Optimized Intelligent Traffic Control and Management System for Vehicle

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Abstract: In this new Era the growing Vehicle population in all developing and developed country calls for a major improvement and innovation in the existing Traffic control systems. This goal of this paper is to model a system that uses an efficient traffic light system to control autonomous vehicles at intersections and also gives priority to emergency vehicles. The optimized traffic control system for vehicles are intelligent, the traffic light agents are reinforced using Q-Learning. The most widely used automated system uses a simple time based system which working on a time interval basis which is now inefficient for random and non-uniform Traffic. The system assigns the emergency vehicles a separate lane in the network. The system will detect and identify vehicles that exceed the maximum authorized speed limit on selected carriageways, and is capable to grant priority to selected vehicles (e.g. Public Transport (PT), Emergency Vehicles) at an intersection controlled by some form of traffic signals. The system helps to enhance traffic control system and management and its technology senses presence of Traffic near any junction and then able to route the Traffic based on Traffic availability. This system does not require any system in vehicles so can be implemented in any Traffic system quite easily with less time and less expensive also.

Keywords: **Intelligent traffic control, traffic management system, vehicle control system.**

I. INTRODUCTION

The Traffic Congestion is expanding at a disturbing rate in emerging nations which require the need of Advance keen Traffic signs to supplant the Conventional manual and time based Traffic signal framework. The Conceptual System which depends on association of vehicles and can't be essentially carried out in nations like India which have practically in excess of 100 million vehicles on Road [1]. Keen Transportation Systems is a worldwide pattern, drawing in overall interest from transportation experts, auto industry, and political leaders. 'intelligence transportation system is connected with cutting edge correspondence, data, and hardware innovation to tackle transportation issues, for example, gridlock, wellbeing, transport 'effectiveness and ecological protection [2]. Wolfgang Lutz projected a 20 percent likelihood expansion in the total populace size in the year 2050. This is because of pinnacle expansion in populace size toward the finish of each and every year [3]. Thus, this developing number of human populace has likewise meant a worldwide expansion in street traffic all over the planet as additional individuals are going for either financial purposes or individual requirements. The capacity to control this normal increment of street traffic particularly at street network convergences is turning out to be very difficult which in numerous ways caused misfortune in efficiency; weakening in the way of life of metropolitan city occupants because of high fossil fuel byproducts. As can be anticipated, these decays result from longer holding up time at intersection focuses [4]. Be that as it may, the utilization of multiagent frameworks has been extremely fruitful in recreating and creating positive outcomes equipped for tackling issues emerging from these issues. Displaying ideal traffic signal planning framework that is insightful to limit holding up time at intersection and stay away from vehicles impact [5]. Blockage in rush hour gridlock is a difficult issue since it might make the serious harm the everyday arranged exercises. Checking the traffic is likewise a difficult issue. The constant expansion in the blockage level on open streets, particularly at busy times is a basic issue in numerous nations and is turning into a central issue to transportation trained professionals and leaders. Existing isn't productive to control the clog in cosmopolitan urban areas. Measures are as yet taken to stay away from gridlock by developing flyovers, new expressways and sidestep. In any case, every one of these led to increment in the asset necessity and labor.

II. INTELLIGENT AGENTS

Intelligent agent based traffic control system should be capable of calculating and optimizing control strategies, also know about the intersection(s). The 'intelligence transportation system agent can straightforwardly impact the control procedure of their intersection(s) and can get understanding in on-coming rush hour gridlock. In any case, fostering a framework that arrangements with the difficulties (gridlock, security, transport 'effectiveness and ecological preservation). In any case, for certain specialists, the idea of a solid canny specialist is viewed as PC specialists that partakes in these properties recorded and furthermore has some mentalistic thoughts, for example, Belief-Desire-Intention (BDI) [6]. In this unique circumstance, solid keen specialists show human-like ascribes, if conceivable more canny than people. Be that as it may, the extent of this work doesn't cover specialists with mentalistic credits. Allow us to consider a piece of programming that changes over data demands into a proper Server Query Language (SQL) question for an offered data set and returns the response. This product specialist just shows favorable to animation for example just objective coordinated conduct. Nonetheless, this basic programming model just works in a framework with a perpetual climate. Tragically, this framework will essentially crash when it experiences unclear circumstances. Hence, the framework despises reactivity property. Additionally, there is no collaboration between this framework and other programming specialists; subsequently needs friendly capacity.

2.1 Learning Agents - Reinforcement Learning for Traffic Control

RL is a sub area of machine learning that implores a computational learning approach from agent's interaction with their environment. According to Michael L. Littman [7], no specialist lives in a vacuum; it should collaborate with different specialists to accomplish its objective. Notwithstanding, support hypothesis depends on the hypothesis of Markov Decision Principle; this rule is reasonably applied to control specialists connecting in a period discrete stochastic powerful climate while settling on choices that the result of the following state is unsure [8]. Thus, support learning can be referred as an AI calculation which is objective coordinated, and specialists follow up on their current circumstance in view of the prize they got in their past activities. Hence, specialists will more often than not map activity to states in their current circumstance in view of a mathematical prize worth. The higher the worth, the almost certain they will make a move with most elevated reward. RL guarantees that specialist keeps on learning until it has procured an ideal prize worth. Thus, learning is a constant cycle and all support learning specialists have unequivocal objectives and should pick activity that expands reward. As a matter of fact, a state will undoubtedly have a prompt most elevated reward esteem; it is the prize worth after a long disagreement the climate that is important. RL is applied in building games; well known among them is "spasm tac-toe".

2.2 Related Literature Review

According to [9], proposed an Emergency Management System (EMS), it is a new research field in the intelligent transportation system. There is a major problem with mixed vehicle (e.g. cars, scooter, heavy vehicle etc) traffic flow that has been tackled with this system. EMS is mainly concerned with the application of different intelligent transportation system technologies to develop a transport system which can provide help in the emergency conditions.

In [10], demonstrated motion-based tracking with trajectory analysis method is to improve intersection behavior analysis for accurate turning movement count at the intersection.

According to [11], Image processing algorithm is used to estimate traffic density using cameras. Based on analysis of traffic images from live traffic evidence of congestion collapse which lasts for the extended time period.

In [12], demonstrates many ITS applications rely on lane-level vehicle arrangement (positioning) that requires high accuracy, bandwidth, availability, and integrity. Lane-level positioning methods must reliably work in real time in a wide range of environments demonstrated. There are many lighting and weather conditions effects on vision-based systems. Such system must adopt all these lighting conditions. The different cues are given related to this kind of situation in [13]

In [14], modelled an optimal traffic light scheduling system using Multi-agent Reinforcement Learning (MARL). In their work, they introduced a novel use of a multi-agent system and RL framework to obtain an efficient traffic signal control policy. This was aimed at minimizing the average delay, congestion and likelihood of intersection cross-blocking. Their framework comprised of two types of agents, a central agent and an outbound agent. The outbound agent schedules traffic signals by following the longest-queue (LQF) algorithm, which collaborate with the central agent that provides the local traffic environmental behaviors. The central agent in this framework learns the behavior of the traffic condition in its environment using a value function. They were able to measure the efficiency of the system by comparing two different methodologies, QL algorithm with a feedforward neural and LQF. However, experimental results clearly showed that MARL using QL algorithm outperformed LQF in a more complex traffic control setting. But, their work took no account of emergency vehicles.

In [15], utilizes linear time algorithm for traffic control and thus reduces computation power in decision making. Furthermore, reinforcement learning comprises these four components: policy, reward function, value function, and a model of the environment. Policy deals with which action should an agent choose at any given time; which action can be mapped to the current state of environment? It is a sensor/actuator type of communication. The reward function simply maps the perceived sate/action pair of the environment to a numerical (reward) which determines how desirable the state is. On the other hand, the value function specifies what is good in the long run. This is unlike the reward function which considers only the immediate reward. Hence, value function takes account of all the rewards from the beginning till the end of the learning process. Finally, the model of the environment is optional that can predict the next state of agent environment.

III. DESCRIPTION OF EXISTING APPROACHES

Based on the literature reviewed, the previous work done on the existing system of traffic control with various approached is described as follows:

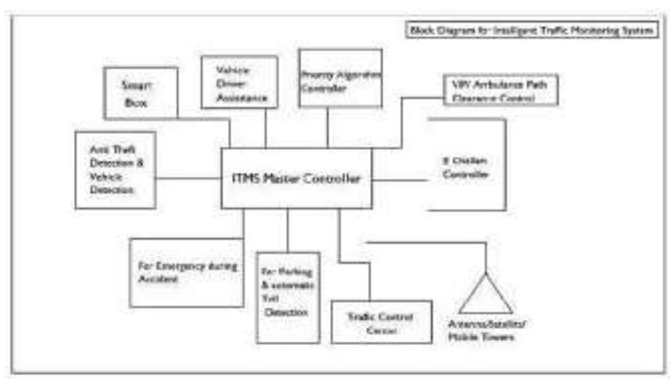
The problem of vehicle counting is mostly done using deploying inductive loops. These loops provide high accuracy but are very disturbing at the roadway, that's why it comes with high maintenance cost. Most of video analytics system on traffic congestion focuses on counting and doing classifications for more statistics. The existing system lacks simulation model (i.e approaches used to make traffic routing and a signal controlling decisions, i.e. adaptive (learning) versus non- adaptive, simulation versus real-time and hybrid strategies, types of parameters (input and output) such as traffic quantity, waiting time, previous and current traffic data information/knowledge to make traffic routing and Video Analytics Deployed in traffic domain for traffic congestion control) for implementing emergency vehicles in the design of road network by transport engineers. This will create difficulty to analyses traffic performance and strategies on how to improve the travel time and safety of emergency vehicles and also it affects assigning of emergency vehicles a separate lane in the network. The algorithm will be difficult in case of modification to use data such as the number of vehicles waiting at intersection to provide a more optimal method for traffic control. Below are some of the algorithm used and result of the system.

Table 1.

Reference	Algorithm	Results
C. Lan and G. Chang,	An optimization model for signaling time at intersection under mixed heavy traffic	The investigation provides queue length, queue clearance time
Shirazi, Mohammad Shokrolah, and Brendan Tran Morris	Vision-based Vehicle tracking system	Estimate turning movement count, speed profile and waiting time
P. Y. P. Singh and U. P. Bijnor	Road traffic congestion system	Intelligent decision making for traffic controlling
A. Vu, S. Member, A. Ramanandan, A. Chen, J. A	Computer vision and differential pseudo range Global Positioning System with Kalman filter	Inertial navigation
Y. C. S. Huang and L. F. P. Hsiao,	Vision based automatic vehicle detection under lighting condition	Vehicle detection
H. Hajimolahoseini, H. Soltanian-Zadeh, and R. Amirfattahi	Night time traffic surveillance	Vehicle detection, racking and speed estimator
Sameh Samra, Ahmed El-Mahdy, and Yasutaka Wada	Traffic Signal Controlling using image processing	Automatically estimation of traffic density and duration of each traffic light

3.1 Vehicle Detection

Intelligent traffic lights in many urban communities are designed to distinguish vehicles moving toward a crossing point or when numerous vehicles piled up at a convergence. Have you at any point thought about how these traffic signals recognize vehicle? A parking structure is a typical model which utilizes little drove bulbs overhead each stopping opening to effortlessly direct a driver to one of the free stopping spaces. These little bulbs basically substitute their lighting tone from green to red. For this situation, red connotes an inaccessible stopping space, while green implies free stopping opening. A little exploration to comprehend the hypothesis behind these indicators focuses to enlistment circle and supports this finder with other two sorts: path based locators, multi-beginning/multi-objective identifiers [16]. Finders are likewise used to find a focal point inside a recreation for legitimate examination in traffic light framework.



Block diagram of intelligent traffic control system [17].

IV. EXPERIMENTAL

The simulation environment was modelled as a 2 x 2 grid network and 300 number of vehicles were loaded into the network. The vehicles were distributed and emergency cars accounted for 25% of the total number of vehicles. This was done because, hardly in a real world do emergency vehicles constitutes over 25% of all the vehicles in a road network except in a disaster management. SUMO output edge based traffic measure files were generated using an additional file. Each of the files contains all the output traffic data that took place in the whole network edges based on a specific vehicle type. Dump output containing all results for emergency and normal vehicles can be found in Appendices A and B respectively. The vehicle speed was limited to 15 m/s and the simulation was run for at least 1000 time steps with a delay of 120 m/s and results were collected at intervals of 50 - 1000 time steps.

4.1 Result and Discussion

The results strongly show that reinforced agents give priority to emergency vehicles and in overall reduce waiting time of other vehicles. According to [4], the arrival rate of multiagent learning agent outperformed LQF Scheduling delay. The system provide a simulation model for implementing emergency vehicles in the design of road network by transport engineers. This will assist them to analyze traffic performance and strategies on how to improve the travel time and safety of emergency vehicles and other vehicles. The system assigns emergency vehicles a separate lane in the network. The system will detect and identify vehicles that exceed the maximum authorized speed limit on selected carriageways, and is capable to grant priority to selected vehicles (e.g. Public Transport (PT), Emergency Vehicles) at an intersection controlled by some form of traffic signals.

V. CONCLUSION

This goal of this paper is to model a system that uses an efficient traffic light system to control autonomous vehicles at intersections and also gives priority to emergency vehicles. Several researches have been carried out on intelligent traffic monitoring system, but the proposed system is an optimized system that will detect and identify vehicles that exceed the maximum authorized speed limit on selected carriageways, and is capable to grant priority to selected vehicles (e.g. Public Transport (PT), Emergency Vehicles) at an intersection controlled by some form of traffic signals. It also presents a method to detect and counter hacking of traffic signals the optimized traffic control system for vehicles are intelligent, the traffic light agents are reinforced using Q-Learning. Which is a very common problem nowadays. The distance between intersections and emergency vehicles were estimated to achieve the target travel time of emergency vehicles with minimal delay time, considering both hacked and non-hacked traffic signals. The proposed model not only distinguishes emergency messages with several priorities, but also prevents false warnings from malicious entities.

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