Improving VANET Performance with Heuristic and Adaptive Fuzzy Logic Scheme

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Published online: 1 March 2015
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Abstract Rapid topology change in vehicular ad hoc network (VANET) is common due to the inherent high mobility nodes and unpredictable environments in VANET. In order to ensure efficient packet transmission, nodes in VANET should react adaptively to topology change in VANET. In this paper, we present a new heuristic and adaptive fuzzy logic scheme (HaFL), which adapts the contention window size and transmission power according to network and traffic conditions. The current existing schemes in VANET utilize only a single parameter to optimize the contention window and transmission power without consideration on the effects of interference as one of the main factors in VANET transmission degradation. In VANET, packet loss can occur at different stages of transmission due to interference or due to elapsed time. In the proposed HaFL, fuzzy logic is used to adaptively optimize the contention window size based on three parameters namely collision rate, SINR and queue overflow which represent packet drop at different stages of transmission. Transmission power which is usually a static parameter is also optimized with consideration on the effects of VANET interference in the proposed HaFL. The performance of the proposed HaFL is evaluated in Vehicles in Network Simulation with

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road traffic simulator, Simulation of Urban mobility. Simulation results show that the proposed HaFL demonstrates adaptability with improved throughput, low end-to-end delay and higher packet success rate in comparison with the default IEEE802.11p and existing schemes.

Keywords   VANET · Contention window size · Transmission power · Fuzzy logic · Optimization

1 Introduction

Vehicular adhoc network (VANET) brings a revolutionary leap to our roadways by creating communication awareness among drivers on the road to ensure safety. Statistics in [1] show that a large amount of road accidents are caused by incorrect decisions made by drivers due to failure to anticipate hazardous conditions on the roads, blocked line of sight by preceding vehicles and bad weather conditions. With VANET, hazardous conditions can be shared amongst road drivers to ensure that they are well informed on the road ahead and thus, preventive measures can be taken to avoid accidents by giving early warning to the drivers. In a typical VANET scenario, nodes move in high mobility with no prior information on the locations of neighboring nodes. In addition, VANET is prone to rapid topology change. The aforementioned factors contribute to the increase of packet collision and packet delay, which prevent VANET from sharing information amongst drivers. The main purpose of VANET is to create awareness amongst drivers to ensure safety on the road. Therefore, a failed or a delayed packet transmission might cause loss of lives. VANET efficiency can be increased if the delay in VANET is kept at minimal and throughput is high to ensure packets are successfully delivered in time.

Challenges in VANET have been discussed extensively in [2], with examples showing the effects of hidden terminal and the dynamic nature of VANET. Various work, Hafeez [3] and Danda et al. [4] have been proposed to solve the challenges of hidden terminal and dynamic nature of VANET. In [4], collision rate is used to set the contention window size whereas transmission power is adjusted based on the transmission range calculated. In [3], a novel Distributed Multichannel and Mobility Aware Cluster-based MAC Protocol (DMCMAC) is used to alleviate the impact of hidden terminal issues.

Hidden terminal in VANET occurs when two stations are too far away from each other to sense their transmissions. Thus, both stations detect that the medium is idle. If both stations simultaneously attempt to send to a third station located in between, their transmissions are interfered and packets are dropped. In view of this, the hidden terminal effects should be alleviated as it causes a major drawback in VANET. Due to the dynamic nature of VANET and with the consideration that packet drop can occur at different stages of transmission, we propose to use several parameters to ensure accuracy in measurements in evaluating traffic conditions before contention window size and transmission power are optimized. In order to solve hidden terminal issues, according to the best of our understanding, a joint optimization of contention window and transmission power with usage of several parameters from different layers namely SINR, queue length and collision rate to accurately optimize the contention window size and the usage of SINR to optimize transmission power based on the surrounding interference caused by vehicular and non-vehicular objects have never been carried out. The main contributions of this work are as follows: