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An Intelligent Traffic System Based on Internet of Vehicles Using Adaptive Traffic Management Algorithm

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Abstract: Many countries face the traffic related issues regardless of the wide effects adopted for developing and improving the traffic flow. Depending on the drawbacks of existing traffic management systems like inefficient time management, absence of priority options and lack of dynamic and adaptive services, the need for the incorporation of intelligent concepts is mandatory. This facilitates the replacing of traditional approaches with an array of sensors and artificial intelligence (AI) through vehicle traffic control system. In this paper, the intelligent traffic system (ITS) is proposed on the basis of techniques such as internet of vehicles (IOV) and vehicular adhoc network (VANET). A road side unit (RSU) controller connected with the traffic control system acts as the key component of ITS. The on board unit (OBU) is fixed with each vehicle, which exchanges the real time information with RSU (road side unit) and other OBUs. Additionally, an adaptive traffic management algorithm (ATMA) is provided to govern the ITS for the generation of high performance outputs. Furthermore effectiveness of ATMA in the proposed work is proved by simulation using Python. Eventually, the ATMA is compared with fixed-time (FT) algorithm and traffic signal control algorithm (TSCA) under various traffic conditions. The findings depicts that the proposed ATMA-based ITS outperforms the current traffic management systems in terms of average waiting time (AWT) obtained as 277.5s with respect to number of vehicles and 282.14s with respect to number of roads at an intersection. Added to this average number of serviced vehicles is given by 1731 with respect to the number of roads.

Keywords: Internet of vehicles, Road side unit controller, On board unit, VANET.

1. Introduction

Traffic congestion and inefficient traffic management pose longstanding challenges for numerous countries around the world. These issues have serious implications, causing increased travel times for commuters, elevated fuel consumption and negative impacts on the environment. Despite various attempts to develop and improve traffic flow, existing traffic management systems continue to face significant drawbacks [1]. Key issues include inadequate time management leading to suboptimal signal timings, the lack of priority options for critical situations and a limited capacity to adapt dynamically to changing traffic conditions. The urgency to address these shortcomings and create a more effective traffic management system has become paramount [2]. Utilising cutting-edge technology like artificial intelligence (AI), the internet of things (IoT) and real-time data analytics, intelligent traffic systems (ITS) have emerged as a possible option [3]. The IoV has evolved into an ITS with AI and machine learning with the introduction of 5G and new technologies like network function virtualization and software defined networking. The implementation of ITS is hampered by issues with scalability, high availability and data privacy. Federated learning is suggested as a cooperative method that enables fault recovery and enhances system performance to deal with them. Despite its benefits, potential drawbacks like communication overhead and privacy concerns should be considered for widespread implementation in 5G networks [4].

A smart traffic management platform is proposed, to address volatile traffic conditions, high-frequency data streams and unlabeled data, ultimately optimizing traffic flow and improving system adaptability [5].

Vehicles are used as mobile nodes or routers in the vehicular Ad hoc network (VANET) concept to enable direct communication between vehicles (V2V) and between vehicles and fixed infrastructure along the road (V2I) [6]. VANET relies on the transportation department to manage the RSU and the OBU [7]. Each vehicle is equipped with an OBU as a transmitter for communication with other vehicles, while the RSU is installed on the street to facilitate communication between vehicles and the infrastructure [8].

As the demand for autonomous vehicle and ITS is increasing, a clear survey has been performed to access the traditional V2X (vehicle to everything) [9]. Based on the V2V (vehicle to vehicle) communication, an adaptive traffic management system is advanced for VANET to minimize an average travel time of vehicles [10]. The traffic congestion is automatically detected and the notification are passed through the V2I communication [11]. In [12] Ant colony optimisation with elliptic curve cryptography Ad hoc It is suggested to use an on-demand distance vector routing protocol with an adaptive path selection algorithm, CA for key mapping and IoV for secure message distribution. However, increased computational overhead and complexity affects performance in dynamic vehicular environments. In [13] Block-CLAP is an IoV protocol that uses a blockchain to help with certificate-less key agreements. The protocol offers superior security and efficiency compared to other authentication schemes, but potential scalability challenges may arise in the blockchain implementation.

Federated learning [14] approach for privacy-preserving collaborative machine learning in IoV applications. However, the use of numerous separate data service providers could have a negative effect by increasing transmission costs and computing complexity. Multi-channel blockchain scheme optimizes parameters according to vehicle density levels and application requirements, achieving superior performance. However, managing multiple channels may introduce complexity and overhead in the system's implementation and maintenance. [15]. In [16, 17] green IoV considerations in communication, computation, traffic, EVs and energy management, comparing relevant literature on energy optimization is proposed. However, the potential challenge lies in adopting emerging 6G technologies, which may require substantial infrastructural changes. The timer algorithm aids the ATLC (autonomous traffic light control) system to predict the elements such as the intensity of traffic, number of vehicles and type of the vehicle [17]. If the predictions are inaccurate or fail to reflect real-time traffic conditions, it leads to suboptimal traffic flow and potential congestion. Urban traffic and greenhouse gas emission are reduced by developing a pheromone based GTS (green transportation system) [18, 19]. The failure of the system results in vulnerability to external factors. By using Q-learning technique, a traffic control system is formed for balancing the signals between roads and for improvising the number of vehicles crossing the intersection [20]. In [21] DBN-SVR method is employed for traffic flow detection in some intersections, but imitations in data processing, leads to delays or reduced accuracy in traffic flow detection. In [22] reinforcement learning is proposed for ITS, demonstrating improved vehicle waiting time reduction under varying traffic conditions. However, a potential drawback might arise from the reliance on detection rates, as low detection rates may impact the algorithm's performance in accurately predicting traffic flow and control decisions. A switchable ramp with on and off condition is designed for the urban highway to reduce the traffic congestion [23]. Nevertheless, disruptions in traffic flow occurs during on-off conditions. In consideration with self-organized critical state, traffic guidance method is introduced for the neighboring weaving segments to avoid the lane changing behavior of vehicles [24]. However, increased congestion and reduced traffic flow efficiency due to avoidance of lane changing behavior. To avoid the road hazards, the block technology is combined with the IoT and to develop communication network among various vehicles, the hash graph technology is used [25]. However, these applications fail to meet the requirements of ITS in the metro cities. The contribution of proposed work involves

