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Designing a control system for traffic lights by VANET protocol

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Abstract

In this paper, VANET protocol is used to reduce traffic jams and accidents on the roads. The proposed algorithm is dependent on the wireless network between cars. The system is part of a wireless control node located at the intersection, which determines the optimal values of the phases of traffic lights. The protocol used in this research provides traffic fluency when compared to adaptive systems based on the use of cameras. It has also been developed as an integrated system validation simulator. The simulation framework consists of a realistic vehicle navigation model and a wireless network simulator. The proposed system designed as a work system that can be analyzed for peak hours and we got acceptable results. Average delay, fuel consumption and pollution are significantly reduced.

Keywords: VANET; Control System; Traffic Light.

1. Introduction

In fact, when the first traffic lights were installed at the Cleveland intersection in 1914, the sole objective was to prevent accidents by showing the right way without giving any benefit to reducing traffic delays, pollution, and fuel consumption. Over time, traffic volumes were increased and goals expanded to include maximizing the capacity of the road system and improving traffic flow [1]. To go further in this regard, we proposed a simulated environment that interacts with peak hours making the connection between the cars and the central administration as well. The

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nodes (cars) are interconnected by exchanging data to determine the best route to take to their destinations in a fast and less consuming way. Dedicated Vehicle Network (VANET), a form of a dedicated mobile network, is used in this paper to establish short-range communications (DSRC) between nearby vehicles (V2V communications) and between vehicles and infrastructure equipment located nearby Roadside Equipment (V2I Communications) [2]. Since physical cars are not used, we used Java scripting to mimic my proposed work. The reason for developing the environment simulator is to design a traffic light system for the intelligent management of an entire city. There are some algorithms that propose the VANET technique, the study [5] is a proposed system that uses a global positioning system in vehicles to detect and distribute traffic jam information, that system is called COC, which used VANET protocol. This system depends on and distributes three types of information: raw, density, and congestion zone. Higher levels contain aggregate information. In the study [6], proposed a new VANET crowding detection system. Smart Street uses aggregation as a data-aggregation method to combine unusually related, slow-speed data. Smart Street uses aggregate algorithms that run across a distributed network where each node investigates the statistics collected and eliminates the need for a central entity. The aggregation process can be defined as a composite process that contains data points; these points have similarities with each other using many types of scales. In [7] proposed a traffic estimation system depended on the road segmentation and focusing on the complex inner city, some of these systems rely upon, expressly or implicitly on the presence and place of all vehicles in the current traffic jam determine the presence and location of congestion.

2. Methodology

We will design a traffic light system for the smart management of the city. The traffic light management system uses the Vehicle Dedicated Network and Vehicle to Infrastructure (VANET-V2I) protocol; the receipts are used to help collect traffic data from roads and streets by computing each vehicle built by a mobile device that supports a VANET connection; then the collected data is forwarded to the local base station. Then the management system will make the best decision to manage the traffic.

1. We have assumed that all or most vehicles in the city have a mobile device running on the VANET protocol to send and receive information with the receiving devices with a unique identifier.
2. To distribute the receiving devices in regular places. We use an Omni antenna [3].
3. Each area has a station called a Sub-Base Station (SUB-BS).
4. Recipients from each region are connected by SUB-BS.
5. All SUB-BS stations are connected to the main base station MAIN-BS.
6. The MAIN-BS consists of an Omni-antenna, a database center and a processor

responsible for making decisions to control traffic lights by calculating vehicle rates for each street. Figure1 shows the interaction between the units [4].

