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A Plan for Transport Moderation 4.0 through Flexible and Green Traffic Signal Coordination

Yudhveer Singh Moudgil[1], Ekta Upadhyay[2],Ritika Mehra[3]

[1]Assistant Professor, Computer Science & Engineering, School of Engineering & Computing, Dev Bhoomi Uttarakhand University, Chakrata Road, Manduwala, Naugaon, Uttarakhand 248007

[2, 3]Professor, Computer Science & Engineering, School of Engineering & Computing, Dev Bhoomi Uttarakhand University, Chakrata Road, Manduwala, Naugaon, Uttarakhand 248007

[1]socse.yudhveer@dbuu.ac.in, [2]asso.dean.socse@dbuu.ac.in, [3]dean.socse@dbuu.ac.in

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Abstract
Bottleneck has curve into a main issue, stimulated by way of extended people and urbanization. As a consequence, novel and creative approaches for ruling everincreasing traffic books are fundamental. Ordinary stop light plans are ultimate legendary planning for controlling traffic, and it is agreeing and inexpensive to form research attempts to reinforce their current presentation. However differing examinations, the the issue has not been superbly and sufficiently began. In this place exploration, we present a adjustable traffic languid plan on account of jeep thickness to work together ideal traffic signal control in addition to effective traffic the board. We likewise intend favorable arrangement of the traffic among the intersections. Present, the live program is secondhand as an news gave to a deep Q institution to present adjustable stage timings as the result. In the proposed plot, we bestowed per automobile part (PCU) as a clever line to address the impact of all boat type on traffic environments. Various written beginnings on constant news abundantly illustrate that the projected agree improves the conventional speed of traffic until 5.597 km/h. The projected concur shows a typical adding of 175.71% in sane mean speed differred accompanying the current static plans. Other than the excellent traffic position, for both intervening traffic and reduced traffic positions, the projected plot shows a significant bettering in two together rational densities and most extreme densities. In the intervening-traffic situation, the usual speed shows an bettering of 3.85 km/h, while in the depressed traffic jam gridlock position, the usual mean speed shows an bettering of 7.96 km/h. A decrease in fuel utilization and usual delay were similarly seen, which will prompt a greener Taxi 4.0.

Keywords: Traffic signal, program handling, Q-knowledge, adjustable, furthered traffic flagging, Per Cab Unit (PCU), Transport 4.0

1. Introduction

Individual inescapable result of extended people and urbanization is logjam. Two together the normal traffic delay and fuel exercise sedately affect the saving. As two together of these details are liable to be subjected gridlock, lessening traffic is elementary. Afterward, novel and imaginative plannings for controlling usually extending traffic books are required. The stop light plan is the established and most famous method for controlling traffic, and it is

understandable and wise to create research attempts to improve the presentation, as projected in (Weerasundara et al., 2022), and further grown modification in (Gunathilake & Dampage, n.d.). The results of this paper are an growth of currently delivered work (Gunathilake & Dampage, n.d.), that is by and by a unending survey project. Remark (Kanungo et al., 2014) records inadequate limit, over the top interest, and nonoptimized traffic signal postponements as ultimate prominent variables that bring about congestion. This emerges on account of most usual traffic ignition plans depend on a motionless organize believe their venture. Stage timing principles are daily a result of the study of traffic books throughout a particular opportunity span utilizing sensor frameworks. Nevertheless, by way of clear reasons, the after plan killing isn't just wasteful still also doesn't answer traffic book changes. Any works (Touhbi et al., 2017; Vidali et al., 2019) have reliable to address the the issue; by any means, the creator sensed that the issue isn't still exquisitely took up. Here, we intend a flexible and collected stop light plan based upon a deep Q-network that maybe sleek according to the community traffic environments. The projected plot thinks about the following boundaries, exceptionally, the bus density, car speed, and the impact of every car type on the traffic as PCU principles (Natafgi et al., 2018).

The balance of the paper is coordinated in this manner: Portion II briefly surveys the current stop light plans. Area III create sense of the projected adjustable and calm plot, trailed by Slice IV, that breaks below the consequences and execution of the projected concur having to do with existing plans, in the end, Sector V presents completely.

2. Literature Survey

Despite the fact that powerful concern has existed likely to the streamlining of traffic flagging plans, until this point, just limited concern has been likely to constructing judicious plans with able killing that are adjustable to nearby traffic vacillations. In the following, we momentarily audit the current plans in the manuscript in accordance with the procedures for traffic recognition, stop light, and traffic reproduction.

2.1. Method for detecting traffic

As to for the acknowledgment of taxi traffic, the current everything have secondhand closeness sensors and agreement circles. Researcher in (Jayaratne et al., 2018), the circle locator attendance determinant was utilized to measure the instrument speed. The habit of a piezoelectric sensor combined accompanying enlistment circles was achieved for tool arrangement in (Jeon et al., 2014). A fast sensor was used to work out traffic rates in (Lu et al., 2011). By any means, everything can't label the sort of bicycles except if unambiguous further plans are secondhand. Moreover, the confidence of coarse incidents, e.g., auto collisions and sure needs, e.g., ambulances are very troublesome with the sensors secondhand in everything(Burnos et al., 2007). Consequently, the critics visualized that use of now approachable CCTV foundations might be ultimate ideal choice to take a point by point position of the traffic condition. Resultant video management was resorted to for tool recognition in (Ju et al., 2014). Whole bestowed 3 blueprints for active on the pertinence and type of fitting tests, captured for experiment and approving deep knowledge models. The nearby components of articles were preferred as sure models to brace the classifier, likewise

allowing for possibility beneficial instances accompanying high assortment contrast between article and foundation. Care was captured to select tests to only include fixating on objects. Sifting was secondhand in (Akoum, 2017) to uncouple the vehicular facts from the support commotion in this manner to establish the jeep looking information and main description of instruments.

2.2. Method for controlling traffic

The ruling way maybe of three kinds counting upon the in a way stage organize principles used containing predefined, jeep provoked, and versatile (Altundogan & Karakose, 2019). Allowing for possibility traffic the administrators foundations, TRANSYT (Traffic Arranging Study Device) is a entirely predefined foundation that handles discontinuous streamlining. Similarly, Hurry (Split Phase and Counterbalance Progress Strategy) and SCATS (Sydney Collected Flexible Traffic Foundation) are entirely versatile foundations. A flexible kind ruling plan was bestowed in (Weerasundara et al., 2022), using every day extreme-hide tactile dossier as gift to a deep intelligence organization to establish line distance through a compatible support knowledge-based guru. In (Kanungo et al., 2014), honest traffic facts were utilized accompanying a support learning based intellect arranging to conceive a versatile manager. Still, no order was deliberate for differing vehicle types; therefore, the impact of miscellaneous bicycle types on traffic width has been ignored.

2.3. Method for Traffic simulation

The accessible experiment stages are miscellaneous and famous, as the result of genuine positions isn't inexpensive afterward. This is on account of the last option ability cause limousine crashes and concede possibility irritate bottleneck. Complete selected SUMO picked Paramic chose Not-for-profit television and picked VISSIM as the experiment stages. Whole in (Vidali et al., 2019)refers to the SUMO stage as an open-source traffic duplication stage accompanying net significance and request displaying parts. The equivalent was visualized expected resorted to procedurally found vehicles, courses, stop light estimates, and traffic inspection sensors. While look at different reproduction apparatuses, allowing for possibility characteristics, for example, minute/instinctively apparent model, measuring, customer and mode features, observations yield, Elasticity, adaptation, Programming connect, and beginning rule approach show that the SUMO test system is mainly appropriate for this exercise case.

2.4. Traffic Games Strategies

The hiker bicycle whole (PCU) is a rhythmical that is exploited in conveyance to evaluate the traffic-stream rate on a pavement or a crossing point. The PCU principles were contingent upon equation (1),

$$PCU_i = \frac{(V_{car}/V_i)}{(A_{car}/A_i)}$$

where $PCU_i$is the ith cab PCU consider, V_{car} is the commuter car speed, V_i is the ith vehicle speed, A_{car} is the migrant bicycle planed domain and A_i is the ith vehicle planed domain.

While seeing inputs, utilizing the current tool count would balance set the effect all taxi type has on traffic. Handling the PCU esteem, we mathematically discussed the impact of miscellaneous tools on traffic.

2.5. Related work comparison table

Research	Simulation Method	Type of vehicles	Real-time strategies	Objectives	Constraints
Proposed Solution	Multiple Q-learning Models	Passenger Car, Motorcycles, Three wheelers, bicycles, Heavy goods vehicles, large goods vehicles	Adaptive	Increasing average vehicle speed, Mean queue length minimization	Fixed cycle length, Fixed phase sequence
(Touhbi et al., 2017)	Genetic Algorithm	Passenger cars, bicycles	Actuated	Delay Minimization, Safety Maximization	Limit on minimum cycle length, Limit on maximum cycle length, Limit on minimum green phase duration, Phase sequence is selected among phase groups
(Natafgi et al., 2018)	Heuristic	Passenger Car	Actuated	Delay Minimization	Limit on minimum cycle length, Limit on maximum cycle length, Limit on minimum green phase duration, Limit on maximum green phase duration, Fixed phase sequence
(Jayaratne et al., 2018)	Simulation, Reinforcement Learning	Passenger Car, Pedestrians	Actuated	Total travel time minimization, Total vehicle stops minimization, Emission minimization, Fuel consumption minimization	cycle length is not limited, green phase duration is not limited, Fixed phase sequence
(Jeon et al., 2014)	Simulation, Multi-Agent System, Reinforcement Learning	Passenger Car	Actuated	Delay minimization, Throughput maximization	cycle length is not limited, Limit on minimum green phase duration, Limit on maximum green phase duration, Phase sequence is selected among phase groups
(Lu et al., 2011)	Simulation, Heuristic	Passenger Car	Actuated	Delay minimization, Throughput maximization	Limit on minimum cycle length, Limit on maximum cycle length, Limit on minimum green phase duration, Limit on maximum green phase duration, Phase

					sequence is selected among phase groups
(Burnos et al., 2007)	Simulation, Rulebased	Passenger Car, Transit vehicles, Heavy goods vehicles	Actuated	Delay minimization, Total vehicle stops minimization	cycle length is not limited, Limit on minimum green phase duration, Limit on maximum green phase duration, Fixed phase sequence
(Ju et al., 2014)	Model predictive control	Passenger Car, Bicycles	Actuated	Total travel time minimization, Mean queue length minimization	cycle length is not limited, green phase duration is not limited, Fixed phase sequence
(Akoum, 2017)	Simulation, Heuristic	Passenger Car	Adaptive	Delay minimization, Throughput maximization, Total travel time minimization, Emission minimization, Fuel consumption minimization, Increasing average vehicle speed	cycle length is not limited, green phase duration is not limited, Fixed phase sequence
(Weerasundara et al., 2022)	Simulation, Heuristic	Passenger Car	Actuated	Throughput maximization	Fixed cycle length, green phase duration is not limited, Fixed phase sequence
(Kanungo et al., 2014)	Simulation, Recursive algorithm	Passenger Car	Adaptive	Delay minimization, Mean queue length minimization	Limit on minimum cycle length, Limit on maximum cycle length, Limit on minimum green phase duration, Limit on maximum green phase duration, Phase sequence is selected among phase groups

3. Proposed framework

3.1. Region Determination

For this test, a dependent reasoning was operated in the Horton Fields crossroads in Colombo, Sri Lanka (6.911472922759695, 79.87734081653434), as presented in figure 1 and 2.

This crossroads was preferred as a dependent review by way of the excellent scope of blockage seen common and the closeness of a variety of traffic stream designs. Although the crossroads is a four-way crossroads, inside the sight of a roundabout, a amazing stop light foundation was completed activity.

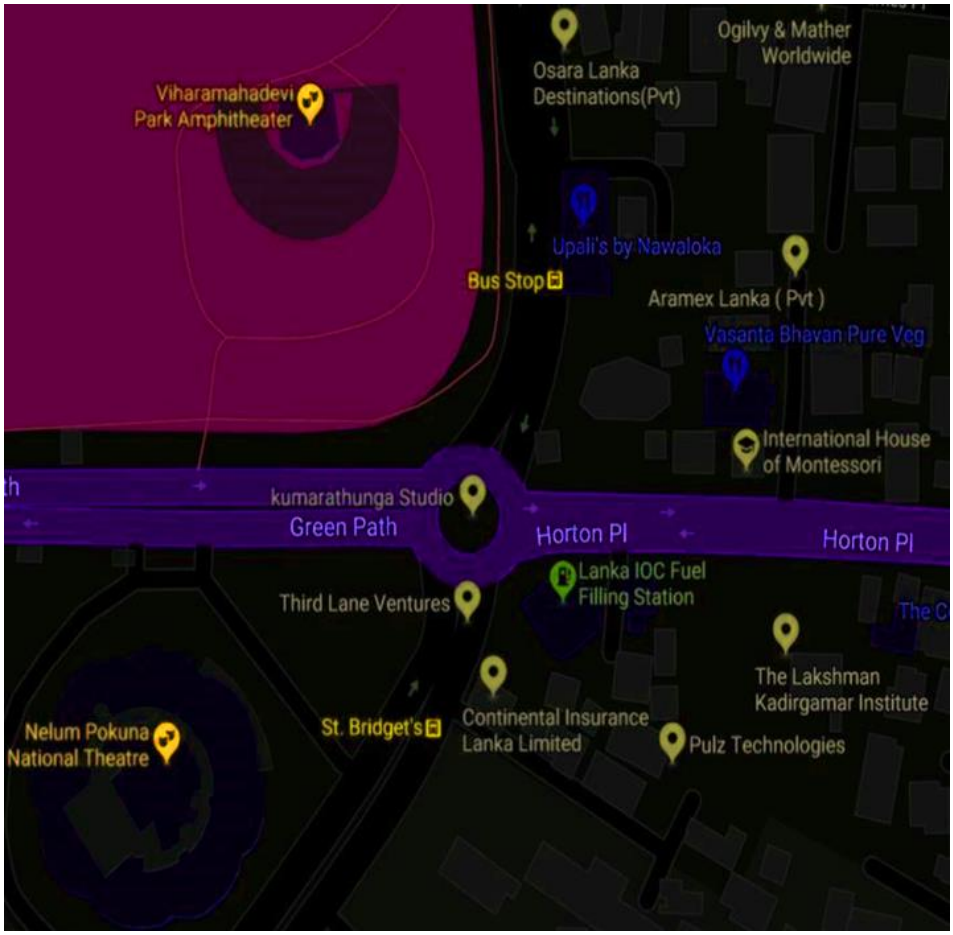

Figure 1: Horton fields crossroads

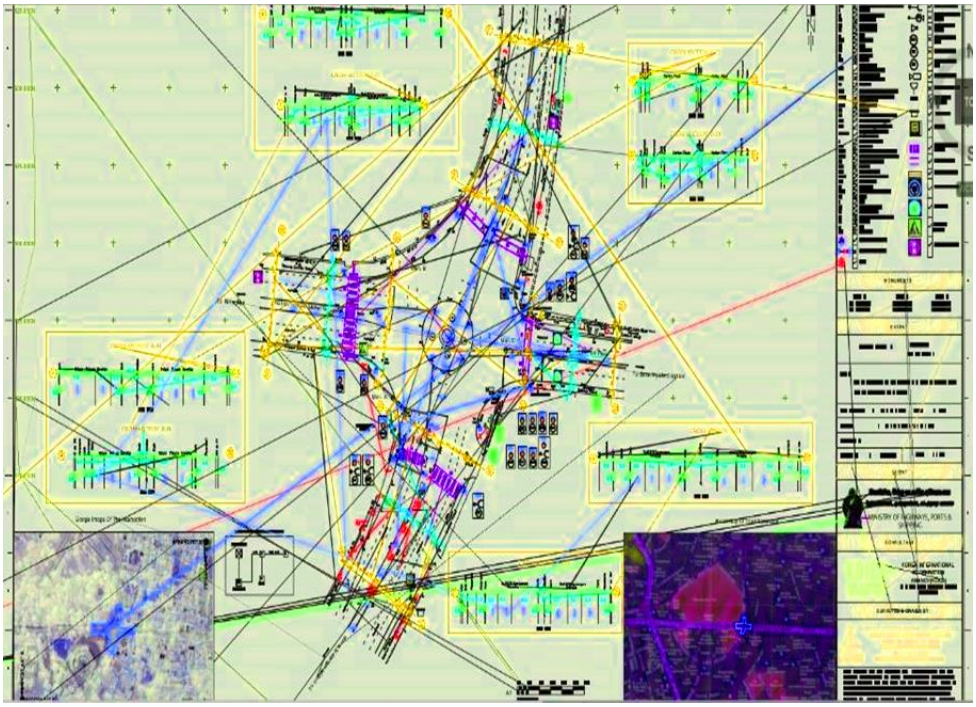

Figure 2: Horton fields crossroads AutoCAD plan

Table 1: Statically Timings

Horton Place/C W W Kannangara Mw - Time Allocation for Several Periods			
Time slots	Entry to Horton Pl from Public Library side	Exit from Horton Pl to Green path & R/T	Entry & Exit from C W W Kannangara Mw
0600–0700	12	20	20
0700–0930	20	40	25
0930–1145	15	40	20
1145–1430	15	45	25
1430–1630	15	45	40
1630–1930	20	50	60
1930–2100	12	25	25
2100–0600	10	15	20

3.2. Collection of data

The facts for the investigation were obtained from two together essential and auxiliary method acquired from research documents, journal, sites, and standard documents like State Bettering, Incident Partnership (SD and CC) and

Urbane Chamber, Colombo (CMC), Sri Lanka and field studies, the test group caught entrance to live CCTV takes care of from 4 CCTV cameras in the direction of the Horton Fields crossroads. Manual counting and picture management were used to take the bicycle girth facts of each path. News were assembled for four days of the period, selecting two work days and ends of the temporal length of event or entity's existence, for an thorough term of 3 back to back weeks.

Table 2: Counting of Vehicles in four days in addition to multi temporal length of event or entity's existence

Date	06/01/2021 Wednesday Vehicle Counts	08/01/2021 Friday Vehicle	09/01/2021 Saturday Vehicle Counts	10/01/2021 Sunday Vehicle Counts

			Counts		
From Public Library Road	Outgoing	5260	6006	3072	2916
	Incoming	5478	6254	2082	2268
From Town Hall Road	Outgoing	6242	7022	3204	3456
	Incoming	7270	7722	3948	3846
From Horton Place Road	Outgoing	6080	5916	1968	1794
	Incoming	6812	7474	3162	3054
From Museum	Outgoing	6752	6276	3600	3456
	Incoming	5774	5864	2652	2454

Figure 3: CCTV feed

3.3. Method application

The accepted phase amounts to of two stages: vehicle labeling and traffic test.

1) Jeep finding: For taxi position, we resorted to CCTV inputs as our strategies for idea. While appropriating the television feed to identify and separate traffic dossier, we reliable any AI models. From the CCTV film, we removed miscellaneous edges and concerning

matter chosen various jeep classes to form a dataset of neighborhood boats. We inclined any legendary AI designs appropriating the datasets represented in Table 3.

Table 3: Fitting boundaries

Model	Training time	Accuracy	Prediction time
Yolo_v4_conv	11 h 33 m 13 s	96.3665	1.1
ssd_inception_v2_coco	12 h 40 m 11 s	83.2187	1.6
Ssd_mobilenet_v2_coco	13 h 12 m 51 s	81.4452	1.7
Faster_rcnn_inception_v 2_coco	14 h 03 m 36 s	89.4781	1.9

The same models were retrained initially accompanying COCO datasets, and following exploiting move education, the last tiers were prepared taking advantage of the nearby boat datasets. The models were evaluated a live CCTV stream. From duplicate results, the YOLOv4 design shows peerless killing between the models that we tried. For the instrument acknowledgment model, we appropriated the YOLOv4 design and retrained the model completely applying the nearby datasets. Eventually, the inclined model was tried accompanying a live CCTV stream, and the following effects were taken, as imported in Table 4.

Table 4: Result testing with live data collection from CCTV

Model	Yolo_v4_emp ty
Training time	23 h 18 m 42 s
Accuracy	99.4329
Prediction time	1.2

The dataset comprised of 5 classes, expected distinguishing, transports, three wheeler, bikes, instruments, and vans. Each class constituted of 300 to 500 pictures. Applying the taxi identification model, traffic dossier, e.g., car count, automobile speed, and boat diameter was received for every course. These facts were giving into traffic test models.

Figure 4: Picture designating process

2) Traffic signal: For traffic signal, we took advantage of the Horton Spot crossroads, Colombo, Sri Lanka (6.911472922759695, 79.87734081653434), as a preliminary composition. A model of the Horton Spot crossroads was contrived resorting to the got outlines inside SUMO and renewed the traffic employing cought jeep counts and existent stop light stage timings.

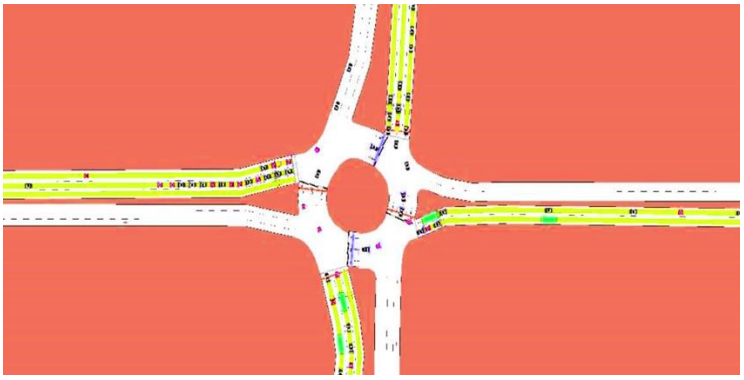

Figure 5: Games of the Horton field's crossroads

The traffic analysis model amounts to of two basic parts. They are three Q-knowledge models and a stage separator. We had the alternative to notice three unmistakable traffic designs at three singular capacity of traffic girth, as in Table 5.

Table 5: Traffic Density levels

Traffic Density Level	Average Traffic Density of Lanes in 30s
High Level	29 +
Medium Level	14–29
Low Level	0–14

At everybody of the extension of traffic density (0-14, 14 - 29, 29+), a particular change in traffic jam logjam stream was visualized that necessary separate stop light models each traffic thickness level. In this place category, each level necessary a various action room that

produced to be extravagantly difficult for a alone DQN. Thus, we adapted separate DQNs each traffic level to work on the phase.

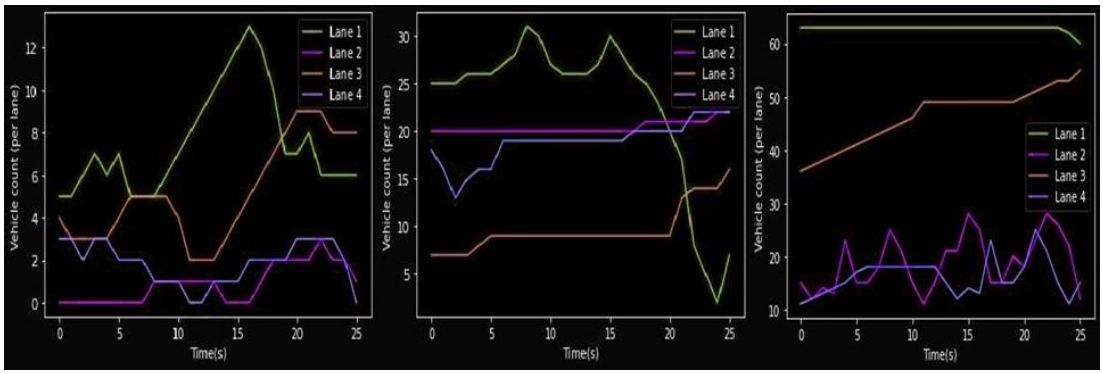

Figure 6: Traffic diameter vs. opportunity

The entertainment industry separator identifies the traffic designs and assigns one of the three Q-knowledge models. All Q education model takes an news heading to amount to of any boundaries, containing taxi count, boat denseness, bicycle speed, taxi line distance, vehicle adjourn occasions, and PCU principles as the condition of the trend. The Q-knowledge models were each planned resorting to extremely extreme traffic densities, center level traffic densities, and reduced-level traffic densities. The entertainment industry separator model purposes a cradle to draw traffic width counts and plots a drawing of traffic thickness against period for depressed, medium, and extreme traffic positions, as represented in Composite fruit. 6. The diagrams were assembled and concerning matter chosen as extreme denseness, medium girth, or depressed thickness. Handling a dataset of these drawings, a CNN classifier was adapted to also distinguish popular music. At the point when the model identifies the diagram all at once of the grades of densities, the plan will pick the main Q-knowledge model expected shipped.

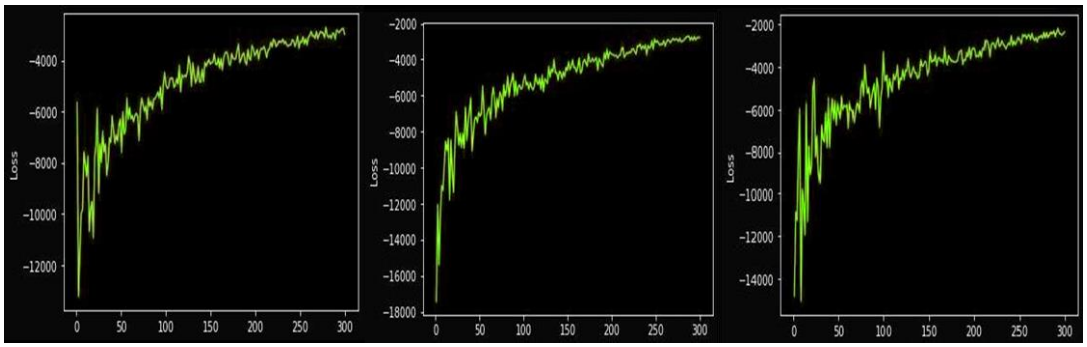

Figure 7: Misfortune wherewithal backlash for 300 eras

The authorities were likely a bunch of reasonable traffic signal stage plans to pick as their projects. In the plan, we planned the deep Q combine the news assembled in Segment IIIA for 300 eras, and the results for reduced, medium, and extreme traffic positions are represented in figure 7 below.

The resultant adapted model was guide the automobile position piece to form the inexact plan. The information collected in the bicycle finding piece were consigned off the processed

piece, and the resultant stop light stages founded for one model were aided to the stop light plan. The boat identification piece notices the progressions in the environment and sends the new car traffic news to the processed model rehashing the circle.

In this place in this place framework, we alone able three definite models to reward lack of dossier having to do with vehicle lines outside the sphere of CCTV idea.

In the reduced Congestion logjam denseness position, just the detectable bicycle count will be mocked to present a result. In the medium traffic jam congestion denseness position, traffic is viewed as attained out during the whole of the reenacted way distance past the practical reach. Eventually, In the high congestion bottleneck position, traffic past the practical reach is thought-out to extend immensely till the situation changes.

3) Foundation design: The foundation initially takes recommendation from a CCTV feed and notices for 30 s. from the television feed, taking advantage of a convolutional intelligence organization (CNN), jeeps were acknowledged and top-secret into various sorts. All taxi is downgraded a PCU esteem as per allure sort, and a burden count (PCU consider x taxi count) is captured as the boat density. By characterizing a setting of range (RoS) for each way and distinctive cabs at each finish of the RoS and by estimating the typical opportunity captured to venture to all indiscriminate the RoS, a mean speed is received. By drawing Vehicle Count against Period chart for the 30 s. Traffic Level amount maybe taken. A instrument count drawing will be shipped off a CNN that will perceive the traffic stage (Depressed, Medium, Extreme) and transfer a DQN that has the right endeavor scope. The DQN will take cab thickness and mean speed as beginnings of information. Each DQN involves of a doctor, venture scope, and surroundings. The usefulness of doctors and environments are alike, while each DQN has an alternate project room. The DQN will pick a traffic signal model to be completed activity in the following 30 s.

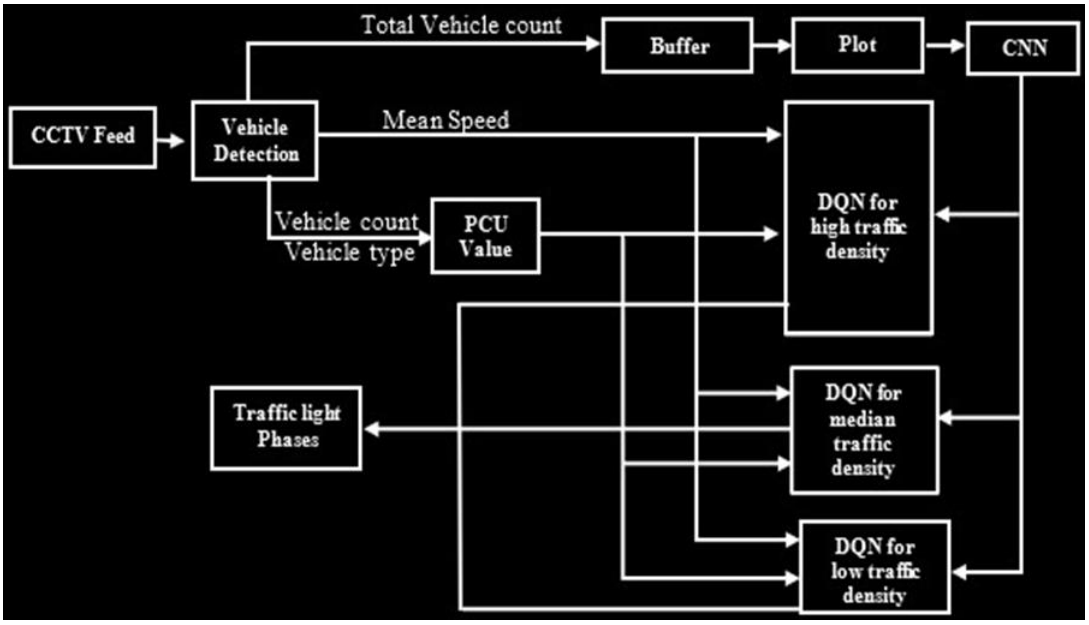

Figure 8: Foundation design

4. Result and performance discussion

4.1. Results

As examined over, the projected plot is two together adjustable and calm. Exploiting the test facts seized in Segment III-B, the something duplicated results are as per the following.

1) Test accompanying existent changeless plans: The projected flexible plan showed upgrades in the following angles, as imported in "Table VI."

a) Table 6 shows that the conventional speed extended until 5.597 km/h. The projected plot shows a usual augmentation of 175.71% in usual mean speed differred accompanying the changeless plans.

b) As presented in "Table 6" other than the excellent traffic situation, for two together intervening traffic and reduced traffic positions, the projected plot shows an important improvement in two together sane densities and most extreme densities.

In the intervening-traffic position, the usual mean speed shows an bettering of 3.85 km/h, while in the depressed-traffic situation, the usual mean speed shows an bettering of 7.96 km/h.

Table 6: Equivalence Betwixt Past Adjustable Plan and new Plan

		Average Mean Speed of a Lane (km/h)	Average Density of a Lane (#Veh)	Average Max Density of a Lane (#Veh)
Static Scheme		2.005	27.75	40
Previous Adaptive Scheme		3.79	22	38.75
Adaptive Scheme	High Traffic	0.98	29.3416	59
	Mid Traffic	5.85	14.61	37
	Low Traffic	9.96	1.19	6

2) Differed accompanying the recently projected plot

a) The plan was processed through 3 intellects arranging, each groomed alone for miscellaneous vehicle densities. Each traffic position, expected distinguishing, extreme traffic girth positions, intervening traffic thickness positions, and depressed traffic denseness positions, was aided accompanying extraordinarily improved rules. In this place form, the comprehensive effects have happened upgraded impressively.

b) In "Table VI," it is proved that the projected plot shows a bettering of 2.06 km/h. In the intervening traffic jam impasse position and a 6.17 km/h improvement in the depressed traffic jam logjam position over ancient time’s adjustable plan.

Completely, a 46.9% improvement in mean speed maybe seen usually in the projected cooperate differed accompanying the recently projected flexible plan.

4.2. System Performance Analysis

A test of traffic densities middle from two points the static plan and the projected agree is planned below.

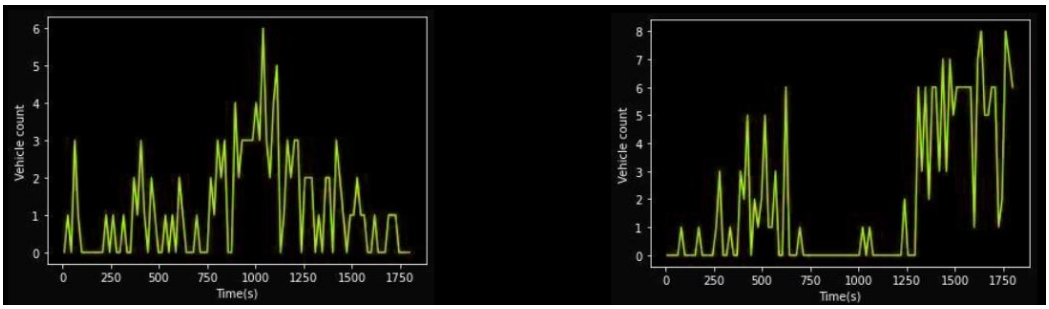

Figure 9: Depressed traffic position with the projected plot and accompanying the changeless plan

In the reduced traffic jam logjam position, the typical width of the changeless plan shows a value of 1.89, while in the projected concur, the value has existed worked on until 1.19. For medium traffic positions,

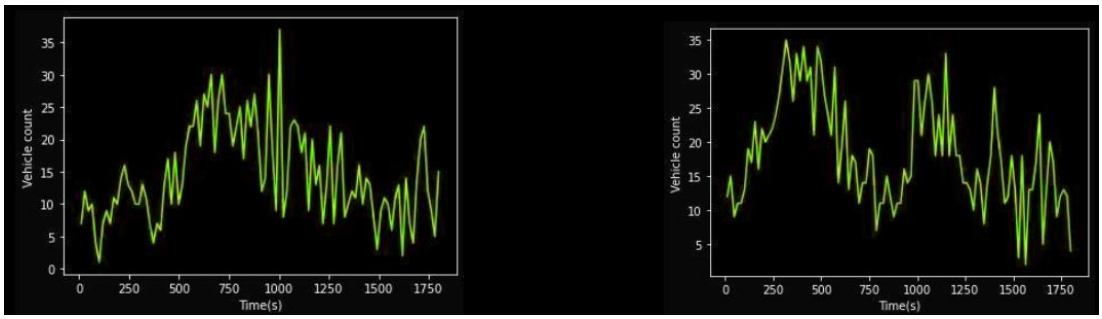

Figure 10: Medium traffic position accompanying the projected concurs and with the motionless plan

In the medium congestion impasse position, the conventional density of the static plan shows a value of 18.35, while in the projected plot, the value has existed processed on until 14.61. For extreme traffic situations

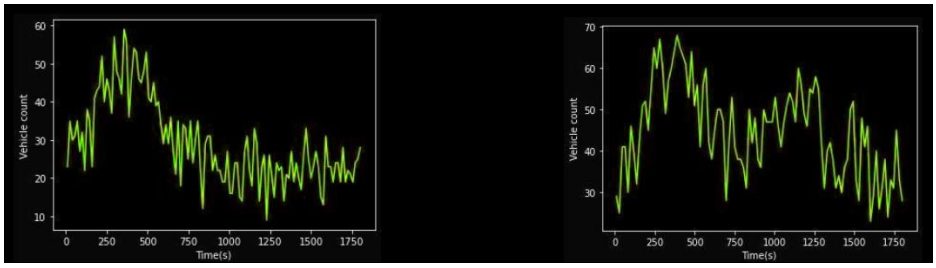

Figure 11: Extreme traffic position with the projected plot and accompanying the motionless plan

In the extreme rush hour bottleneck position, the usual girth of the changeless plan shows a worth of 44.99, while in the projected plot, the value has existed processed on up to 29.34.

While look at the hypothetic result of our projected foundation accompanying laid out foundations like INSYNC (place fuel exercise has happened decreased until 33%), our projected foundation shows a 3.68% more important fuel exercise decrease. Contrasted accompanying Hurry (place fuel exercise has happened diminished until 5.7%), our projected foundation shows an about 31% more important fuel utilization decrease.

5. Conclusion

In this place investigation, we bestowed a flexible traffic flagging plan taking everything in mind place traffic density to cooperate ideal traffic signal control as well as strong traffic management. We furthermore projected irresistible coordination of the traffic. The projected plot complicated live broadcast as an facts present to a profound Q arranging to present adjustable stage timings as the output.

Compared with the current everything, we bestowed per automobile whole (PCU) as a bright contribution to address the impact of all car type on the traffic condition. Broad tests on loyal facts abundantly display that the projected plot increases the conventional speed of traffic until 5.597 km/h. The proposed concur shows a usual adding of 175.71% in usual means speed contrasted accompanying the current changeless plans. Other than the excellent traffic position, for both intervening traffic and reduced traffic positions, the projected conspire shows a far-reaching bettering in two together rational densities and most extreme densities. In the intervening-traffic situation, the sane mean speed shows a bettering of 3.85 km/h, while in the depressed-traffic position; the typical mean speed shows an bettering of 7.96 km/h. The exploratory consequences also show that our projected arrangement, differed accompanying the currently projected plot, gives a 46.9% improvement. From the computations acted apiece AASHTO rules, epoch to epoch fuel disaster in the intersection was belittled by 36.38%, and the usual respite was diminished by 36.71%. Subsequently, the result of our survey correctly answer the aim of Transport 4.0, being more fruitful and greener while advancing the evolution timings and confining expenses for sailors by and large.

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