- Integration of ITS with IOV and VANET to enhance traffic management with advanced techniques.
- Facilitating effective communication between the traffic control system and vehicles using RSU.
- Adoption of ATMA dynamically adjusts traffic flow based on real-time data, generating high-performance outputs.

Table 1. Parameters and descriptions

CHARACTER	DETAILS
$R_{i,m}(t)$	m^{th} car detail in i^{th} road at time t
$V_{i,m}(t)$	Speed information of m^{th}car on i^{th} road at time t
$P_{i,m}(t)$	information regarding position of m^{th}car on i^{th} road at time t
N	Number of roads in network
$ID_i(t)$	vehicle ID set on i^{th} road at time t
$O_{i,m}(t)$	m^{th} vehicle information collected at t on i^{th} road
$O_{i,m'}(t)$	Information of m'^{th} vehicle information at t on i^{th} road
$R_{i,m}(t_m)$	m^{th} vehicle information on i^{th} road at time t_m
$R_{i,m'}(t_{m'})$	m'^{th} vehicle information on i^{th} road at time$t_{m'}$
$\lambda_{ij}(T),$	Rate of vehicle arrival at neighboring road segment
Δ	Time duration
$Q_i^d(T)$	virtual queue of length
R	Number of roads at crossroads
$t_r(r)$	The time when the road turned red
τ	Current time
D_{max}	Value is set to 400 m
τ_{gmax}	Maximum time to open a road
r_g	Currently opened road
t_g	Time since the green light turned on
g_t	A timer for open road
τ_{gmin}	Maximum period for road opening
r_{em}	Closed road which has EV
τ_{rmax}	Maximum time for red signal
T_y	Transition state to change from open state road to close state road

- Evaluation of proposed ITS with ATMA through python software to predict the effectiveness of proposed system.

The paper is organized as; description of proposed work followed by system modelling in section 2, results and discussions in section 3 and section 4 details the conclusion of proposed work. Table 1 provides a comprehensive list of symbols and notations used in this paper for easy reference.

2. Proposed concept of ITS

The implementation of ITS is an essential approach for reducing the traffic congestion and road incidents. ITS helps to shorten vehicle travel distances, which reduces fuel consumption and pollution. To achieve normal traffic flow, the vehicles communicate with the intelligent signals wirelessly. The police, ambulance and fire fighter vehicles are provided with priority access through the ITS. It inherits all the functional layers and features of IOV.

The vehicular networks such as VANET and IOV are the base communication technologies of ITS. The ITS architecture is represented in Fig. 1.

2.1 ITS Implementation technologies

The VANET is consisted of two types of communications calledV2V and V2I. The V2V communication enables the vehicle to exchange informations regarding the location and speed. In V2I communication, the vehicles communicate with the RSU. The services and layers of VANET are allowed through OBU, which are equipped in each vehicle. Fig. 2. Representsthe functions of VANET.

The IOV inherits various features of IoT and VANET. The IOV includes various communication services such as V2S (vehicle to sensor), V2P (vehicle to pedestrians), V2B (vehicle to building), V2G (vehicle to grid), V2D (vehicle to device), V2H (vehicle to home) and V2R (vehicle to road sign). The IOV functions are represented in Fig. 3.

V2S communicates inside of vehicle, the V2P allows communication to road users, the V2B provides communication to surrounding buildings, the V2D communicates with onboard devices and the V2R communicates with the road signals.

2.2 Application of ITMS (Intelligent Traffic Management System)

The ITMS consists three subsystems called OBU, RSU and a cloud center. The inclusive structure of the ITMS is represented in Fig. 4. The ITMS takes all the functional layers and characteristics of IOV. The operation of ITMS is performed by the OBU, which is equipped in each vehicle. The OBU is enhanced by including various modules. The traffic signal

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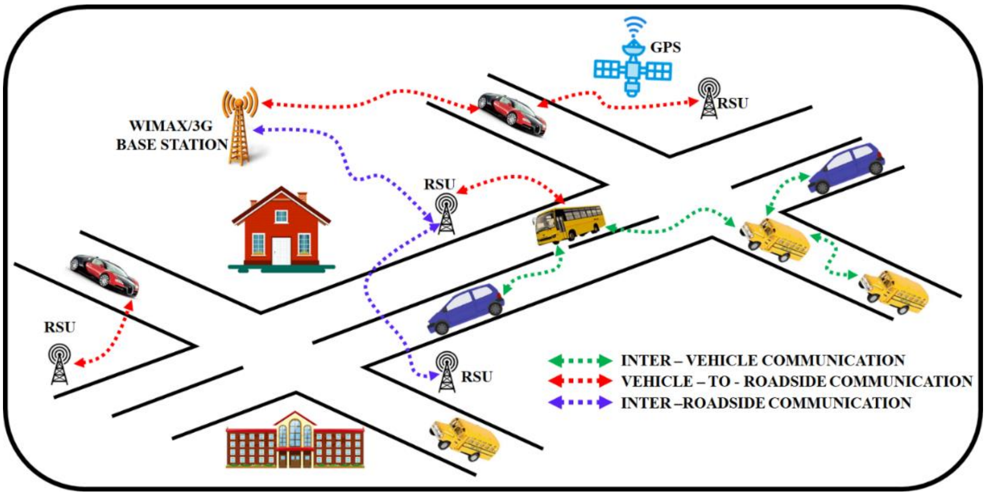

Figure. 1 Intelligent transportation system

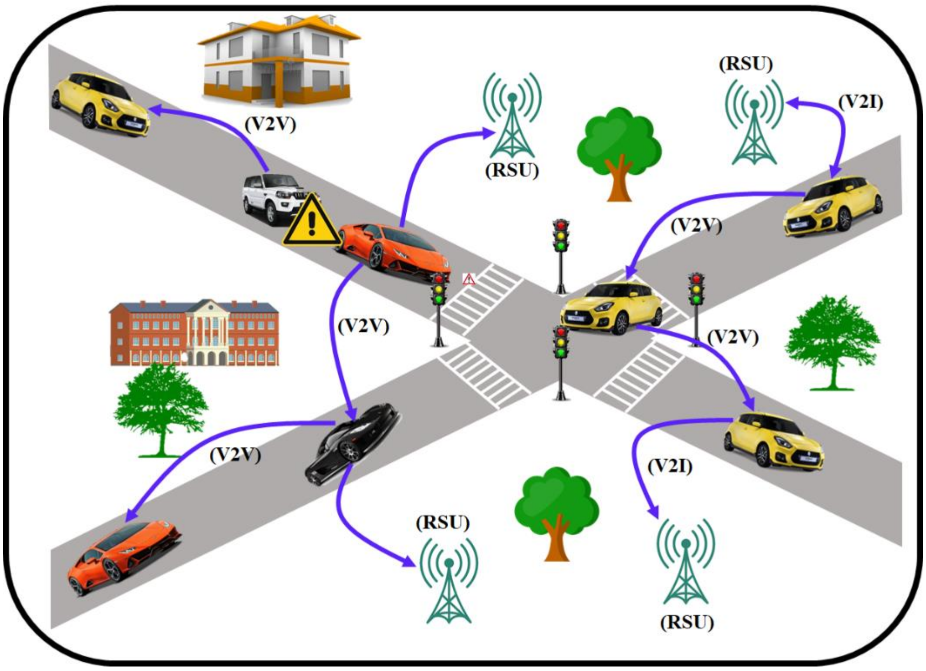

Figure. 2 VANET system

controller is connected with a RSU controller, which serves as the major component in ITMS. The vehicle informations such as location, speed and vehicle ID are collected through a model as shown as follows:

$$R_{i,m} = \{V_{i,m}(t), P_{i,m}(t)\} \quad (1)$$

The original data, which is gathered by the VANET gets exchanged by the driving vehicles within the communication range.

$$i\epsilon\ \{1,2, \dots, N\}, m\epsilon ID_i(t) \quad (2)$$

Here, $R_{i,m}(t)$ denotes the original vehicle details of the m^{th} car on the i^{th} road at time t, $V_{i,m}(t)$ denotes the speed information of the m^{th}car on the i^{th} road at time t, $P_{i,m}(t)$ denotes the information regarding the position of the m^{th} car on the i^{th} road at t, N denotes total number of roads in network of road and $ID_i(t)$ denotes the vehicle ID set on i^{th} road at t.

2.2.1. On board unit (OBU)

OBU is equipped in all vehicle and it connects various modules, which are applied by an on-board computer. Different modules in OBU are GPS, driver UI, ECU (Electronic Control Unit), IOV protocol stack, OBD-II Bridge, ITS communication unit, wireless transceiver unit, V2V communication,

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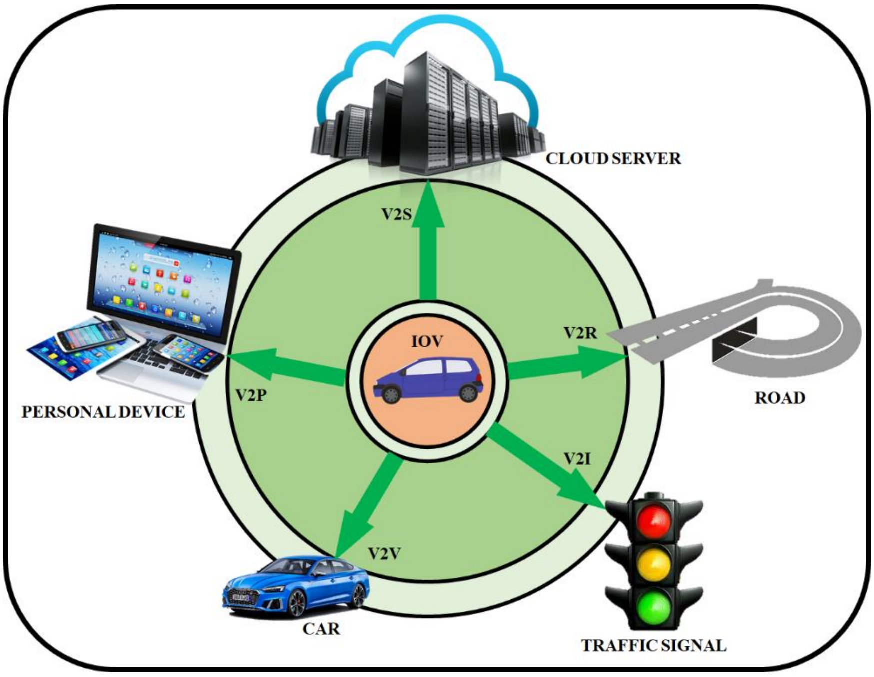

