Pollution Reduction using Intelligent Warning Messages in VANET

Esraa Al-Ezaly, Ahmed Abo-Elfetoh and Sara Elhishi

Faculty of Computers and Information, Mansoura University, Mansoura, Egypt
Email: esraagamal@mans.edu.eg.com

Many conferences all over the world about the environmental protection are situated. Air pollution resulted is an urgent issue for all people on the earth. Crowded cars in the intersections in the traffic light intersections are one of causes of air pollution. Also, rapid accelerations and deacceleration in the intersection cause air pollution. They also lead to packet transmission delay. This paper treats these issues using an intelligent warning message which reduces crowded cars, rapid accelerations and deacceleration. Using vehicular ad hoc networks (VANETs), intelligent warning messages is used. Results show that our system outperforms previous studies such as traffic light control and pre-timed method in transmission delay, CO2 emission which causes air pollution.

Keywords: CO2 emission; Warning Messages; Vehicular Ad-Hoc Network (VANET); Traffic Light

1. Introduction

The traffic jam is increasing in higher rates in all countries especially in intersection. In intersection, warning messages forces drivers to stop suddenly when the traffic light turns red. Warning messages forces drivers also to accelerate suddenly when the traffic light turns green. This leads to so much fuel consumption, and air pollution (Muhlethaler, Renault , & Boumerdassi, 2020).

In latest years, wireless networks are used to direct road and traffic. Vehicular ad-hoc network (VANET) is a wireless network for vehicles which allow easy communication between vehicles. We can also use VANET to enable communication between road-side units (RSU) and vehicles and between RSUs. Based on VANET, smart warning messages can disseminate important warning messages information, e.g., current, next traffic light color, appropriate advised speed to vehicles. Vehicles can then disseminate to neighbors (D. da Costa, J.B., de Souza, A.M., Rosário, D., 2019).

Smart traffic lights help in reducing traffic jam and pollution due to reducing stops and urgent acceleration at intersections. It also reduces accidents which are caused by urgent stops, acceleration, and deacceleration (Pang, Shen, & Wu, 2021).

The early information to the driver of the vehicle reduces stops and urgent acceleration. It also reduces traffic jam and pollution at the intersections. Intelligent organization of traffic in intersections is needed. Smart warning messages can used to support traffic information and smart decisions to the driver (Damuri , Ariestandy , Putra, & Aisyah, 2021). A communication between the driver and the smart warning messages is needed. Segment 2 includes a brief overview of related works as well as an examination of sources of inspiration. The proposed philosophy is presented in the third segment. The re-enactment results

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and investigation are presented in Area 4. This work's conclusion and future implications are presented in Segment 5.

2. Related works

To know warning messages information disseminated by traffic lights, the type of warning messages control must be determined. The adaptive congestion aware routing protocol (ACARP) steering convention for VANET was proposed. The goal of ACARP was to use AI to predict VANET congestion and use the results of that prediction to construct safer and more dependable routes. High VANET congestion causes longer delays, longer travel times, and more CO2 emissions, all of which are harmful to humans. As a result, the CO2 emission reduction problem was formulated (Giripunje LM, Vidyarthi A, Shandilya SK., 2021).

Traffic information data, also known as Floating Car Data (FCD), must be transferred efficiently between mobile vehicles while avoiding the broadcast storm problem as much as feasible. In this regard, data aggregation appears to be a promising method for combining FCD messages to provide a summary (or aggregate), which will surely minimize network traffic (Allani , Yeferny, & Chbeir, 2020).

The fundamental idea of traffic light controller method was to compute the green/red times for each direction on a crowded intersection with a traffic light controller using the recorded traffic history information. The use of historical data in estimating future traffic loads on each street leading to a traffic light intersection is offered as a robust heuristic. (Khalil , Shatnawi , & Latayfehb, 2019)

A study offered a distributed congestion management method in response to data transmission requirements that may occur in the future Infrastructure to Vehicle (IoV) system, based on the existing congestion control algorithm. The suggested congestion control algorithm tackled real-time data transmission problems with high priority requirements and enhance data transmission efficiency (Allani , Yeferny, & Chbeir, 2020).

