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Develop A Simulation Model And Signal Timing Improvements To Study Traffic Patterns And Identify Areas Where Congestion Occurs.

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Abstract- In recent years, traffic congestion prediction has led to a growing research area, especially of machine learning of artificial intelligence (AI). With the introduction of big data by stationary sensors or probe vehicle data and the development of new AI models in the last few decades, this research area has expanded extensively. Traffic congestion prediction, especially short-term traffic congestion prediction is made by evaluating different traffic parameters. Most of the researches focus on historical data in forecasting traffic congestion. However, a few articles made real-time traffic congestion prediction. This paper systematically summarises the existing research conducted by applying the various methodologies of AI, notably different machine learning models. The paper accumulates the models under respective branches of AI, and the strength and weaknesses of the models are summarised.

Keywords- intelligent traffic management system (ITMS); vehicle detection; vehicle tracking; traffic signal control systems (TSCSs); simulators

I. INTRODUCTION

Social and economic well-being of the citizens is the aim of every nation. Apart from food, cloth and housing transport and communication system is one of the basic necessities that come into focus while discussing economic and social development. Without proper transport and communication system, no society can imagine the maintenance of speed of development at all. Even for arranging food, cloth and shelter everybody realises the need for transport and its means. If we look at the progress of civilization, development of system and means of transport has been found to keep the pace of activities required, facilitate reaching required items and human being themselves to their destinations in time, reduce cost of transportation, save time which is more crucial in a growing busy schedule. Finally, it facilitates connectivity between societies and exchange of ideas and goods.

In the rapid development of the urban area, the volume of vehicles has greatly increased which creating issues such as collisions, traffic congestion, economic losses, environmental pollution and excessive fuel waste. In these issues, road traffic jam is a significant problem related to the transportation field in the urban area. Intelligent Transportation Systems (ITS) is an interdisciplinary field that uses data analytics from different mathematical models, and is also seen as an important technology to alleviate congestion in urban traffic. Accurate traffic forecasting and traffic light regulation are important steps in the development of an ITS and are essential for transport system efficiency. There is a need for an efficient traffic management system to forecast and control traffic flows in urban areas. Prediction of traffic helps to avoid traffic before there is congestion. Typically, the urban traffic forecast uses historical and current traffic flow data to predict future moments of road conditions (Niu et al. 2015). With the development of technology mobile phones, sensors are widely used to analyze the traffic condition. For managing and forecasting traffic congestion, machine learning algorithms and big data analytics techniques are used. Big data analytics plays an essential role in the intelligent traffic management system reach. Data Analytics helps us to predict Traffic before congestion and the occurrence of traffic can be avoided. This research work proposes a smart framework for the domain of transportation that performs traffic prediction with fuel consumption model and analyzes the traffic flow congestion using genetic and regression model. Based on Multi-Agent system, it will control traffic light and deviated the traffic route.

II. ROAD TRANSPORTATION

Transport is vital for almost every aspect of economic, cultural and social growth. Road transport segment plays a very important role in the growth of any country mainly for developing nation like India. The surface transport system is important for the movement of passengers and goods and road transport is the backbone of Indian economy. Roads are always considered as one of the basic components of infrastructure as it plays a decisive role in initiating and accelerating the process of development.

Connectivity in terms of roads is considered as an indicator of development.

Traffic Congestion

Traffic congestion in Indian metropolis roads is extended enormously due to the growing rate of urbanization. Globalization of the Indian financial system and the improvement in economic fame of the residents has as well brought on better effect on the transport system. Growing insufficiency of public transport, growing price of automobile ownership and immigration of people to city outer edge has brought about big use of private modes, congestion the road system. The site visitor's actions in metropolis roads were compounded by means of not unusual interruptions, ensuing in excessive decrease in velocity, most vital to congestion.

Traffic congestion in metropolis areas has broad problem observed by people of Central Business District (CBD), except it has now stretched and intensified within the city periphery and close via suburban areas additionally. People make use of mixture of modes of transport to assemble their travel require. The development in automobile technological know-how has brought in a combo of two wheelers and four wheelers available in the market same to ones financial plan and cause, thereby adding collectively more congestion. The homework of suburban areas will not be sustainable and isn't flourishing in containing the journey demand of the individuals inside the region (Hoover, 1984).