Figure. 3 Internet of vehicles

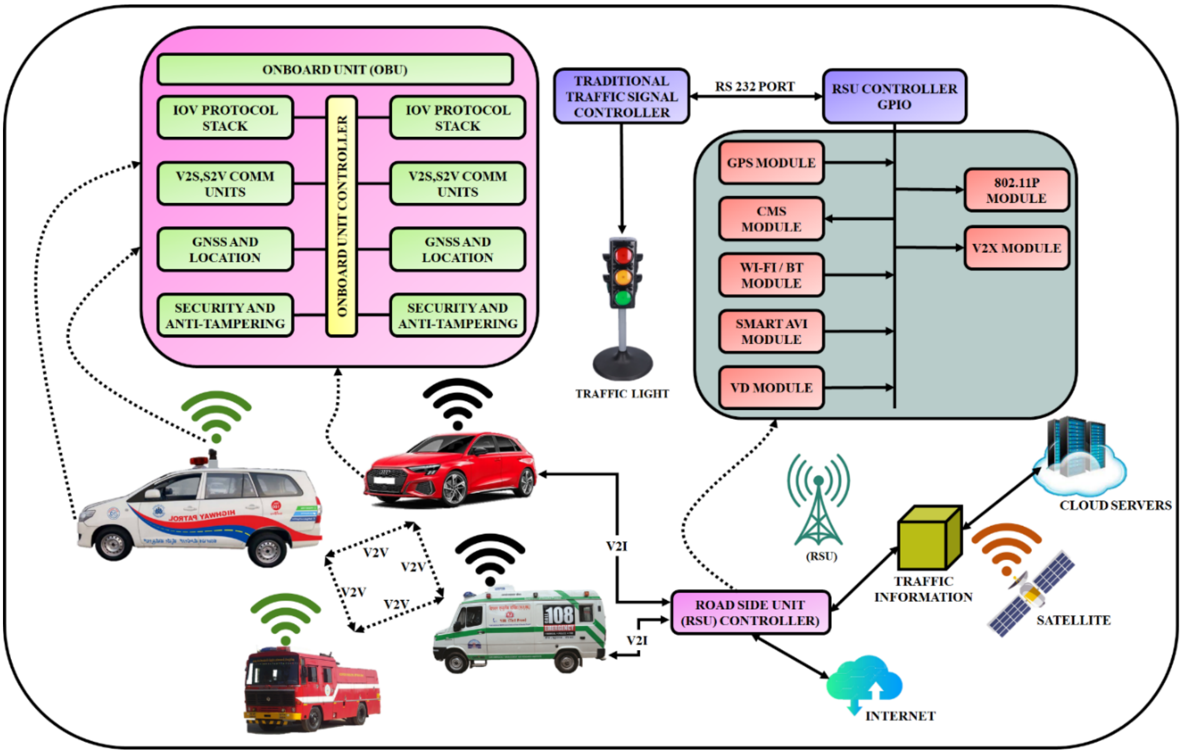

Figure. 4 Overall architecture of ITMS

security and anti-tampering unit, OBU controller, 802.11 p module, 4G/5G module,

Through VANET, all vehicles have interchanged its original information with others by forming a group of original vehicle information for the respective road. The collected data are used as a valuable source of information for the traffic signal timing. The transmission model for the original vehicle information gathering is given as follows:

$$O_{i,m}(t) = \{R_{i,m}(t_m), O_{i,m'}(t)\} \tag{3}$$

Every vehicle updates its own collection of information with other vehicles in the road,

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$$O_{i,m'}(t) = \{R_{i,m'}(t_{m'})|m' \epsilon \{1,2 \ldots, ID_i(t)\}\} \quad (4)$$

$$R_{i,m'}(t_{m'}) = \{V_{i,m'}(t_{m'}), P_{i,m'}(t_{m'})\} \quad (5)$$

The vehicle update its own information and continue to obtain the information from other vehicles on the road.

$$m, m' \epsilon \{1,2, \ldots, ID_i(t)\}, m \neq m' \quad (6)$$

The initial vehicle information collection gets updated on the basis of the recent information to ensure that the vehicle information collection is current.

Here, $O_{i,m}(t)$ indicates the m^{th} v vehicle information collected on time t at the i^{th} road, $O_{i,m'}(t)$ indicates the m'^{th} vehicle information collected on time t at thei^{th} road, $R_{i,m}(t_m)$indicates the m^{th} vehicleinformation on i^{th} at time t_m , $R_{i,m'}(t_{m'})$indicates the m'^{th} vehicle information on i^{th} at time$t_{m'}$ and $ID_i(t)$ indicate the vehicle ID set on i^{th} road at time t.

2.2.2. Road side unit (RSU) controller

The main component of the ITS called RSU is fixed to traffic signal control system. The adaptive traffic management algorithm is used in the RSU controller. The modularization concept is designed by the industrial computer.