Based on VANET, this research presents an intelligent traffic light control method to reduce vehicle CO2 emissions. Wireless connection between automobiles and traffic signals was used in the recent concept to acquire real-time traffic information. The method to intelligent traffic signal control can be broken down into two steps. The first step was to design an adaptive traffic signal control algorithm with the goal of lowering vehicle waiting time. We model four separate phases and create a demand function to assign the green light to each phase depending on a variety of traffic factors such as traffic density and other variables.

To reduce the time, it takes for vehicles to stop, they then calculate the recommended speed for each vehicle (Damuri , Ariestandy , Putra, & Aisyah, 2021). The goal of this phase was to increase the intersection's throughput so that the number of vehicles halted by the signal was reduced. We also present a CO2 emission-estimation model for calculating vehicle CO2 emissions (Giripunje LM, Vidyarthi A, Shandilya SK., 2021). A communication between the driver and the smart warning messages is needed to reduce accidents. It also reduces delay and CO2 emissions.

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3. Intelligent warning messages

In Dammam, Saudi Arabia, the TL are green, yellow, red then green consecutively. The waiting time for the main road is 40 seconds which is larger than the subways (30 seconds). Where both road branches are two directions.

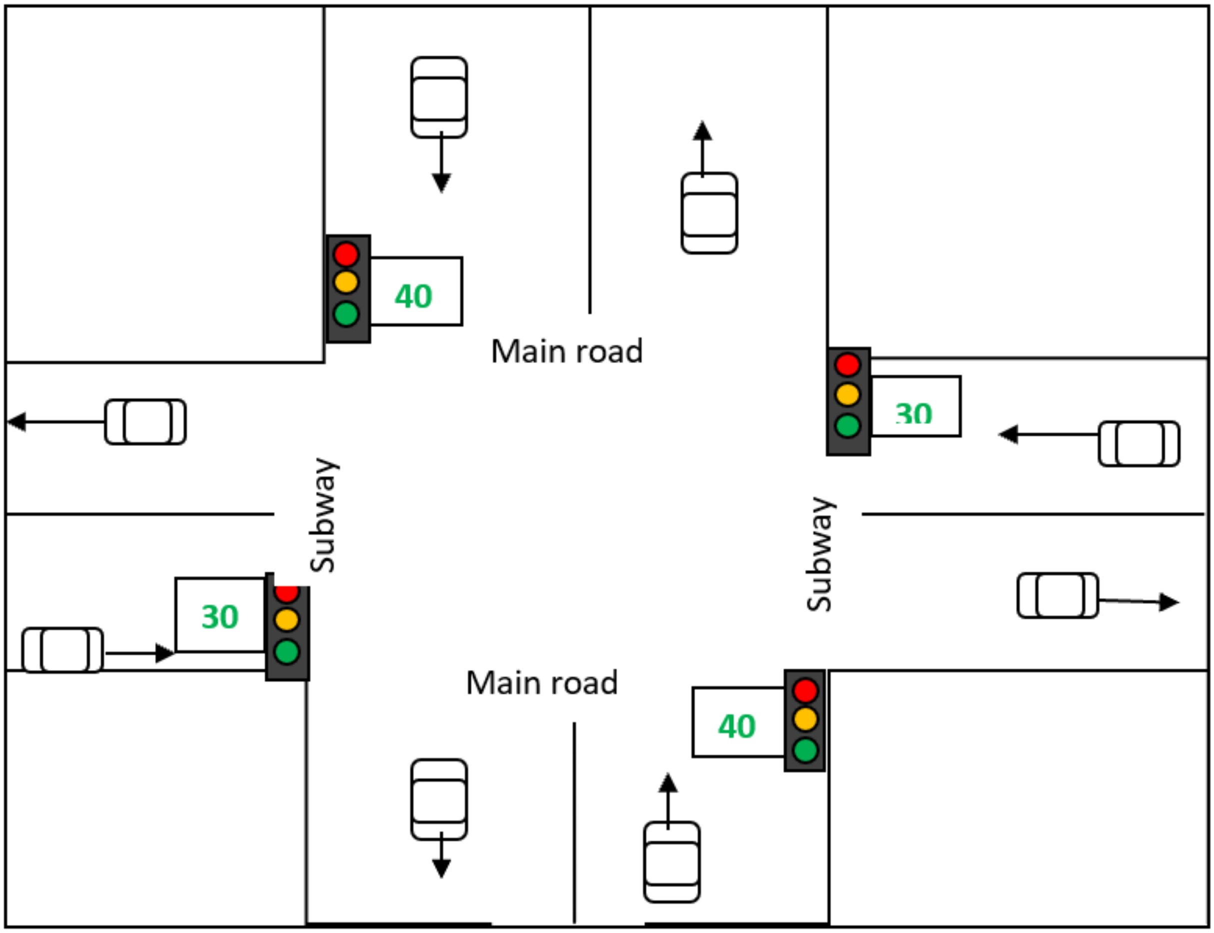

Figure 1 warning messages boxes in each road direction