The men and women from the newly developed areas travel closer to the town for their requirements adding extra congestion. The congested traffic flow has lead to enlarge in vehicular emissions which have spoiled the urban air superiority. Traffic congestion has a ways achieving multiplying possessions on the economic, climate, environment and universal exceptional of lifestyles. Now not any of the cities in India has an affordable stability of the modal divide of diverse transport modes. Restricting the growth of the usage of motor vehicle doesn't look to be possible in the close future, given the fiscal and other benefits of expanded mobility. Development of road infrastructure can't be matched with the transport demand as a result of financial and spatial restrictions.

The available choice is to mitigate congestion with the aid of use of the accessible resources optimally. Steady efforts were taken by way of the transportation authentic and authorities in developed countries to measure and devise method of reducing congestion. The causal reasons of congestion in Indian context need to be understood to reach at insurance policies for mitigation. A transparent understanding of the heterogeneous traffic operations on urban artenals and quantitative measure of congestion is required to plan policies to manage the usage of motor cars causing minimal damage to the environment. No longer have many reports been carried out in India to quantify congestion for the heterogeneous visitors drift prevailing on urban roads. For that reason, on this be taught, an effort has been made to construct a mathematical relationship to quantify traffic congestion for heterogeneous traffic flow. Traffic congestion may lead to the following issues:

- **Delays:** during the morning commute there is additional stress because delays caused by traffic can make people late for work or others places. Then, at the end of the day, the afternoon rush hour is again a frustrating time because the workday is done and people want to get home to relax and traffic is preventing it.
- **Road rage:** road rage is a senseless reaction to traffic that is common in congested traffic areas. If someone is not driving as fast as the person behind him thinks he should, or someone cuts in front of someone else it can lead to an incident that is dangerous to the offender and those around him on the road.

III. MAJOR REASONS FOR CONGESTION

Traffic congestion is always increasing vehicles in particular place with slower speeds and longer times and its enlarged vehicular queuing

- **Big vehicles:** big vehicles like lorry, trucks, bus compare to other vehicles these vehicles very huge ones. Unplanned cities the roads are very small, when this type vehicles arrived the cities may congested to the traffic.
- **No parking place:** If we are parking vehicles in no parking will causes traffic congestion
- **Absence of traffic signal:** if we are not putting the signals in suitable place and in necessary traffic place, heavy crowds may occur and it will cause traffic congestion.
- **Accident incident:** if any accidents happens in the traffics may cause heavy congestion.
- **Natural disaster:** sometimes Heavy rain, building collapse, tree fall, electrical pole fall, land slide in traffic roads may cause traffic congestion.
- **Road shows:** bicycle rally, bike ride shows and political rally may cause traffic congestion.

IV. MOTIVATION

Traffic congestion is a significant problem especially in growing nations; to encounter this, many models of traffic system were proposed. For a smart transportation system, a new framework is traffic prediction is needed to avoid congestion. This thesis proposes a smart framework for the domain of transportation that performs traffic prediction with fuel consumption model and analyzes the traffic flow congestion using genetic and regression model. Also proposes a traffic light controller with a traffic deviation system using the multi-agent system. On hourly volume in low and, moderate recurring volume sample data are obtained and establish a probability model and genetic

prediction model for predicting traffic congestion and avoidance. This prediction technique with fuel consumption model helps to avoid congestion and also reduces pollution, protects the green environment and safe travel.

V.PROBLEM STATEMENT

Problem Statement:
The tremendous growth in transport systems and the increase in the number of vehicles over the last decades have created a significant problem in urban areas, namely traffic congestion.
Traffic congestion increases fuel consumption, causes air pollution. By answering the following research questions, this research aims to solve these problems:

- How to predict and avoid road traffic congestion?
- How and what method is used to predict the traffic flow pattern?
- How to control the traffic light and how to provide the deviation system?
- How to develop an intelligent transportation system for controlling traffic?

VI. LITERATURE REVIEW

[1] Base Paper- Khalid Mohammed Almatar, Traffic congestion patterns in the urban road network: (Dammam metropolitan area): Traffic congestion is a significant problem affecting the sustainable development of urban traffic. It is important to analyze the congestion and forecast future traffic models to prevent traffic congestion.

This study is conducted with the main aim to determine the most congested area of the road network and determine how they are related to the demand of the drivers. This study uses the Floating Car Data method to find the traffic congestion and the degree to which observed congestion clusters are a meaningful representation of congestion patterns within a more extensive urban road network. Statistical calculations have been carried out to determine the correlation between clusters based on which conclusions are drawn. Findings have shown that this approach can effectively identify the traffic congestion patterns in the urban road network. The analyses of the traffic congestion behaviour have shown that congestion is more severe and widespread in evening rush hours than morning. Overall, the results can be used to develop a framework to describe potential traffic issues and a system for predicting congestion.

