A NEW CONCEPTUAL ALGORITHM FOR ADAPTIVE ROUTE CHANGING IN URBAN ENVIRONMENTS

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Abstract

In this paper an attempt is shown in a Mathematical Model of an alternating route adapting for large scale, which was previously done in small scale. This evaluation is done considering 75 and above traffic junctions with a scale of 4 to 6 vehicular density per second in each junction. The main objective of this paper is to show how an Adaptive Route Changing [ARC] application responds to assumed scenario & also proposing effective software architecture to monitor traffic in all the junctions at real time to minimise traffic congestion.

Keywords : *ARC, Intelligent transport system, Traffic Monitoring.*

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1. INTRODUCTION

ITS is one of the most research happening fields in the modern automobile industry. Its variety of challenges includes avoiding traffic congestions, increasing fuel efficiency of the vehicles and so on. A still more sophisticated systems with profound algorithmic ideas on improving the present ITS is needed as the traffic congestions being the most haunted problems of urban hubs at present. Previously done works on ITS addresses several problems such as GLOSA [1] which intimates the vehicles to accelerate or decelerate so as to avoid waiting at traffic signal at intersections. The extension to this paper is Adaptive Routing technology which is done on a small scale on 2*2 grid of road addressing an algorithm that advises the drivers to change path as to avoid traffic congestion on route. Yet another kind of paper 'an adaptive routing algorithm for two tier traffic information system' which mainly focuses on an algorithm that broadcasts messages between vehicles also addresses on ITS. However, the main objective of this paper is to develop an algorithm to effectively manipulate the traffic density for higher number of traffic junction (75+ assumed) connected to a base station using V2I communication & vice versa is proposed in this paper. The block diagram of the proposed system is shown in Fig.1.

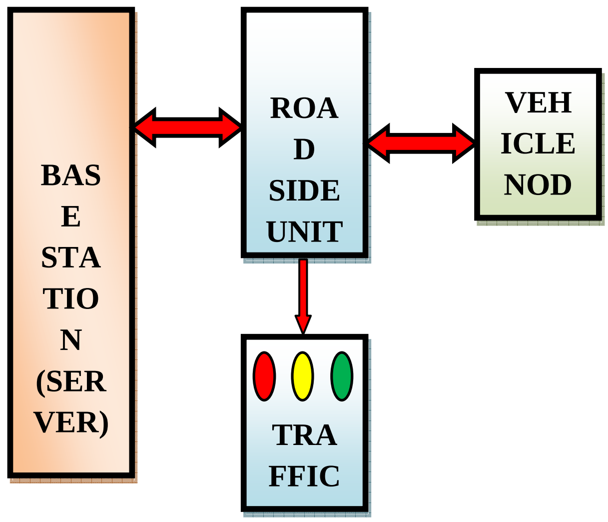

Fig-1 Block Diagram of proposed system

The rest of this paper organised as follows section2. Related Work: Explains in brief of different papers previously published on ITS along with their cons. Section3. Algorithm: Explains in detail, how the proposed system operates along with some assumption made also some mathematical Equation, Graphs needed in support. Section4. Performance Evaluation: Explains how evaluation can be conducted with scenario considerations. Section5. Conclusion and Future Work: This section explains predicted results and also Future work that can be extended.

2. RELATED WORKS

Several works suggesting various algorithms to reduce traffic congestions have been previously made. Such as, the one from TU Berlin [2] which uses GPS to acquire digital maps & live traffic data in real time further used for optimal route guiding system. The results obtained from the simulation of this system showed a decrease in the overall trip time & also predicts a decrease in these benefits as equipped vehicle penetration increases. This is because the system does not include the effect of their recommendation to the measurements causing furthermore congestion. This system also alerts minority of driver to take longer routes, making way for majority of driver's to shorter routes, which makes this system being avoided by certain driver's who are instructed to longer routes. In contrast with the said system, PRE-DRIVE C2X project [3] proposes a new algorithm in which each vehicle has ability to exchange data between each other regarding traffic conditions around them. This helps other vehicles to decide whether to alter its pre fixed route, thus provides an advantage of knowing nearby traffic congestions. Simulation results of this systems shows benefits of vehicle 2 vehicle (V2V) application penetration applicable even to non V2V equipped vehicles.