To avoid information loss, each sample time duration is taken as Δ, which is determined by the sampling theorem. During the T^{th} sample time duration, an average inflow rate of road segment $(i,j)$is denoted as $\lambda_{ij}(T)$. It is stated as,

$$\lambda_{ij}(T) = \frac{1}{\Delta}\sum_{t=(T-1)\Delta}^{T\Delta} \lambda_{ij}(t) \quad (7)$$

Where, the rate for the arrival of vehicle from neighboring road segment in t is represented as $\lambda_{ij}(T)$, time duration is denoted as Δ and the set of all the roads is represented as T.

The virtual queue of length $Q_i^d(T)$ is maintained by RSU, which denotes buffered number of vehicle at intersection.

Hence, virtual queues total length i is $Q_i(T) = \sum_{d\epsilon\gamma} Q_i^d(T)$, where

$$Q_i^d(T) = \max\{Q_i^d(T-1) - \sum_{j\epsilon Ji} \mu_{ij}^d(T-1), 0\} + \sum_{u\epsilon Ji} \lambda_{ui}^d(T-1) \quad (8)$$

An outflow rate of the road segment (i, j) is $\mu_{ij}^d(T-1)$with destination d (T-1)th sample time is $\mu_{ij}(T-1)=\sum_{d\epsilon\gamma} \mu_{ij}^d(T-1)$.A leftover number of vehicle at the sample time is given by the following equation.

$$Q_{ij}(T) = \max\{Q_{ij}(T-1) - \mu_{ij}(T-1), 0\} + \lambda_{ij}(T-1) \quad (9)$$

When the road $(i,j)$is not congested, the $\delta(I_{ij} = 1$. The relationship between the road capacity and indicator is given as,

$$C_{ij}(T) = C_{ij}^N . \delta\left(I_{ij}\right), \forall \delta\left(I_{ij}\right) \epsilon [0,1] \quad (10)$$

$$\mu_{ij}(T) \leq c_{ij}(T) \quad (11)$$

The outflow rate needs to be reduced than the road capacity as mentioned above.

2.3 Operation of ITS

The RSU controller is adopted in the existing infrastructure without replacing the traditional traffic controllers. The signals are wirelessly broadcasted by using S2V communication unit. The emergency vehicles such as ambulances, police vehicles and fire trucks, which are equipped with OBU have regularly transmitted the current status. The RSU and V2X, which are interfaced within the signal coverage collect the EV messages and respond instantly.

T_{on} and T_{off} are used to describe the on and off periods of the vehicle. Similarly, the distance of travel in the on period is denoted as $U_{on}$with T_{on}= $\frac{U_{on}}{\bar{V}}$whereas the travel distance in the off period is denoted as $U_{off}$with T_{off} =$\frac{U_{off}}{\bar{V}}$. Here,$\bar{V}$ represents the vehicle's average velocity.

If a vehicle travels with a distance of at least u during the T_{on} period, the RSU needs to satisfy two conditions before communicating with RSU controller. The conditions are given as,

No vehicle is present within (u) of the RSU's coverage end.

At least one vehicle is present at a distance of 2R-u, in which indicates the movement of vehicle and R indicates the range of transmission of vehicle or the RSU. It is represented as,

$$P_\gamma(U_{on} > u) = \frac{(e^{-c.u})^{bc-1}[1-(e^{-c.(2R-u)})^{b\gamma-1}]}{1-(e^{-c.2R})^{b\gamma}} \quad (12)$$

Here, b represents a total of all road length and γ represents anaverage road density of the roads.

An overall operation procedure of ITS is explained in this section.

i) The heading angles, digital certificate and ending lines are regularly broadcasted by each ITSs.

ii) ITS guided cars at the intersection are aware of the present road's endpoint. If the vehicle crosses the road when it is closed, a red-light signal crossing violation is recorded in an internal memory of OBU. The informations of current road, location, ITS ID, current time and ending line are saved in the vehicle.

iii) The vehicle broadcasts its heading angle and location when it approaches the intersection or the information was received by ITS.

iv) Number of vehicles idling on each road is counted by ITS.

v) The ITS selects roads with the greatest number of waiting vehicles. These roads are only opened for the vehicles when there is no EV on the road. This is accomplished by sending the broadcast road information signals on a regular basis.

vi) The roads with low traffic wait for a long duration and crowded roads get the priority. When the road is closed, the timer is changed from the open state to close state. As the ITS inspects all the timers before making decision, it decides the road, which has to be opened. When the ITS figures out that the maximum allowed closing time is exceeded by the timers, it chooses the road with maximum timer value and opens it.

vii) The normal procedure gets cancelled when an emergency vehicle (EV) is approaching a road. The road is opened immediately and the road is kept open until the EV passes the intersection. The road is then closed and the normal procedure is continued.

viii) Before opening the route for EV and closing the currently opened road, the ITS provides a warning signal to all vehicles to wait for 3s. Then opens road for the EV.

2.4 Adaptive traffic management algorithm (ATMA)

ATMA is used in RSU controller, which manages the ITMS.

Steps,

For r in R,

When the closing time of road is set as equal to the current time, set$t_r(r)$ = τ.

When the vehicle count is initialized in all the roads, set V (r) = 0.

Set an open timer to an average of maximum and minimum open timer,

Set $g_t = \frac{(\tau_{gmin}+\tau_{gmax})}{2}$

When current open road is the first one, set r_g= 1.

Find number of vehicles on each road and intersection's distance $< D_{max}$

Wait for the transition period when there is no vehicle withinD_{max}.

After waiting for transition period, road is closed and the following road is then chosen.

If the EV is approaching in a closed road (r_{em}), the warning message is send to each vehicle inr_g, which indicates that the road is going to be closed to give the way for the EV in another road.