[2] Haojie Li, The effects of congestion charging on road traffic casualties: A causal analysis using difference-in-difference estimation: This paper aims to identify the impacts of the London congestion charge on road casualties within the central London charging zone. It develops a full difference-in-difference (DID) model that is integrated with generalized linear models, such as Poisson and Negative Binomial regression models. Covariates are included in the model to adjust for factors that violate the parallel trend assumption, which is critical in the DID model. The lower Bayesian Information Criterion value suggests that the full difference-in-difference model performs well in evaluating the relationship between road accidents and the London congestion charge as well as other socio-economic factors. After adjusting for a time trend and regional effects, the results show that the introduction of the London congestion charge has a significant influence on the incidence of road casualties. The congestion charge reduces the total number of car accidents, but is associated with an increase in two wheeled vehicle accidents.

[3] Xue Xing, Recommendation of urban vehicle driving routes under traffic congestion: A traffic congestion regulation method considering road network equilibrium: Vehicle travel route selection is the main task of the traveler information service system in the intelligent transportation system. In this study, a dynamic graph convolutional neural network (DGCN) was constructed to perform multi-time-step travel time prediction for each road section of a road network, and vehicle travel route recommendation was performed according to travel demand and in consideration of factors such as avoiding congestion areas and balancing the road network.

[4] FredyRosero, Assessing on-road emissions from urban buses in different traffic congestion scenarios by integrating real-world driving, traffic, and emissions data: In recent years, the integration of traffic simulators and emission models has become the most preferred option for evaluating vehicle emissions in different traffic states. However, the definition of a 'traffic condition' is often subjective, as driving patterns can vary significantly with the spatial domain of study. Alternatively, the implementation of 'Cooperative Intelligent Transport Systems' has led to a growing variety of devices being installed, both on the road and in public transport vehicles for monitoring traffic-flow conditions and vehicle speeds in cities.

[5] HarithaChellapilla, Bi-objective optimization models for mitigating traffic congestion in urban road networks: Traffic congestion in road transportation networks is a persistent problem in major metropolitan cities around the world. In this context, this paper deals with exploiting underutilized road capacities in a network to lower the congestion on overutilized links while simultaneously satisfying the system optimal flow assignment for sustainable transportation. Four congestion mitigation strategies are identified based on deviation and relative deviation of link volume from the corresponding capacity. Consequently, four bi-objective mathematical programming optimal flow distribution (OFD) models are

proposed. The case study results demonstrate that all the proposed models improve system performance and reduce congestion on high volume links by shifting flows to low volume-to-capacity links compared to UE and SO models. Among the models, the system optimality with minimal sum and maximum absolute relative-deviation models (SO-SAR and SO-MAR) showed superior results for different performance measures.

[6] Xue Chen, Quantifying on-road vehicle emissions during traffic congestion using updated emission factors of light-duty gasoline vehicles and real-world traffic monitoring big data: Light-duty gasoline vehicles (LDGVs) have made up >90 % of vehicle fleets in China since 2019, moreover, with a high annual growth rate (> 10 %) since 2017. Hence, accurate estimates of air pollutant emissions of these fast-changing LDGVs are vital for air quality management, human healthcare, and ecological protection. However, this issue is poorly quantified due to insufficient reserves of timely updated LDGV emission factors, which are dependent on real-world activity levels. Here we constructed a big dataset of explicit emission profiles (e.g., emission factors and accumulated mileages) for 159,051 LDGVs based on an official I/M database by matching real-time traffic dynamics via real-world traffic monitoring (e.g., traffic volumes and speeds). Consequently, we provide robust evidence that the emission factors of these LDGVs follow a clear heavy-tailed distribution.

[7] Christin Hoffmann, Clear Roads and Dirty Air? Indirect effects of reduced private traffic congestion on emissions from heavy traffic: Traffic and transportation are a major source of CO2 emissions. As the volume of heavy goods vehicle (HGV) transportation is difficult to reduce, many governments target private traffic. Next to the direct effect of fewer private vehicles on the roads, an indirect effect may be very important: The less congestion, the more fuel-efficient the remaining drivers may be able to drive because there would be less need to speed up, brake, and maneuver, for example while overtaking. On the other hand, clear roads may be tempting for drivers to speed and thus result in a negative impact of less private traffic.