The implemented research on GLOSA [1] from Surrey University, suggests an algorithm that effectively impacts on fuel & traffic efficiency through a constant communication between the vehicle & the road side unit [1] to know for the present traffic light status. This information is further used to calculate the speed & time required to cross the traffic signal without being stuck on red at individual junction either by accelerating or decelerating. The fuel efficiency reduces as the traffic density decreases. On the other hand traffic density effects inversely to traffic efficiency. GLOSA also assumes that No vehicle waiting at traffic light which is not always the case [1]. The further extension to the said paper (GLOSA) in ARC [4] addresses & effectively increases fuel efficiency also decreasing the average trip time considering only a small segment of 2-by-2 grid area with traffic signals which has a control of 4 intersections of bidirectional roads as scenario. In the ARC algorithm method the efficiency is increased by alerting the drivers to alter their path at the time of congestion, thus reducing the average trip time. This algorithm alerts the drivers to take shorter routes thus overcoming the limitations in the project done by TU of Berlin. The con as of the referred paper includes its scalability issue as it is considered only for a shorter grid with traffic flow in one direction. In the present proposed paper these said cons are addressed with improvements.

3. ALGORITHM

Following assumptions are made for the present scenario: more than 75 Intersections with 4 roads intersecting & having two lanes for each direction with each intersection have a Road Side Unit (RSU) & considering a threshold limit of 4-6 vehicles per second per junction as vehicular density.

To implement effective routing Algorithm three independent applications are proposed, namely:

Vehicle node: This forms the least form of a node that updates its id, acceleration, and location to nearest junction to which it is approaching to the RSU. Vehicle node also receives the information from RSU in order to alert drivers about the traffic scenario on way to their destination. The CGGC [5] protocol is used for the communication between Vehicle Node & RSU. It receives the message from RSU to adapt a new route during congestions.

Road Side Unit: it is the actual nodes present at traffic junctions which collects all the information's that are required to be updated to the base station like individual id's, traffic density in their vicinity, id's of all roads that meets at its point. These units play important role, once the base station detects any congestion & informs individual RCU's around the congested junction to reduce traffic flow through congested one. It is possible because each junction knows the exact vehicle counts in each road intersecting. Thus with the command from base station previous RSU changes waiting time & passing time of the vehicular traffic according to data from the Base station, thus avoiding further block out.

One more advantage of such RSU is that its capability to alter the signal lights according to the priority basis during congestions. This is done as follows, when the queue length of vehicles at any road at any individual intersection reaches threshold limit, then the corresponding RSU responds to this by sparing extra time with green signal to that road taken from those roads with minimum queue limit, providing high priority to the longer queue length roads. Additional time provided for congested road can be calculated as

Addition time for congested road is given by

$$[Ta - Trqa] + [Tb - Trqb] + [Tc - Trqc]$$

Where,
Ta = Time allocated for green light for Road A
Trqa = Time required to clear the queue length at road A

Assuming 1 mtr traffic clears in 1 sec (Qm)

Then the threshold queue length can be calculated using the expression 2

$$\text{Qth} = [1.5 * Tgl * Qm]$$

Where Tgl = Green Light Time

$$\text{Queue length} \cong \frac{Di - Do}{L}$$

Where, Di = Distance of its own Location
Do = First stooped vehicle at the traffic light
L = length of vehicle (Usually L remains constant) [4]

Here the aspect queue length varies in a wide range, as the considered scenario is for city limits, this queue length which forms an important constrain deciding the traffic light ON/OFF period is in direct correlation with traffic density. Traffic density is nothing but number of vehicles occupying a given length of a lane, usually measured in vehicles per kilometre per lane [8].

$$D = v/s$$

Where, D is density,
V is rate of flow in vehicles per hour (vph),
S is space mean speed (kmph) considered as 40 kmph as present scenario is for city.