In USA, the TL is green, yellow, red then green consecutively. USA's warning messages is popular, so we focus on it as in table 1. It contains green, yellow, and red lights. Warning message comments are shown in Table 1. We suppose the road intersection is large and has two road types, main road, and a branch road. Each road type has two opposite directions. Therefore, there are four directions. Each one has a warning messages box in the side of the intersection (Javadia & Winkenbachb, 2021).

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Table 1: Traffic Light Cycle:

Time (seconds)	Busy Bunny Lane Cycle	Lazy Tortoise Ave Cycle	Warning Messages
0	Green	Red	Busy Bunny Lane Cycle, Lazy Waiting
1	Green	Red	
2	Green	Red	
3	Green	Red	
4	Green	Red	
5	Green	Red	
6	Green	Red	
7	Green	Red	
8	Green	Red	
9	Green	Red	
10	Yellow	Red	
11	Yellow	Red	
12	yellow	Red	Busy Bunny Lane Cycle, Lazy Waiting
13	Red	Red	
14	Red	Red	
15	Red	Red	Dead (prevent accidents)
16	Red	Red	
17	Red	Green	Lazy Tortoise Ave Cycle, Busy waiting
18	Red	Green	
19	Red	Green	
20	Red	Green	
21	Red	Yellow	Lazy Tortoise Ave Cycle, Buzzy waiting
22	Red	Yellow	
23	Red	yellow	
24	Red	Red	Dead
25	Red	Red	

Figure 2 shows VANET transmission using dedicated short-range communication (DSRC). Figure 3 shows VANET Transmission using DSRC.

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Figure 3. VANET Transmission using DSRC.

Intelligent Warning Messages is sent from neighbor vehicle to the driver, it is shown in the vehicle board in figure 4 (Smart Directional Data Aggregation in VANETs, 2018). Equation 3.1. shows prediction speed suggested to the driver.

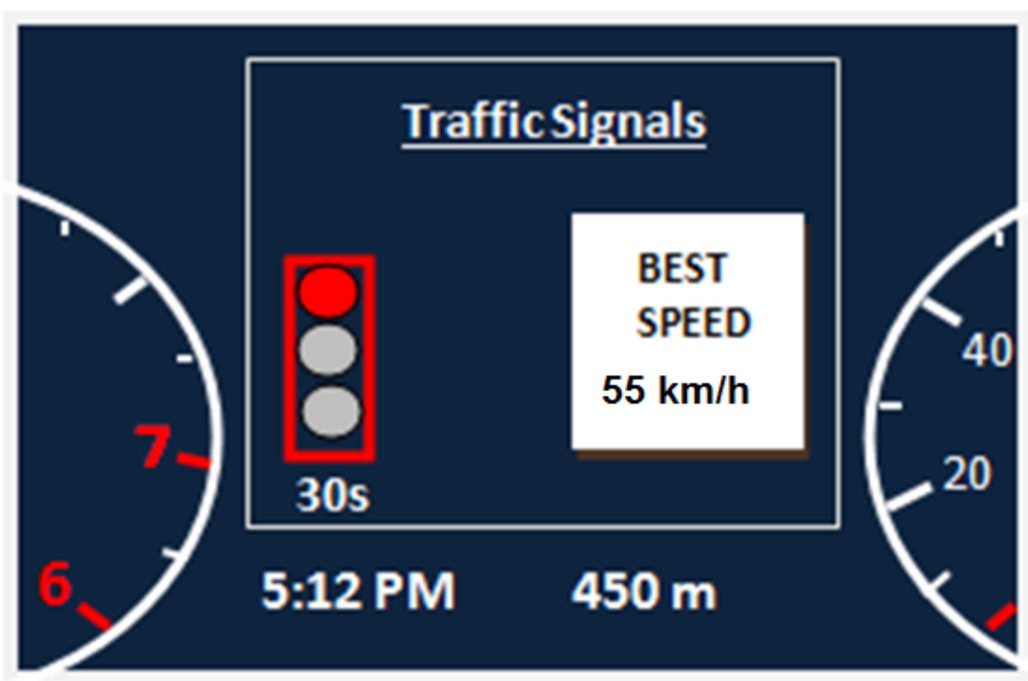

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Figure 4. Driver on board warning messages.