Then wait for T_y

The r_g road, which is opened gets closed

The road with EV is opened (r_{em})

The r_{em} road remains open until the EV is passed through the intersection.

If no EV is in the closed road, τ> (t_g+g_t)

If yes, the system dynamically decides to select the next road

If no, a broadcast message is send periodically to all the roads

Repeat the same process.

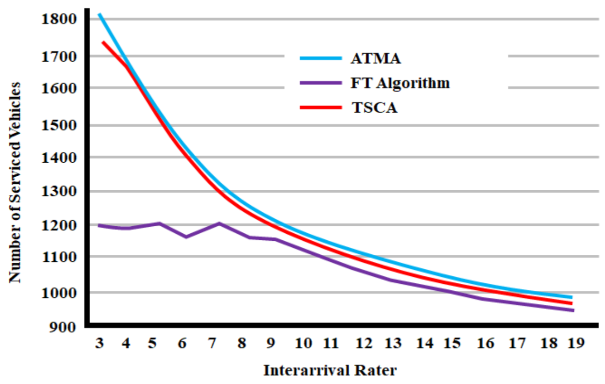
3. Implementation and experimental results of ITS

The traffic congestion is the major issue in the recent days, which indirectly affects the growth of the nation. The normal traffic stream is disturbed by various factors like traffic incidents, weather, work zone, accidents etc. To route the vehicle and pedestrian traffic, the traditional traffic signals are combined with an array of sensors and AI through the vehicle traffic control system. The ITS is proposed in this paper based on techniques like VANET and IOV.

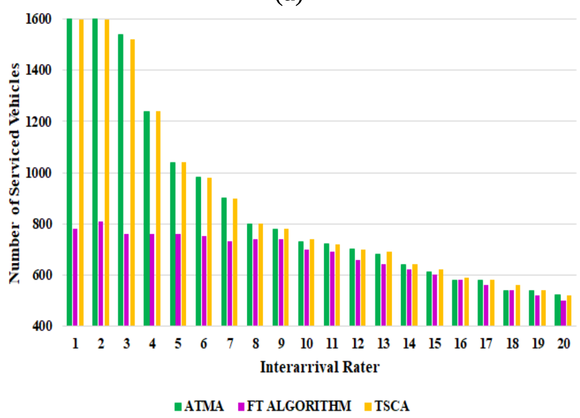
3.1 Simulator for ITMS

The ATMA is simulated by using an event based simulator in Python, which is capable of simulating any intersection with different number of roads. An expatriate (1/rate) exponential random distribution function is used to determine the time between vehicles arriving on each road. For every second, approximately two vehicles are arrived when then rate is equal to 0.5. Likewise, the inter-arrival rate on each road differs on the basis of the number of vehicles.

For different configuration parameters such as R, T_{green}, T_{yellow} and L(r), simulator simulates the FT algorithm [26] and TSCA [27] in all legacy tri-color traffic signals. The simulator calculates a total number of automobiles, which cross an intersection when the road is open. In addition, it calculates the total number of cars arriving on all routes and the

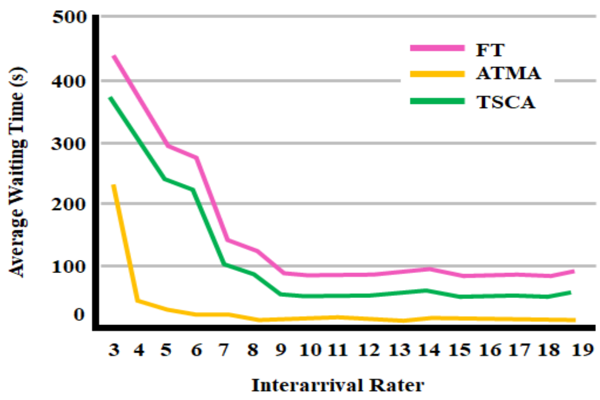


(a)



(b)

Figure. 5: (a) Three roads having constant rate of 10, 15 and 20 seconds, (b) Other roads having same rate of 30 seconds



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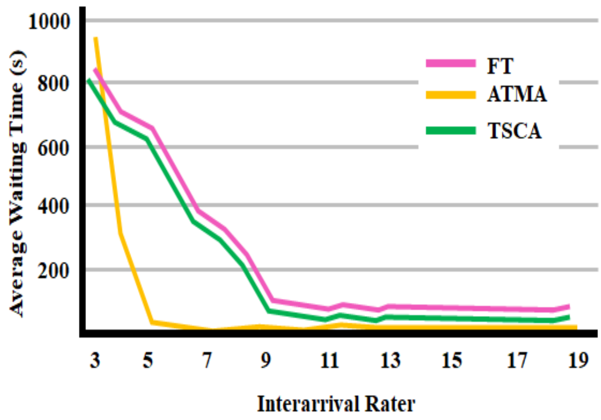

(b)

Figure. 6: (a) Roads with constant rate of 10, 15 and 20, and (b) Other roads having same rate of 30 seconds

AWT of the vehicles. For both FT algorithm and ATMA, these values are calculated. Finally, the obtained results are compared with the existing approaches. The results are discussed in the below part:

3.2 The effectiveness of arrival rates

The performance of the ATMA is studied on the basis of two schemes, for one route, the inter-arrival rate (r) varies from 1 to 20 seconds. The other 3 roads' inter-arrival times in the original design were 10, 15 and 20 seconds; however, in the second scheme, these times were always 30 seconds. When the value of r increases, the traffic density decreases.