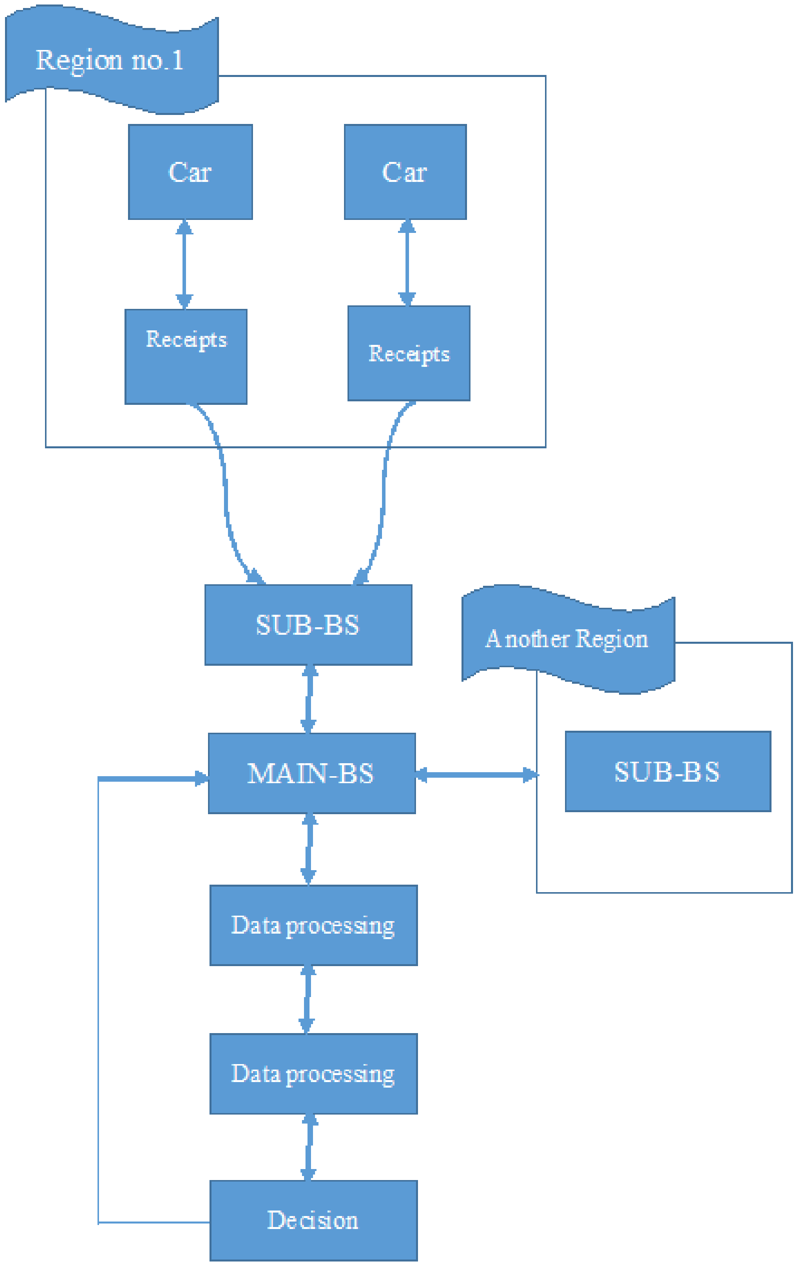

Figure 1: Flowchart of unit's interaction

2.1. VANET Protocol

1. Vehicles equipped with a VANET mobile device periodically broadcast a message that includes the unique identifier. We have used the stateless peripheral greedy routing (GPSR) protocol for the network layer of VANET [8]; table 1 shows the layered view of vehicular networks.

Table 1: Layered View of Vehicular Networks

Vehicular Network	Application Type	-Safety application -Intelligent transport application -Comfort application
	Quality of Service	• Non-real-time • Soft-real-time • Hard-real-time
	Scope	-Wide area -Local
	Network Type	• Ad hoc • Infrastructure based
	Communication Type	• V2I • V2V

2. When recipients receive a message with a new ID, it will be sent to Sub-BS but when the message is the same, it will be discarded.
3. Sub-BS will periodically redirect the number of cars that have passed the road at that moment.
4. Main-BS will calculate the vehicular flow density at that time for each street and then make the best decision [9]. In our project, we assumed that the capacity of all roads is equal so that the decision is made based on the rate of cars only without taking into account the capacity of the roads as shown in the following figure.

