) by providing support for traffic protection, collision caution, advice of lane change, danger caution, and better navigation. IEEE 802.11p is standardized for vehicular communications which are supported on dedicated short-range communications (DSRC) technology which functions at 5.9-GHz band and offers higher data rate up to 27Mbps [1]. The main components of VANet system are Roadside Units (RSUs), On-board Units (OBUs) and Application Units (AUs). An OBU is a Wireless Access in Vehicular Environment (WAVE) device usually mounted on board through which a vehicle can exchange information with RSUs or with other OBUs. The AU is a device equipped within the vehicle which runs applications that can utilize the OBUs communication capabilities. The RSUs are a WAVE devices which are installed along the road side or in dedicated locations. The backbone communications are take place using the RSUs.

Having a safe journey by the road is one of the major concern in today's busy life. Due to road accident an approximate 1.25 million deaths per year happened worldwide according to the World Health Organization [3]. That is, one person is killed every 25 seconds. Whatever the reason may be, it is most important to distribute emergency information regarding accidents to the proper authorities like nearby traffic control unit, hospital or fire-brigade, so that a prompt action can be taken on priority basis for managing such disasters and saving lives. Recently, vehicle communication has become an important research issue in order to develop an Intelligent Transportation Systems (ITS) [4]. Traffic safety, accident reduction, guidance of lane change and improved navigation are supported by ITS.

II. Related Research

In this thesis, improved data diffusion technique for Intelligent Transportation Systems are the focal points. The two main objectives of this doctoral program is – *A. RSUs deployment in an urban scenario with obstacles for maximizing communication probability between V2I* and *B. potential forwarding node selection for efficient communication in an area with obstacles.*

A. RSUs Deployment Strategy to Cover a Convex Region with Obstacles

In vehicular communication Roadside Unit (RSU) is an essential element for collecting and analysing traffic data given from smart vehicles. Due to their deployment cost and product cost, RSUs need to be deployed optimally moreover in an urban area with obstacles. There exist many researches where they proposed several RSU deployment strategy [5-13] but a number of issues still remain unsolved. The main challenges of this work are:

1. The RSUs need to be installed in such a way that each OBU can communicate with at least one RSU directly.

2. Network coverage is another important factor in VANet Scenario. The RSUs have to be installed in such a way that there should not have any uncovered region.

3. The RSUs need to be installed in an urban area where obstacles are present. Due to the obstruction from buildings, other construction or water land, the possible area for RSU deployment is scrappy.

4. The region which is chosen for RSU installation is not always in general geometric shape like rectangle or square; it may be a convex region.

5. Another challenge is reducing the communication delay between V2I.

B. *An overview of forwarding node selection mechanisms*

Frequent topology changes and unpredictable velocity of vehicles are important characteristics of VANets. A stable next node selection strategy for data dissemination is a challenging issue for source vehicle. There exist many researches where they proposed several relay node selection mechanism for efficient communication [14-21] but there is some limitations. In summary, routing limitation for VANets in urban scenario includes:

1. No measure for physical obstacles like buildings or other roadside constructions that may affect the radio propagation.
2. Lack of an efficient mechanism to forward the data in an appropriate direction towards the destination which may increase the end-to-end delay.
3. Lack of forwarding node selection technique that may lower the network performances.

III. Proposed Solution

The methodology of RSUs deployment to cover a convex region with obstacles for maximizing communications probability between V2I can be summarized as follows:

1) At first, identify some initial points on the edge of the target area and the obstacle vertices.
2) Then performs a Constrained Delaunay Triangulation procedure with those initial points with some predefined condition which is described in [22] to have the valid Constrained Delaunay Triangle.
3) RSUs initial position are find out after getting the valid CDT.
4) Then to find out more significant position for RSUs placement an optimization method is applied based on RSUs cost and end-to-end delay to communicate with the nearest RSU.
5) Then to reduce the communication delay between V2I an optimal multi-metric RSU selection strategy is introduced which is elaborately described in [22].
6) Extensive simulations are carried out with different scenario map, different number of RSU, different vehicle density, different vehicle flow to verify the effectiveness of the proposed method by comparing with existing methods.