From Fig. 5 the ATMA exhibits superior performance compared to the FT algorithm in handling high traffic density, resulting in more efficiently serviced vehicles. Additionally, the FT algorithm demonstrates a consistent number of serviced vehicles across traffic rates 1 to 9, suggesting limited adaptability to varying traffic conditions. Furthermore, the ATMA's performance is comparable to TSCA, indicating that the ATMA achieve similar results to a specialized control algorithm designed explicitly for traffic signals. These findings emphasize the effectiveness of the adaptive approach implemented in the ATMA for optimizing vehicle service levels.

The FT algorithm [26] performs poorly in terms of Average Waiting Time (AWT) under high traffic density, reaching up to 369 and 548 seconds for the two scenarios shown in Figure 12. However, adopting ATMA significantly reduces AWT to 46 and 17 seconds for respective scenarios. Even as traffic density decreases ($r > 8.5$), the ATMA continues to outperform the FT by at least four times.

3.3 Effect on various traffic conditions

When the traffic conditions is not same on every road, its effect is determined based on two scenarios. The first scenario, the arrival rate of vehicle in one road is high($r = 1$ to 20 seconds) whereas in next scenario, an arrival rate of vehicle in other three roads is low ($r = 30$ seconds), which is approximately equal to the arrival of one vehicle in every 30 seconds.

In Fig.7, the rate of arrival is constant on three roads and varied on the 4th road. Fig. 7 shows how

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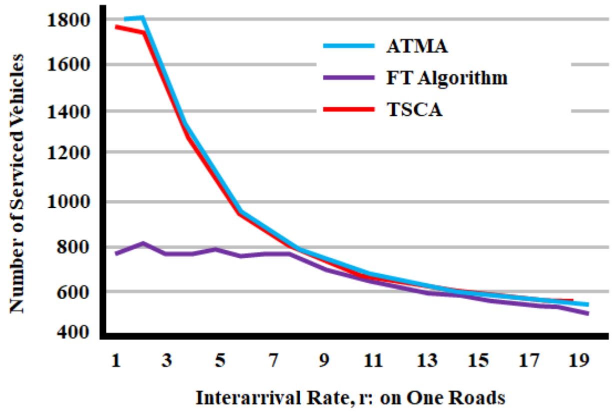

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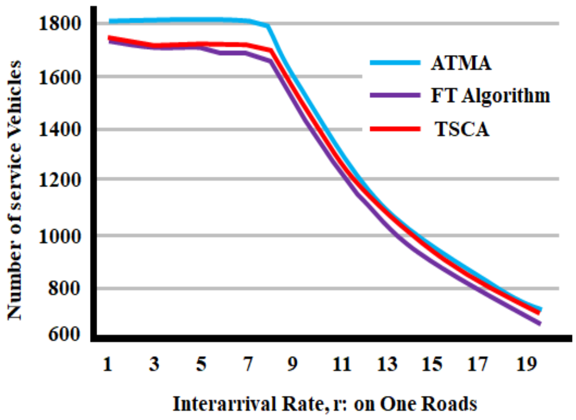
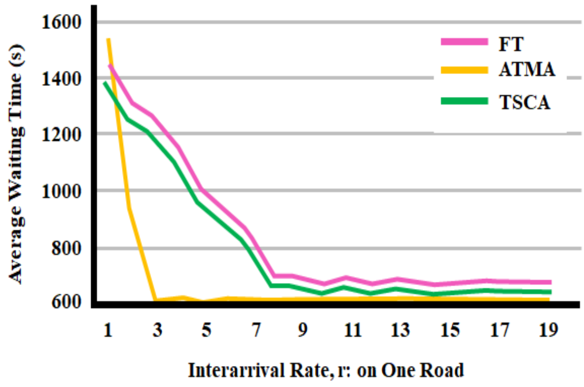
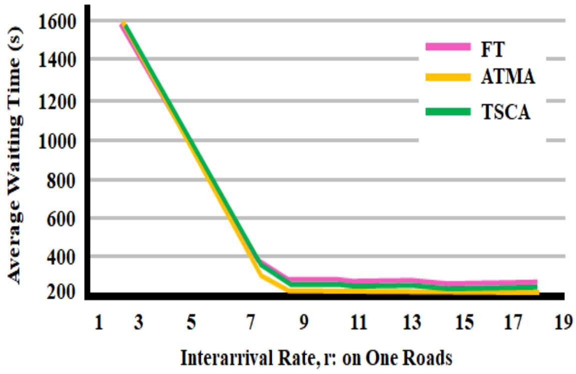


(b)

Figure. 7: (a) Fixing arrival rate on 3 roads and differing on 4th road and (b) Equally differing the inter arrival rate on all roads



(a)



(b)

Figure. 8: (a) Fixing the arrival rate on 3 roads and differing on 4th road and (b) Equally differing the inter arrival rate on all roads

number of serviced cars uses fixed time algorithm, ATMA and TSCA is calculated when the density of traffic on one road is high and on other roads is low (a) and (b). The traffic rate was varied uniformly across all roads, ranging from very high density (r > 1) to low rate (r > 20). The corresponding outcomes are depicted in Fig. 7 (b).

The inter-arrival rate on roads are equally varied from high to low (r =1 to 20 seconds). The results demonstrate that the ATMA reduces the AWT of vehicles than the fixed-time Algorithm [26] and TSCA [27].