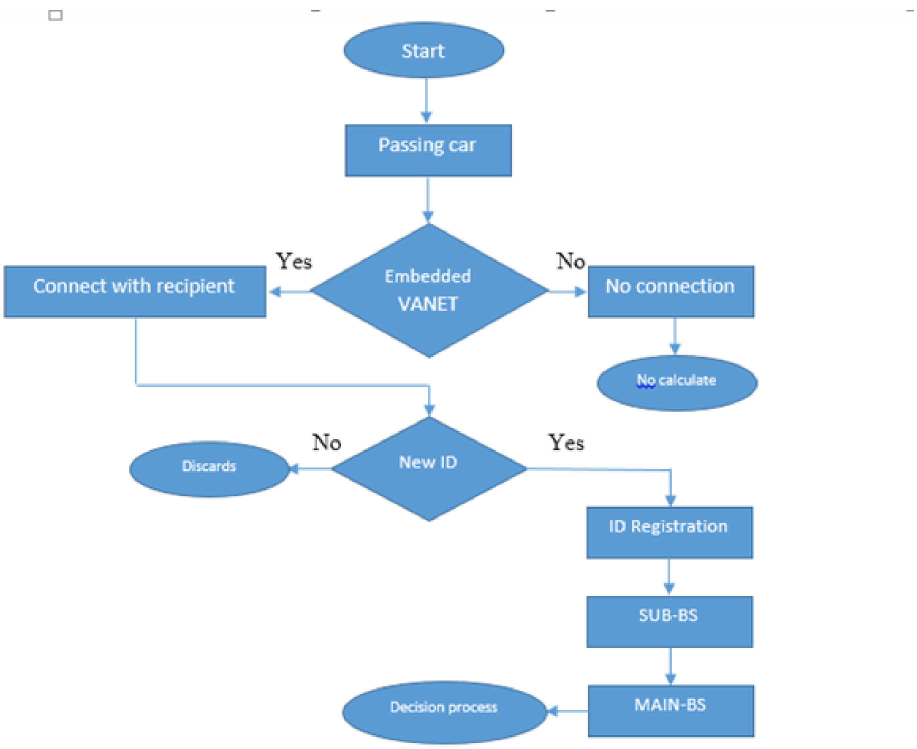

Figure 2: Flowchart of connection steps

2.2. Architecture of CTLM

1. In this paper, we proposed the traffic light management, which is the main computer connected to the ”main base station”[10].
2- Main-BS includes DBMS, which contains the aggregated history fetched by SUB-BS.
3- We assume in our project that all streets are of the same capacity so that the decision is easier.
4- We will apply our system to a few roads (streets) [11] [12].
5- The decision should be made based on the number of cars per street as follows:
a. When the number of cars does not exceed the threshold value, the time will be the same unchanged.
b. When the number of cars exceeds the first threshold value but not the second threshold value, the green time will increase [8].
c. When the number of cars exceeds the first threshold, and the second threshold values, the green time will increase, and the RED time will be reduced.
The following flow chart shows the steps of central traffic light management decisions

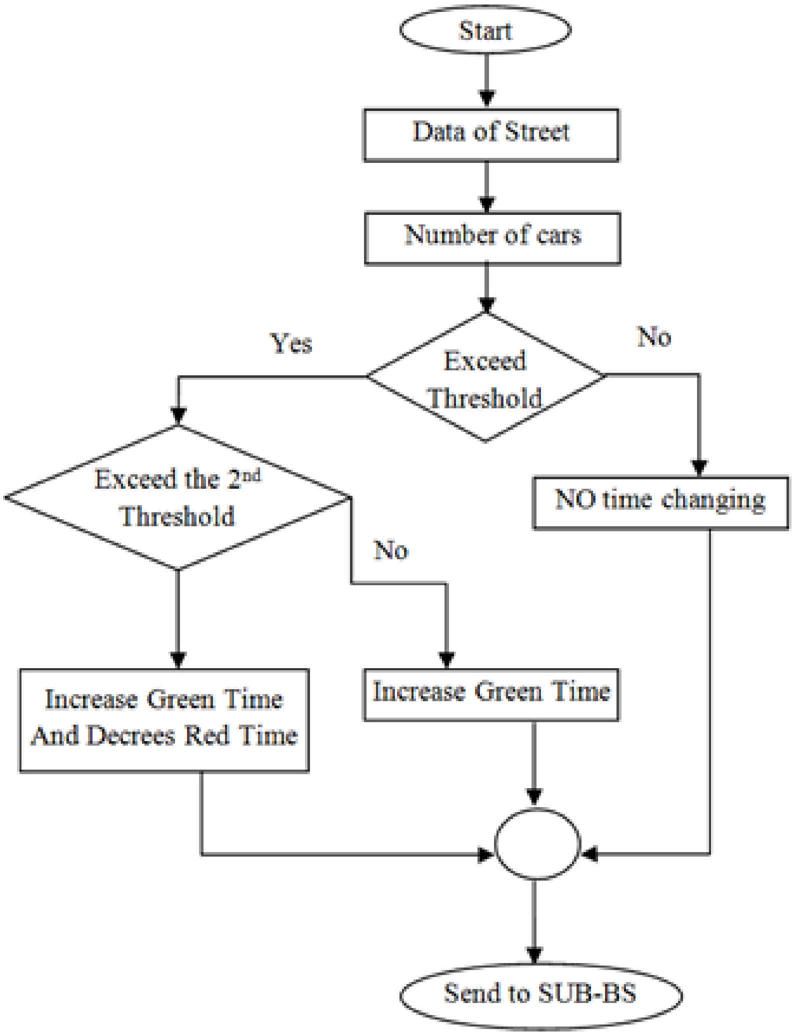

Figure 3: Flowchart of the central traffic light management decision

3. Results

We tailored our design to select a specific vehicle to interact with the data processing center to give it the shortest route (with the least traffic). As shown in Figure 4. We have compared the results of our algorithm in blue, constant time algorithm in green, and DT3P algorithm in red as follows:

1. The average parking time in the same scenario within 50 seconds reduced the time spent in the same scenario compared to the other scenario as shown in the algorithm

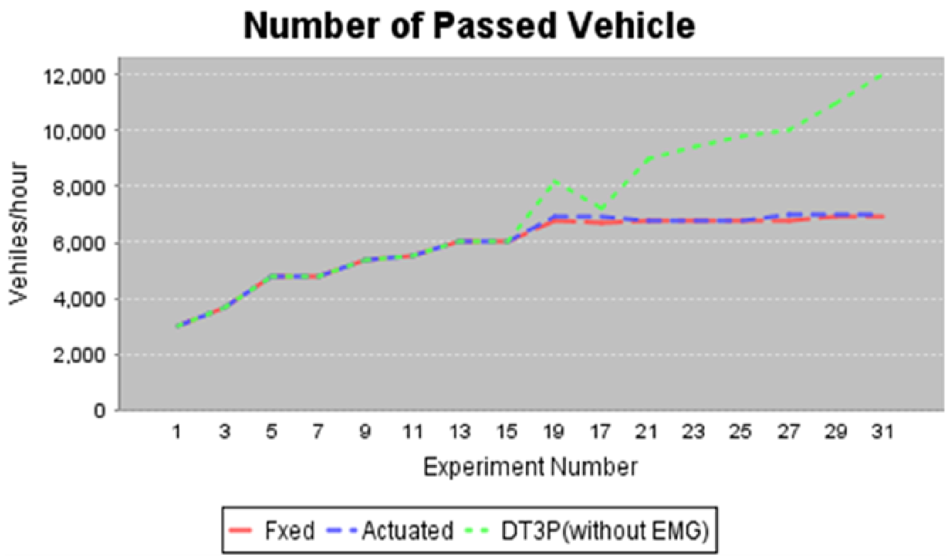

Figure 4: Average of waiting time

2. A total number of passing cars per hour in 31 tries. Figure 5 shows the representation of these passing cars

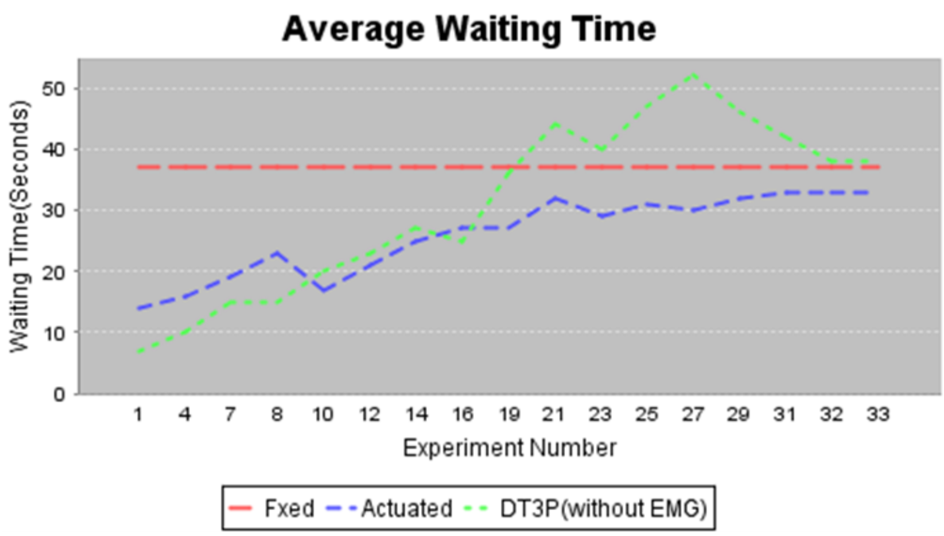

Figure 5: Number of passed cars per hours

3. The average fuel consumption is based on the average parking time as shown in the following figure 6. All shorter paths, dynamic path (routing week 1), and dynamic path (routing week 2) have

very adjacent time values. The results given by dynamic guidance for the first week and the second week are similar with little difference from the shorter course