In urban areas, traffic density varies according to the time i.e. the traffic density at mornings will not be same as traffic at noon, so green light time has to be changed according to the traffic density. If the traffic signal (Green) is kept constant for various traffic density flows, traffic congestion are frequently observed i.e. say Green light period is set to 10 seconds at the peak traffic hour, then traffic congestion is a more obvious. Conversely if the green light period is more at early morning (off peak time) then drivers must wait longer time even with lesser traffic density. **RSU's will change the** Green light time according to the traffic's peak & off peak at real time. The graph in the fig 2 shows the Traffic density v/s Time in general.

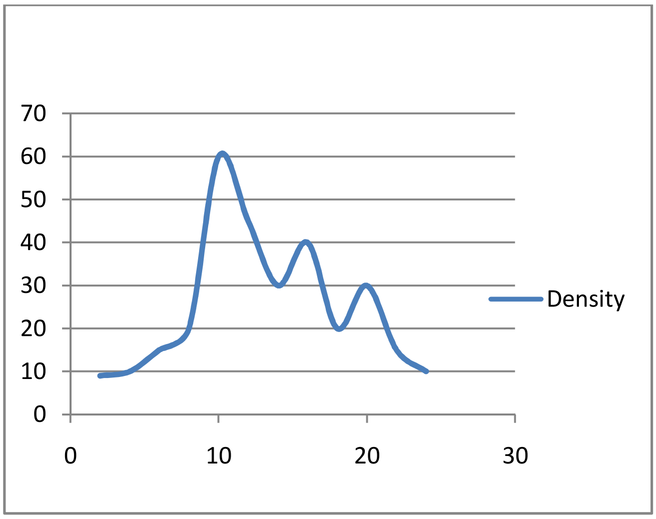

Fig-2 Graph of Traffic density v/s Time

Base station: It is the tool to store information's from the RSU & passes the same to the latter if required. The communication established is a 2-way between base station & RSU.

RSU to Base station communication: The entire RSU's updates all the information obtained at its nodes to the base station, such information includes road id, junction id, traffic density & average vehicle entry at real time at a rate of 5 to 10 seconds on average.

Base station to RSU: this communication is only established when a traffic congestion is observed. During traffic congestion at any junction the following tasks are accomplished by the base station in order to reduce it.

- Updates junction id where traffic congestion has occurred to other junctions as to avoid further vehicle flows to congested junction.
- Passes all required information's to congestion occurred junction to reduce the traffic flow into it without affecting other junction causing further congestion down the line.

4. PERFORMANCE EVALUATION

The performance evaluation can either be done by simulation or by actual hardware implementation. Due to high installation cost it is recommended to go with simulation approach. In the referred papers following tools are used: Fraunhofer VSimRTI [6] to model vehicle traffic, data communication between vehicles & signal lights. SUMO [7] tool is used for wireless network & to connect all the RSU a virtual Base station is maintained.

It is strictly recommended to consider the following scenario's at the time of simulation:
Scenario 1:

Considering an intersection with id #1 & with four roads connecting, named as 1a,1b,1c and 1d. Assuming 1a has the more traffic flow than other lanes. Traffic flow from the cross road to 1a is 1:3 to the main road traffic flow rate.
Scenario 2:

Since we are assuming the 75 Junction consider the scenario 1 for more than 4 Junction at once in different location. This scenario results show's system scalability.
Scenario 3:

In this case consider the full traffic congestion in a complete road. i.e. all the junction in that road are completely congested.

5. EXPECTED CONCLUSION & FUTURE WORK:

In this paper a concept on algorithm for adaptive route changing is effectively proposed along with large scale scenario. Based on several referred papers efficient ways to evaluate the performance of the proposed system is also highlighted. Through a general view over this paper & a broad search it can be revealed that this system can be opted for a highly congested urban metropolis. Although a near to said system has been suggested & implemented through simulations, a systems with a separate Base Station (Server) to maintain all the regarding data's with more precise operative environment has never been proposed on such large scale. On contrast to referred papers & their results, one can expect much better result once the simulation is done for the proposed concept.

The proposed algorithm can be simulated considering the assumptions made, furthermore, improvements in gathering the exact vehicular counts & all the other required data's with more precision should be researched for betterment of the present system.

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