Proposed System for Road Traffic Optimization with Virtual Traffic Light (VTL) Technology

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Abstract

Large cities suffer from traffic congestion, especially at intersections, due to a large number of vehicles, which leads to lose time and increase carbon emissions in addition to fuel consumption. Therefore, we need to optimize the flow of vehicles to improve traffic at intersections and reduce these challenges.

Traditional traffic lights have been used to improve traffic flow at intersections, and have been improved to become more efficient by using algorithms and some of sensors and cameras, but they also face some challenges such as high installation, operation, and maintenance costs.

To improve traffic flow at intersections and solve challenges at a lower cost, this study will focus on developing a new mechanism that combines a proposed system and virtual traffic (VT) technology to reduce lost time, and to reduce vehicles travel time. It also reduces the costs of installation, maintenance and operation of traditional traffic lights, where signals are displayed on screen inside the vehicle instead of traditional traffic lights.

This study relies on the intelligent management of the intersection, where each vehicle approaching the intersection sends a message containing its data to the roadside unit, then the roadside unit selects the vehicle that has priority to pass and allow it to leave the intersection alone, then after the vehicle leaves the intersection, it signs out from the intersection by sending a message to the roadside unit. Our proposed system contributes on many aspects to improve the control of the intersection: the first contribution is traffic control on the intersection evaluated per vehicle not like other techniques which based on cycles or timers for each lane. The second contribution is dividing vehicles into three types to control the intersection according to the priority weight we assigned to each type. the third contribution is signing in and sign out with the road side unit as a

communication steps to update the database continuously in order to make the decisions based on the traffic current state. The fourth contribution we defined the conflict lanes in order to prevent accidents and find what other vehicles can be permitted to cross the junction at the same time without interference.

To evaluate our system and compare it with other works, four scenarios were presented, each scenario used a different number of vehicles of three types (emergency vehicle, public bus, private vehicle) with each type given different priority and assuming a maximum speed of 70 km/h for all vehicles. Then each scenario was implemented by integrating two programs simulators (OMNeT++) and (SUMO), after that importing and building two frameworks (VEINS) and (INET) to prepare a suitable working environment.

After applying the proposed system to the four scenarios and comparing the results with the traditional traffic light system, the proposed system shows an improvement in the average waiting time for vehicles about (90.04% - 90.17%) and reduce the average travel time for vehicles about (44.43% 49.76%).

The proposed system also improves the average waiting time for the emergency vehicles by about (96.63% - 97.63%) at the intersection, and improves the waiting time for public buses by about (94.81% - 97.23%). It also improves the waiting time for the private vehicles at the intersection by about (87.14% 89.71%).

These results prove that the proposed system has improved the management and coordination of the flow of vehicles at the intersection.

Keywords: Virtual Traffic Lights(VTL), Vehicle-to- Roadside unit(V2R), Smart Vehicles(SV), Intelligent Traffic System(ITS).