3.4 Impact on number of roads in intersection

Different simulations are performed based on two scenarios. In first scenario, same inter arrival rate is set on all roads, in which traffic density decreases when no. of roads increases. An impact on varying the no. of roads at intersection using fixed-term, TSCA and ATMA is represented in Fig. 9. The results demonstrate that number of vehicles serviced using fixed-term algorithm and TSCA is less. An impact of adjusting the no. of roads at an intersection on the AWT computation is shown in Fig. 10. The AWT gets reduced when the number of roads is increased. The AWT of ATMA is lower than the FT algorithm and TSCA.

In next scenario, the traffic condition in one road is kept as high whereas the traffic condition in other roads is kept as low. The impact on varying the number of roads at intersection using fixed-term, ATMA and TSCA is represented in Fig. 11. The results shows that the number of vehicles serviced using ATMA is better than the fixed term Algorithm and TSCA.

In the scenario, traffic rate is fixed at (r > 30 sec) for all roads, except for one where high traffic density was simulated (r > 2.5 sec). The outcomes are illustrated in Figs. 11 and 12. The number of serviced vehicles using ATMA algorithm matches that of the TCSA. However, FT algorithm service approximately half of the vehicles serviced by TCSA. Moreover, the ATMA significantly reduces the AWT compared to the FT, particularly for small R values. As the value of R increases, performance of FT algorithm gradually improves.

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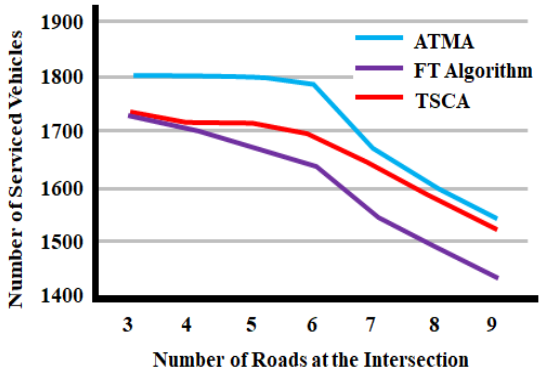

Figure. 9 Impact on varying the number of roads at intersection

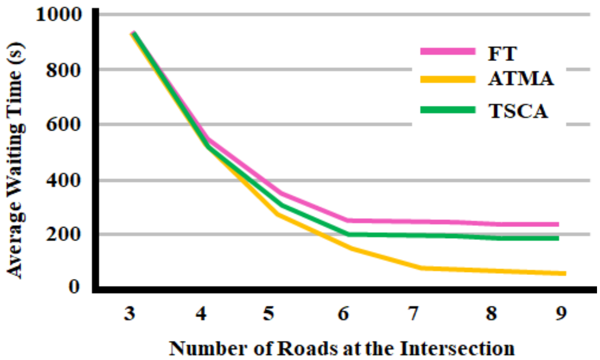

Figure. 10 AWT through the impact of varying the number of roads at intersection

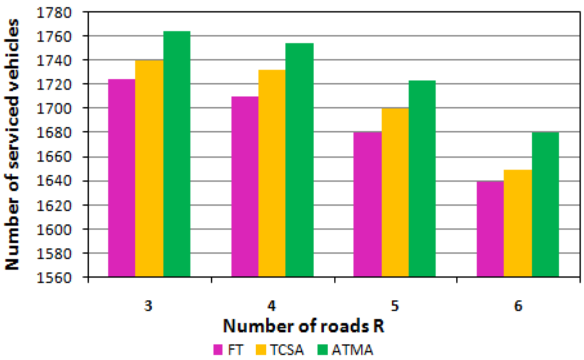

Figure. 11 Impact on varying the number of roads at intersection

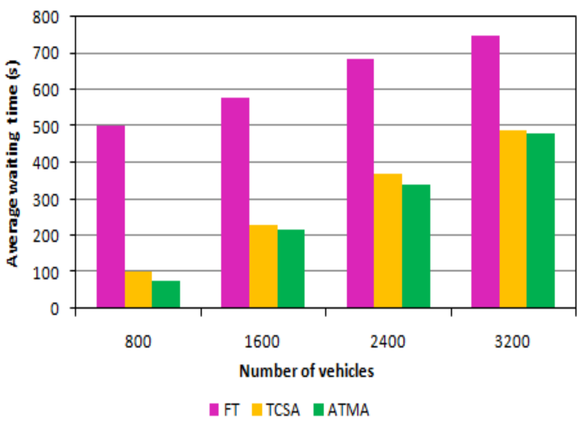

Figure. 12 AWT through the impact of varying number of vehicles at intersection

4. Conclusion

This paper makes a proposal for an intelligent traffic system based on IoV and VANET technologies. The ITS structure and its functions are highly applicable for meeting the necessities of smart cities. The traffic control system is connected with a Road Side Unit controller. Additionally, the ATMA is provided to govern the ITS. Furthermore, a simulator in python simulation is developed to study the effectiveness of the ATMA. The performance of ATMA is analogized with FT algorithm and TSCA under various traffic conditions. The results demonstrate that ATMA-based ITS outperforms existing traffic management systems with an AWT of 277.5s for the number of vehicles and 282.14s for number of roads at the intersection. Moreover, it efficiently services an average of 1731 vehicles concerning the number of roads.

Conflicts of interest

The authors received no specific funding for this study.

Authors' contributions

Conceptualization: P. Oliver jayaprakash, Data Curation: P. Oliver Jayaprakash, Methodology: M. Mohan Babu, B. Damodhara Reddy, Project administration: B. Damodhara Reddy, Supervision: M. Mohan Babu, S. Herald Lessly, Validation: M. Mohan Babu, B. Damodhara Reddy, Writing-original draft: P. Oliver Jayaprakash, Writing-review & editing: P. Oliver jayaprakash

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