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Real Time AI Intervention for Improving Disruptive Road Traffic Conditions

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Abstract: *The Simulation of computer's smart and intelligent behavior has already been observed and experienced by almost all of us. With the advent of the challenging concepts of Artificial Intelligence (AI), machines have become so far successful of imitating intelligent behavior of human beings. The revolution that has come because of the introduction of AI systems has been widely accepted and has truly spread lots of excitement in our society. AI enabled road traffic management is the topic to focus upon which still has huge scope of ground level improvement. First and foremost, commuters must obey the rules without which any system to control traffic would go in vain but as our country has risen in stature towards a more higher position in the world both technologically and economically, the moment has come to carefully steer the traffic conditions using best possible AI techniques to surpass the threats and challenges that it is likely to face along the way from daily commuters.*

This paper presents all possible emerging applications of AI to smartly control the disruptive traffic condition on Indian roads or in any other part of the world.

Keywords: *AI Based Systems, Intelligent Transportation System, Automatic Transfer Switch (ATS), Traffic Jam, Signal, Road CongestionControl System.*

I. Introduction

We all strongly agree by this time that Artificial Intelligence is noticeably transforming every sphere of our routine life. Artificial Intelligence is undoubtedly a wide-ranging tool that has let people to think again and again so as to integrate information thereby analysing the data and effectively using the insights of the results for highly improved decision making process. The AI coated goal for an effective traffic management system aims to efficiently design and manage ongoing transportation resources in a mandatory response to dynamic and highly sophisticated traffic conditions, and once AI is added to it, the outcome goes up many folds. Undoubtedly, the uncontrolled terrible traffic load has miserably uplifted the graph of road accident beyond normal conditions. If thoroughly analyzed, congestion caused due to traffic is unquestionably a social problem that needs to be resolved on account of its long lasting effects. Congestion initiated by unexpected events also leads to higher statistics of vehicular accidents. Over population, narrow roads, obstacles, accidents, dishonor of signals are the main causes of traffic congestions. Congestion decreases the traffic volume that can use the roadway. Congestion also makes it hard to estimate traffic time.

II. Main Areas Of AI In Transportation Sector

Artificial Intelligence at present provides numerous valuable instruments for solving even major problems in traffic management systems covering technical areas such as Real time management system of transport,Logistical systems and freight transport - design, administration, operation and time scheduling, ttransport organization, travel demands analysis and predictions, transport and intelligence technologies of its surroundings, pedestrian and herd behavior simulations-cum-analysis,ssustainable mobility, vehicle's service based architecture for those in communication infrastructure, artificial transport systems and various simulations. AI techniques by this time allow effective use of the applications for the entire existing transport system for managing the vehicle, driver, infrastructural details and the path by which these components readily offer different transport services. All-purpose Artificially Intelligent instruments are highly suitable for more complicated and diversified road transport systems.

III. Ways To Reduce Road Traffic Congestion

The major cities of India has studied well and has made necessary arrangements to have its very own Intelligent Traffic Management System (ITMS) by the year 2019 or 2020. There is an official acceptance by the Ministry of Home Affairs as a well-planned proposal has been sent for the same by Delhi Traffic Police [1] An Artificially Intelligent radar-based monitoring has been designed and will work for the proposed traffic management system.The procedure involves analyzing the traffic pattern, number of vehicles, volume, and similar other factors over the cloud. Key tools being the automated traffic signals totally controlled by computers

connected strongly to each other , forming a network and super ceding human intervention as **shown in Figure 1**. Further,the data then would be utilized intelligently to regulate the traffic.

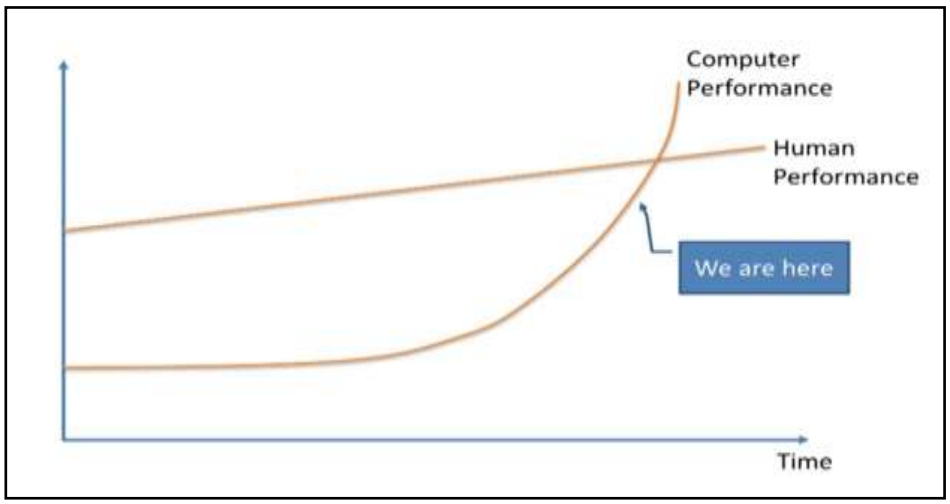

Figure 1: Computer performance superseding human performance in due course of time

One of the most recommended methods for better traffic controlling is the real time signal control and operating them automatically according to on the spot traffic demand. [2]. Many good researches researching on improving the traffic conditions suggested load prediction forecasting and similar other solutions since experiential forecasts have the ability to do so to a considerable extent.[3]There are many highly sophisticated systems working intelligently for the purpose of processing the images and tracking the vehicles. [4] The Ant Colony Optimization as **shown in Figure 2**is one of the best examples which can be accepted effectively as an illustration for tracing an optimized path considering it a useful and a helping hand for studying and sorting varioustransport optimizationsolutions which can be developed using the wise ‘ant behavior analogy as ants has the ability to constitute any path using pheromone [5]. Cyrille Battellesuggested an algorithm to plot the shortest path on the basis of an ant algorithm to have a jam free system for road traffic management. [6]

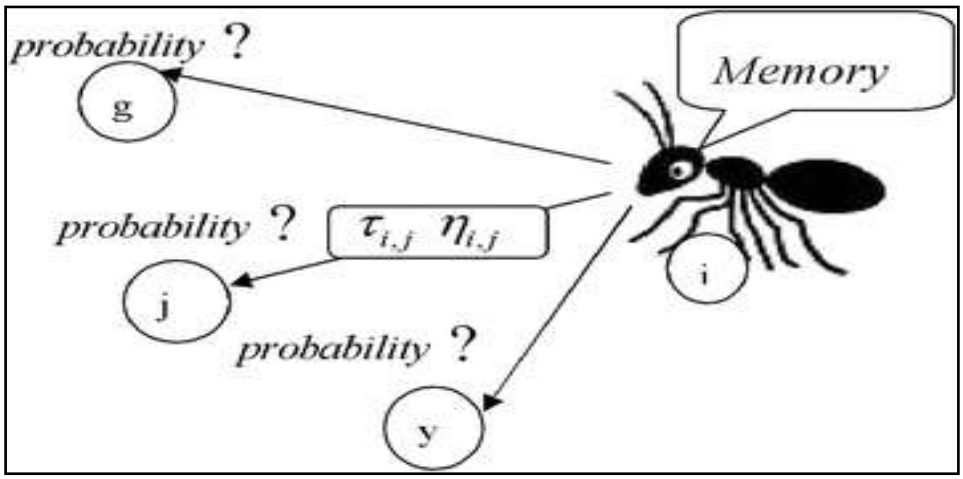

Figure -2: Global Ant Colony Optimization Methods [7]

Constructing more freeways can increase transportation capacity. Road saturation can be considered as a natural way to cope up with growing traffic congestions. Today, the demand for space on the roads is much higher than what is actually available. Public transport system can be promoted specially in large cities although it is not always convenient for people to use. Employing proactive traffic management and planning to be the major way of alleviating traffic congestions. Doing so, one can determine the future state of road segments so as to predict potential congestions before real congestion is reached.

The time based signaling schedule can be adapted and effectively implemented on various predominant traffic patterns. Based on the preset look-up tables, tuning for the step to step adjustment of signal timings can be done. In order to logically approve on signal timing plans, the predefined traffic models needs a proper synchronization. This sort of suits to be readily implemented at the places where traffic congestion is a consistent

activity. A program based approach is another in-use approach which uses locally segregated computers. These networking of computers actively gather the real time data of different traffic movements over different places. The collected information is than forwarded to a central regional computer which further mechanizes a skeletal plan involving signal timings as per the database of collected information. The parameters of the set plan are dynamically adjusted to optimize the flow of the traffic. As per the local level real time feedback, the central computer works and lets the task done successfully.

IV. Latest Trends In AI Powered Traffic System

AI can play a vital role in predicting traffic flows and even misbehavior of individual traffic participants at key traffic locations [8]. Most of the forecasts on congestion mainly focus on observations overs major national highways and expressways. Hence, such predictions are confined to various estimates purely on the basis of past collected information. Based on the combination of various past congestion conditions, the new forecasts can be accuratelycalculated.Using the well-defined learning abilities offered by Artificial Intelligence, the system becomes smart enough to deduce formulas to accurately predict various cases for under what sort of created conditions, a given congestion occurs. For a set targeted location, It will be able to analyze and hence correctly predict the congestion conditions several hours in advanced, where traffic jams look likely to occur frequently. Electronic Toll Collection System usually referred to as ETC 2.0, is considered as the non-stop next generation system acting as the big source of collecting voluminous data such as a vehicle's location information, the current speed through 2-way communication between roadside equipment which is usually installed along expressways, onboard units and roads.

Figure 3 clearly shows that the collected data can be utilized very effectively for various technical purposes which probably covers traffic congestion alleviation and vehicle accidents prevention.

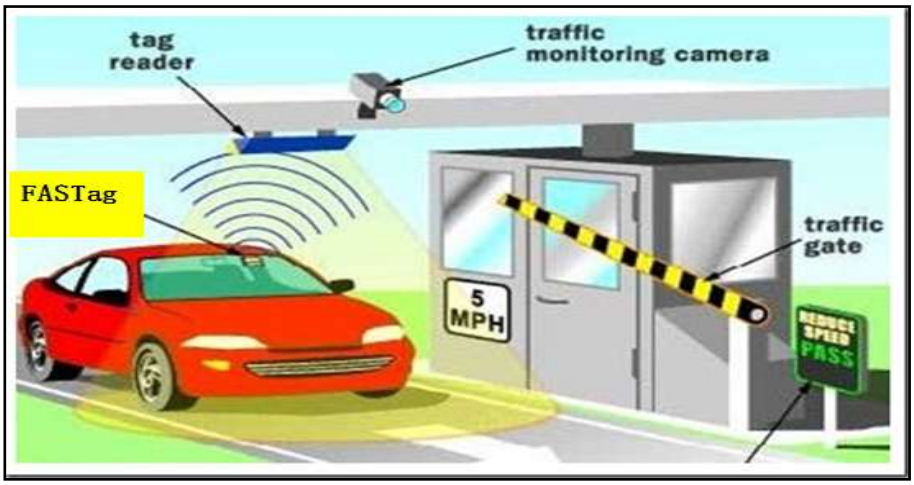

Figure-3: Electronic/Automatic Toll Collection System using Radio Frequency Identification [9]

We can implement the emerging technology which is based on Diffusion Convolutional Recurrent Network Model. This model as shown in Figure 4, fetches both real time and old historical data to calculate and predict future speeds along a road. The model is getting experienced and smarter over the period of time as it confirms and optimizes the predictions by real time data analysis. This results to increase in its accuracy by learning about various methods which may predict the most accrual speed.

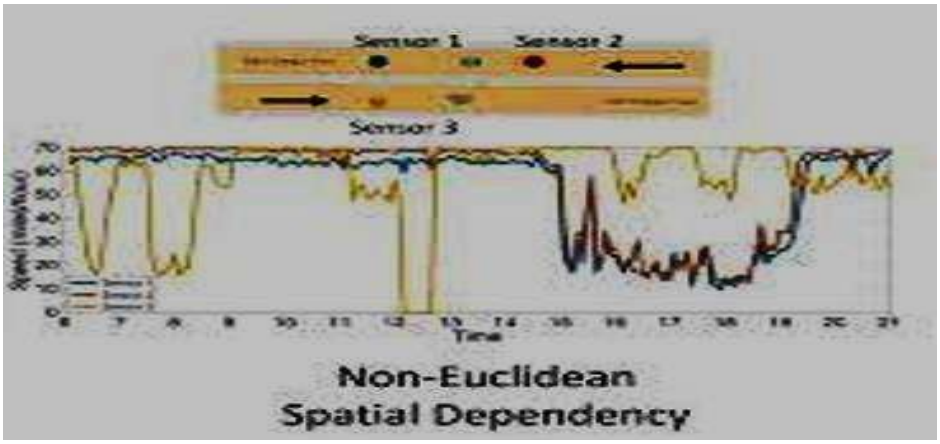

Figure-4: Non Euclidean Spatial Dependency [10]

The working model also learns and processes a series of patterns that influence the ever changing traffic speed of vehicles. The spatial dependency factor among adjacent roads is hence captured. Further it uses those speed changes for more precision based forecasting. Events including closure of roads, accidents are also covered for in real time, letting the model to preemptively and promptly adjust the prediction and giving clear picture of future road conditions to the drivers.

As shown in Figure 5, spatial correlation is dominated by road network structure. Traffic speed in road 1 are similar to road 2 as they locate in the same highway. Road 1 and road 3 locate in the opposite directions of the highway. Though close to each other in the Euclidean space, their road network distance is large, and their traffic speeds differ significantly.

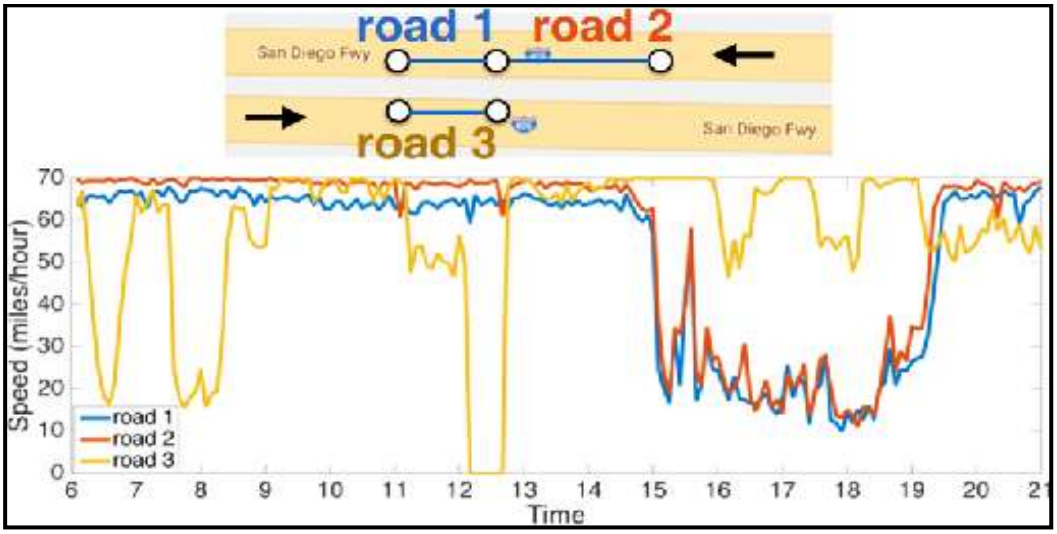

Figure-5: Spatial Correlation and Euclidean Space [10]

Intelligent Transportation Systems (ITS) is now a days gaining huge attention from the researchers and other communities. A large volume of architectures have been recently suggested with the aim to effectively deploy ITS. Smart vehicles which are capable to communicate wirelessly amongst each other through a well-designed On-Board Unit (OBU) has recently been introduced by ITS. This has given rise to fast growing Vehicular Ad-hoc NET works (VANETs).

As indicated in Figure 6 , VANETs can be visualized as a complex networking of inter-connected vehicles and becomes operational in tune with various Electronic Control Modules (ECMs). In VANETs, the network topology needs to be a changeable entity on account of the high mobility of vehicles, thereby acting as purely a network which is ad-hoc based. It let the vehicles sense the environment thereby exchanging the recognized data with all possible surrounded vehicles. Although, is a complex, challenging task to opt for the widespread ITS deployment, number of workable projects has already been developed thereby successfully evaluating their performance through simulation or of deployment at real time. An infrastructure commonly known by the name Road Side Unit or RSU can be installed on the streets tosupport the vehicles plying in the vicinity. Standard

IEEE 802.11pallows ad-hoc communicationand is being specially introduced for vehicular communication purposes (i.e. communication between vehicles, the**p** denotes specific version).