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$$SP=SC-\left(\frac{SB-SE}{TB-TE}\right) \quad (3.1)$$

Where SP represents predicted speed, SC represents current speed, SB represents begin speed, SE represents end speed, TB represents begin time, and TE represents end time.

1. If emergency a warning for road branch that has red light is sent to ambulance.
2. If an accident or closed road in the road a warning is sent to behind cars.
3. If a road branch will have a red light is sent to normal vehicles before red light.

Table 2: notations for algorithm 1:

Notation	Description
S	Source vehicle region
N	Number of destinations in the group member table
W	The waning message about red light
T	The warning event time
C	The waning message about a closed road

Algorithm 1 shows intelligent warning messages for VANET from step 2 to12. Emergency warning is sent in step 5. Red light warning is sent in step 7. Closed road is sent in step 9.

Algorithm 1 Pollution Reduction using Intelligent Traffic light:

1: **Start**
2: **For** i=0, 1, …, N
3: **If** (d is in S) **then**
4: **If** emergency
5: W for road branch is sent to ambulance and neighbours in T
6: **If** a branch will have a red light
7: W is sent to normal vehicles before T
8: **If** an accident OR closed road
9: C is sent to behind cars in T
10: **End if**
11: d++
12: **End for**
13: **End**

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4. Simulation

4.1. Simulation metrics

CO2 emission is computed in equation 4.1.1 (Sharma, S., Kaul, A. , 2021). Where n is number of vehicles.

$$CO2Emission = \sum_{k=0}^{n} \frac{vehicle\ CO2Emission}{n} \tag{4.1.1}$$

The Co2 emission is defined as follows:

In equation 4.4.2, the average delay for all packets is calculated where n is number of vehicles, T_S is the transmission time and T_R is the receive time.

. (Chanal and Kakkasageri 2019):

$$\text{Average } end - to - end\ delay = (\sum_{p=1}^{n}(T_R - T_S))/\text{n} \tag{4.4.2}$$

4.2. Simulation Scenarios

For each case, the average rate is calculated. In Scenario 1, the impact of increasing vehicle speeds on dissemination performance indicators utilizing VANET is investigated. With an average speed of 10 m/s, we tested the impact of a varied number of cars on TLILS performance. In scenario 2, the impact of increasing speed is investigated.

2. Experimental Results

Comparison between proposed technique and previous techniques in decreasing CO2 emissions are depicted in figures 4, and 5 as scenario 1 and 2, and 7 as scenario 2. Scenario 1 depicts the influence of a variable number of cars on the proposed method and Traffic light control method and pre-timed method.

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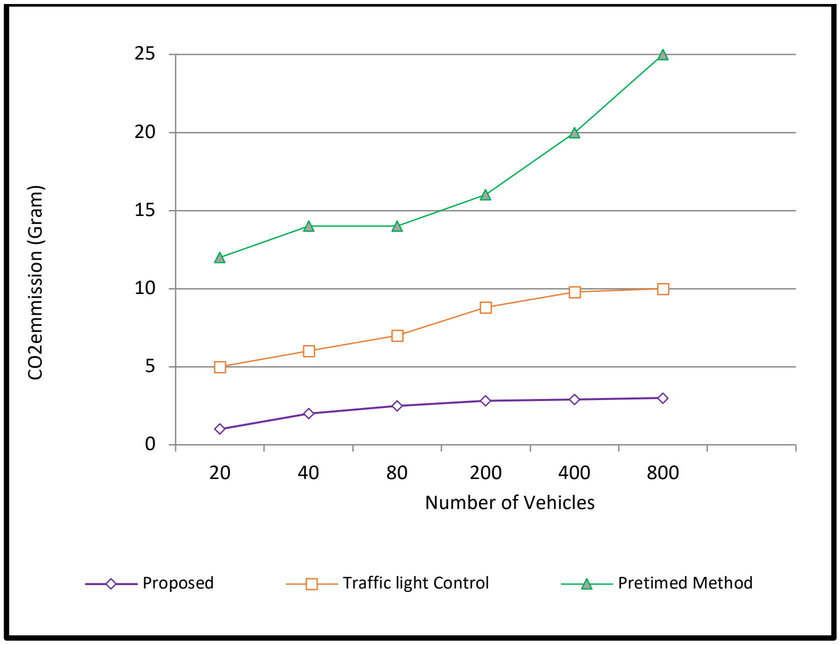

Figure 5. CO2emmission in Intelligent Warning in VANET.