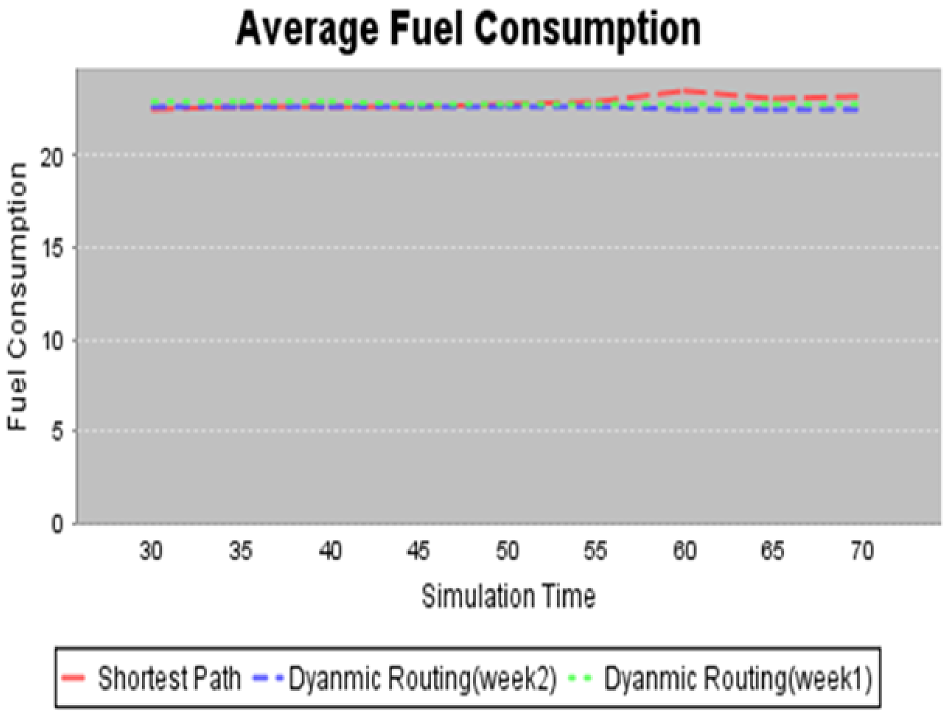

Figure 6: Average fuel consumption

4. The average delay time of cars during the simulation used, as shown in Figure 7, includes three representations (pre-timing, adaptive ideal, and true adaptive). The given results remain the same from the start until the 65th minute. After this time, the adaptive real remains similar to the present time until the 75th minute. Then it starts a different pattern, while the adaptive real differs from the adaptive ideal and the preset time is from 75 minutes to the end of the period

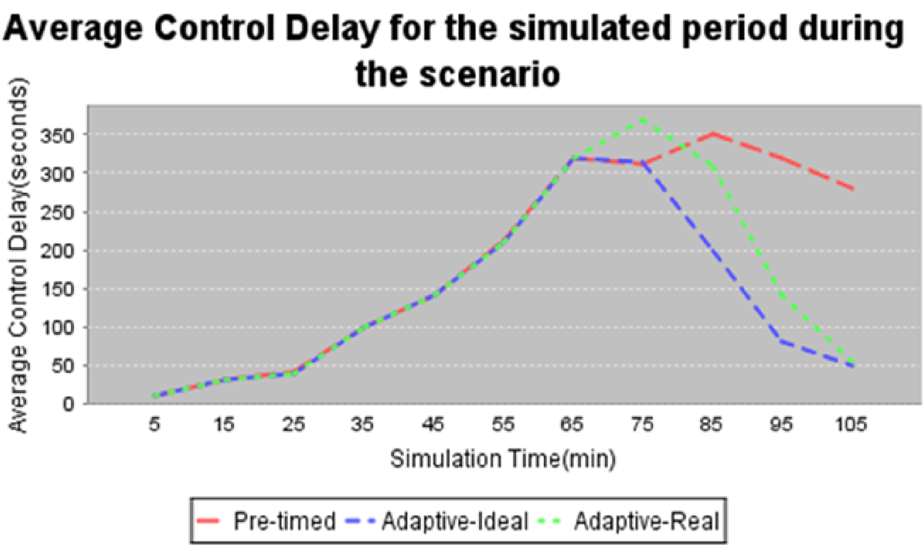

Figure 7: Average delay time

4. Conclusion

In this study, we have a simulation framework consisting of a model with a real mobility model of cars or vehicles and a simulation of a wireless network. We have dealt with two major intersections in many places and have seen that the system significantly improves traffic fluency compared to the current method. It was designed as a work system that can be analyzed for peak hours and we got acceptable results. Average delay, fuel consumption and pollution are significantly reduced.

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