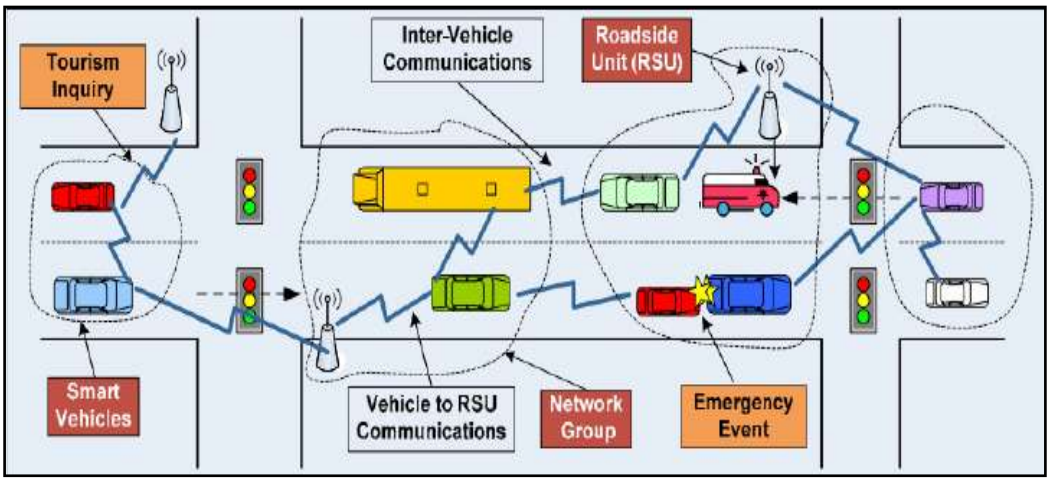

Figure-6: Basic Structure of VANETs [11]

Artificial Intelligence has already been accepted worldwide as an aid to driving behaviors and prevent accidents. To have a seamless connection across sectors and services is in fact the whole and sole idea of digital India .The smooth transportation services being the one of it. Artificial Intelligence is finding its way into the vast Indian automotive sector market through smart solutions based on even behavioral learning. The ticket screens at various bus stations, railway stations and metros will now be able to estimate the customer's age and adapt accordingly, making text zoom for senior citizens who find difficulty in reading at distant. Use of AI has improved awareness many folds, of driving behavior, avoidance of accidents during enhanced traffic conditions.

V. Other Country Initiatives In AI Based Traffic System

There has been noticeably a great improvement in the advancements in technological capabilities and ITS strategy related to congestion mitigation and its avoidance. ITS along with tolling, telecommuting ,transit, have served for many years in number of America's metropolitan areas with the primary objective of Congestion Initiative so as to demonstrate the effectiveness of deploying these strategies in combination rather than in isolation. The United States Department of Transportation in the year 2006 formally introduced the National Strategy. The main objective was to uniformly reduce the traffic congestion on Transportation Network in America by well known "Congestion Initiative." The Integrated Intelligent Transportation Systems (IITS) division in UAE played an important role in regulating the deployment of ITS . It includes planning and overseeing the design and implementation of these systems.The operation and management of the transportation management centers ensures the seamless integration amongst all modes of transport so as to fulfil the transport-mobility, safety and sustainability needs in accordance with the set vision. Japan, through its by birth telecommuting technical mastermind capabilities and experience in social infrastructural technology has contributed a lot to expedite the infrastructure of various demanding countries undergoing rapid economic growth. The most suitable example of Vietnam can be taken herein. In Vietnam, a long North-South expressway has been constructed. The stretch of this expressway has full-fledged features of an Intelligent Ttransportation System (ITS) implemented and installed by a Japanese leading consortium. The ITS system designed and implemented for Vietnam Expressway Corporation is just asmall outcome of a Japanese consortium companies led by grand leader of the field-Toshiba.

VI. Major Challenges

An advanced and especially AI powered traffic management system requires multiple technology layers. However it has been observed that municipal governments often lack the expertise to identify and hence to select the right combination of various provided solutions. Leading global countries are unexpectedly still following the trend to hire a contractor - an expert in designing and implementing advance traffic systems, having the overall control of the project development and who is, thereby adding an unexpected cost to the overall project budgeting. There are incredibly uncountable issues and challenges in changing a city's infrastructure even if technological challenges are ignored. Concerns of rregulatory policy and reliability testing requirements may discourage the deployment of new technologies with the fact that a traffic management is considered a safety critical system.

VII. Conclusion

The discussion makes it very clear that a large number of ITS studies conductedand its implementation have been done in the advanced countries. However, developingcountries are serious and look forward for much work to be done in these domains to resolve the emerging traffic related problems. A majority of the ITS systems have been developed on the Geographic Information System (GIS) or World Wide Web based platforms. Both the platforms reflect own advantages and disadvantages.

GIS platform provides very trustworthy spatial analysis techniques whereas world wide webplatform has been proved to be very fruitful in providing real time based information. More sophisticated and more developed systems are using the integration of both GIS as well as World Wide Web platforms which makes it actually possible to avail the advantages of both the known platforms. Also, most of the developed systems are based in the urban locations and therefore there is a great scope left of the work to be done in rural areas as well. The Global Positioning System - GPS has been proved substantially useful beyond any doubt in all the ITS systems discussed so far. Advanced traffic management is only one tangible aspect as far as an intelligent transportation system is concerned. Smart parking management system and cases of route planning are just few other examples that shape a more demanding and bigger intelligent transportation system.

AI technology is here to stay. However, machine learning still has a long way to cover before reaching worldwide adoption with readiness.

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