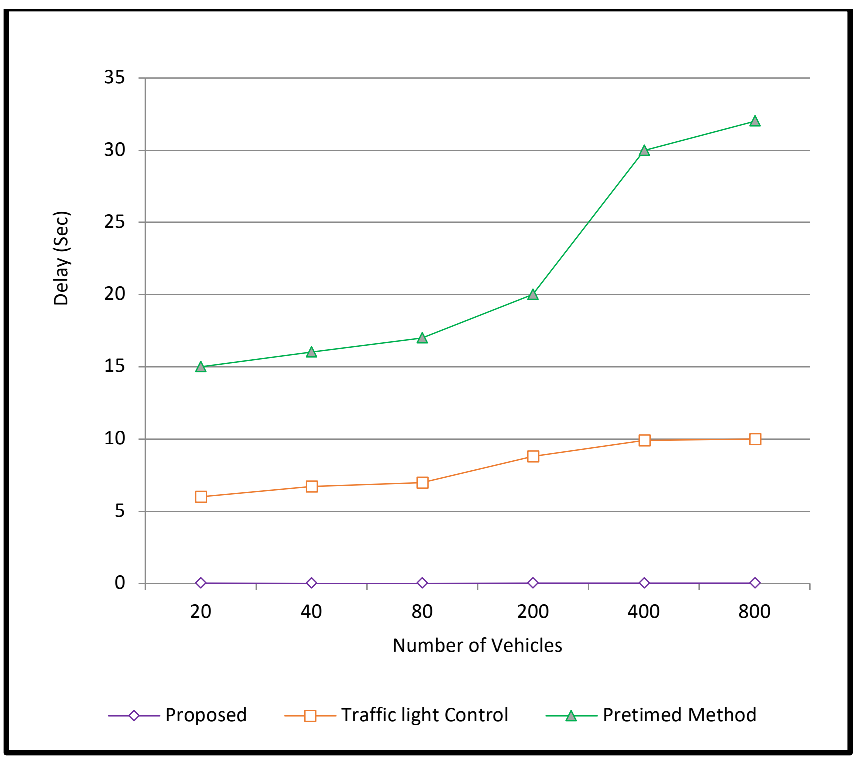

Figure 6. Delay in Intelligent Warning in VANET.

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depicts the influence of a variable speeds of vehicles on the proposed method and Traffic light control method and pre-timed method.

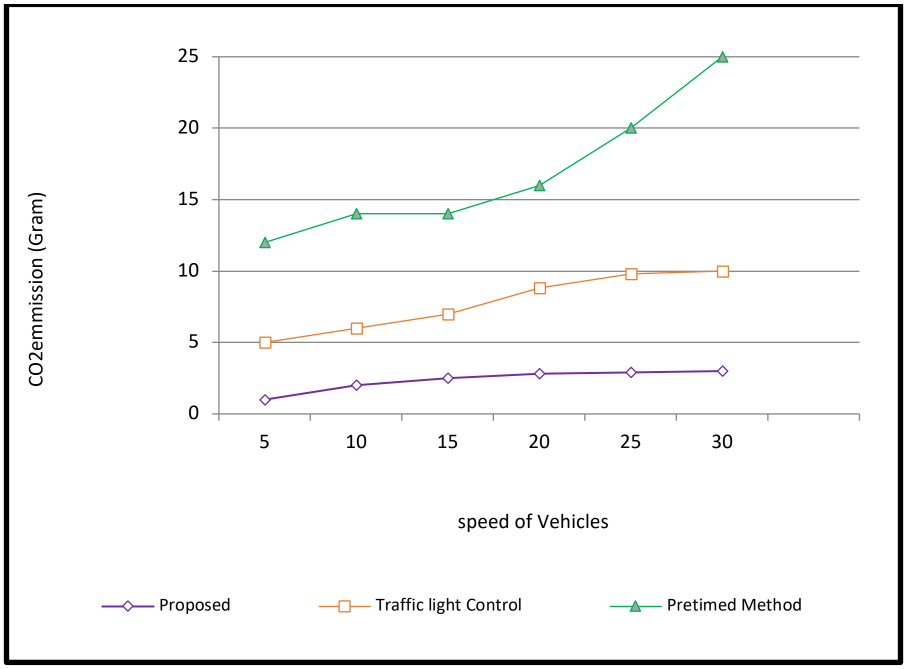

Figure 7. CO2emmission in Intelligent Warning in VANET.