The methodology of forwarding node selection for efficient communication in VANet can be summarized as follows:

1) An obstacle avoidance shortest path finding mechanism towards the destination using Delaunay Triangulation (DT).
2) The shortest path is optimized by removing redundant Torricelli point inside the DT.
3) Forwarding zone calculation along that optimized shortest path obtained from the previous step.
4) Fuzzy rule – based best forwarding node selection mechanism is introduced on that forwarding zone to have the best potential node to forward the data, which leads to efficient communication between source to destination with lesser delay. For this three input fuzzy logic system is introduced here, these are – distance, relative velocity and SIR value between packet carrying node and next forwarding node [23].

IV. Evaluation

The Simulation Scenario & Parameter Set-up of the above mentioned two works has been described in [22] & [23] respectively. For evaluating the usefulness of the proposed approach [22], as compared to the baseline algorithms - GeoCover algorithm [24] and a-coverage algorithm [25], the following performance metrics are considered - packet delivery rate, packet loss, end-to-end delay, throughput and jitter. The proposed method has been tested by varying the RSUs number, vehicle density and vehicle flow. The method has been tested as well in other three scenario – Manhattan map (simple scenario), Erlangen (medium scenario) and Rome (complex scenario). Effect of RSUs cost has been studied as well in [22]. In order to assess the proposed method in [23], AODV, DYMO, LAR and SMRP protocols [2] are considered as the baseline algorithms. The performance of the proposed technique has been studied by varying the vehicle number and vehicle velocity as described in [23].

V. Conclusion

The first work of this doctoral program presents a novel technique for deploying roadside units in an urban scenario with obstacles. Most of the existing methods studied so far are capable to work only in an obstacle free area. Some placements are based on hot-spot or intersection priority. The proposed algorithm also considers an arbitrary map with obstacles and try to maximize the coverage area as a whole. In addition to the RSUs placement strategy, a multi-criteria decision making RSU selection strategy has been introduced here for efficient communication between V2I with less delay. The impact of the proposed method is tested by varying the vehicle density, vehicle flow and RSU cost. To verify the portability of the proposed technique, it has been tested in four scenarios (Manhattan: Simple map, Ottawa's downtown area and Erlangen: Medium map and Rome: Complex map). All the simulation results indicate that the solution outperforms the existing methods in respect of PDR, end-to-end delay and packet loss. The simulation results also investigate the throughput and the jitter and provide suitable results for the same. While tested is a simple map with less number of obstacles, it gives better results as compared to a medium or complex map. Because of the simplicity of the map, the RSUs can be placed effectively. Less effect of urban canyon leads to a better connectivity. And thus, the proposed algorithm reflects better results in simple map than a medium or complex map.

The second work of this doctoral program presents a robust forwarding node selection technique for efficient data dissemination in urban vehicular ad-hoc networks, aiming to improve the throughput and packet delivery ratio. At first, an optimized shortest path finding technique is introduced from source to destination using Delaunay Triangulation, Torricelli points and Dijkstra algorithm. Then a forwarding angle is applied in that path to identify the best forwarding zone. Finally, fuzzy logic is applied to find out the best potential forwarding node within that forwarding zone to forward the packets efficiently. The proposed protocol shows an improvement of about 9% in packet delivery rate, about 11% improvement in throughput, about 9% reduction in hop-count and about 23% reduction in end-to-end delay as compared to the existing methods. Surprisingly, from simulation results, it has been found that at 50 km/h speed, the proposed protocol gives the best performance and beyond that speed the network performances are decreasing. Because, if the vehicles are moving faster than 50 km/h, it fails to forward the packet to the efficient neighbor vehicle due to high vehicle movement.

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