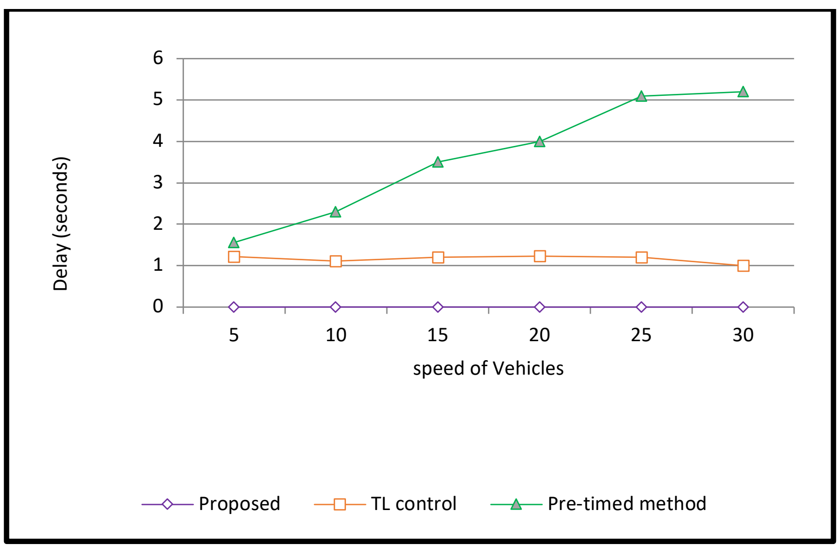

Figure 8. Delay in Intelligent Warning in VANET.

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5. Results

Simulation findings show that the suggested strategy may effectively reduce vehicle average transmission delay, and CO2 emissions when compared to the pre-timed control method. In scenario 1, our proposed method for 20 vehicles in figure 5 shows CO2 emissions is less than 2 grams. For 40 vehicles in figure 5, CO2 emissions is less than 2 grams. For 80 vehicles, CO2 emissions is less than 2 grams. For 200 and 800 vehicles, CO2 emissions is less than 2 grams. in figure 6, delay is less than 0.1 seconds for speed 5 m/s. For speed 10 in figure 6, delay is less than 0.1 seconds. For speed 15, delay is less than 0.1 seconds. For speed 30 in figure 6, delay is less than 0.1 seconds.

In scenario 2, our proposed method for speed 5 in figure 6 shows CO2 emissions is less than 2 grams. For speed 10 in figure 7, CO2 emissions is less than 2 grams. For speed 15, CO2 emissions is less than 2 grams. For speed 30 in figure 7, CO2 emissions is less than 2 grams. In our proposed method for speed 5 in figure 8, delay is less than 0.1 seconds. For speed 10 in figure 8, delay is less than 0.1 seconds. For speed 15, delay is less than 0.1 seconds. For speed 30 in figure 8, delay is less than 0.1 seconds.

6. Conclusion

There are numerous conferences on environmental preservation held around the world. As a result, air pollution has become a major concern for everyone on the planet. One of the major sources of air pollution is overcrowding at traffic light crossings. In addition, air pollution is caused by rapid accelerations and decelerations in the intersection. This study takes a thoughtful approach to these challenges. This article addresses these difficulties using an intelligent warning message that lowers packed autos, quick accelerations, and deacceleration. Intelligent Warning Messages are used in vehicular ad hoc networks (VANETs). Our technology minimizes acceleration, deceleration, transmission delay and air pollution, according to the results. Our algorithm eliminates trip delays for conventional automobiles, as well as the quickest and least amount of time spent waiting at red lights. Our system reduces the number of vehicles on accident roads. Our method removes the trip distance for emergency vehicles and the warning messages waiting for red lights. Using our ad, the lowest trip distance for conventional automobiles, as well as the shortest and least time spent waiting at red lights, is eliminated.

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