[8] Anupriya, Congestion in cities: Can road capacity expansions provide a solution?: Road network congestion: a traffic state characterised by slower speeds, longer trip times, and increased vehicular queuing; is a major issue in most urban areas around the globe. Building more roads is a commonly employed policy intervention to reduce congestion. This strategy, however, is controversial because under certain conditions road capacity expansions may induce growth in traffic volumes.

[9] Chen Wang, Dynamic adaptive vehicle re-routing strategy for traffic congestion mitigation of grid network: This paper proposes a possible methodology for detecting and mitigating traffic congestion. This method is carried out using a custom-designed traffic scenario model. The model is fully developed in lieu of abundant data support from actual traffic events, which is applicable to localized traffic surveillance conditions, where massive data collection from surveilling devices is infeasible, or unviable. This approach includes two parts: model construction, and re-routing strategy. The model construction part focuses on the development of a traffic driving scenario, which takes various criteria such as traffic volume and traffic signal into consideration.

[9] Takashi Nagatani Dynamic model for traffic concentration and congestion near bridge: We study the traffic flow and congestion near a bridge when many cars flow into the roads connecting a bridge at morning peak. We present a mathematical dynamic model for simulating the traffic concentration and congestion near the bridge. The dynamic model is described by differential equations on the decorated one-dimensional lattice with multiple inflows and outflows.

[10] Saravjeet Singh, A novel framework to avoid traffic congestion and air pollution for sustainable development of smart cities: Traffic management is crucial for the sustainable development of smart cities. There has been a continuous emphasis from the research community to predict air quality and manage traffic for congestion-free roads. This paper proposes a novel framework to identify traffic congestion and estimate air quality using crowdsourced information. Navigation Reference Spatial Data (NRSD) was created using the spatial likelihood method using GPS trajectories and OpenStreetMap. This NRSD was also used to design the traffic environment using distance, speed, and time interval mapping. After the NRSD creation, the framework used the real-time data of the registered user to compute the traffic density using the Graham scan with the k means algorithm.

VII. RESEARCH HYPOTHESIS

The study is divided into various sequential steps as follows:

Identification of study parameters

Initially, the study parameters required to build the simulation model are identified from the detailed literature survey as well as from field data analysis. The factors such as speeds, acceleration, longitudinal and lateral gap and headway are considered as the study parameters.

Identification of study location

Ideal study location which is free from side interference is identified. An undivided mid-block section located in the urban vicinities is selected for the data collection. Two different locations are selected, of which data from one location is used for model development and internal validation whereas data from another location is used for external validation.

VIII. CONCLUSIONS

Intelligent traffic management systems (ITMS) make use of video-based traffic monitoring technology, which has advanced significantly. This technology captures images of traffic scenes, analyzes traffic information, and comprehends their activities and behaviors. In this study, we present a comprehensive overview of the ITMS components, including vehicle surveillance, attribute extraction methods, tracking and identification on road networks, the applications used in ITMS, vehicle detection, ITMS applications, and behavior understanding. These components aim to provide a complete solution to traffic control problems and to aid in traffic management. Additionally, the study coverstraffic control signal systems and includes a simulator where problem-solving strategies can be tested in action. The goal is to synthesize the existing studies and identify the most effective strategies and solutions for managing traffic in urban and rural environments in one place. The paper will also provide insights into the future direction of research in the area of traffic management. The ultimate objective of this review paper is to contribute to the advancement of the field of traffic management and to inform the development of more effective strategies for addressing the challenges faced by urban and rural communities. The future scope of traffic management systems is vast and promising. With knowledge of technologies, there are many new opportunities for improving the efficiency and effectiveness of traffic management systems.

REFERENCES

1. Almatar, K. M. (2023). Traffic congestion patterns in the urban road network:(Dammam metropolitan area). Ain Shams Engineering Journal, 14(3), 101886.
2. Li, H., Graham, D. J., &Majumdar, A. (2012). The effects of congestion charging on road traffic casualties: A causal analysis using difference-in-difference estimation. Accident Analysis & Prevention, 49, 366-377.
3. Xing, X., & Li, X. (2023). Recommendation of urban vehicle driving routes under traffic congestion: A traffic congestion regulation method considering road network equilibrium. Computers and Electrical Engineering, 110, 108863.
4. Rosero, F., Fonseca, N., Mera, Z., &López, J. M. (2023). Assessing on-road emissions from urban buses in different traffic congestion scenarios by integrating real-world driving, traffic, and emissions data. Science of the Total Environment, 863, 161002.
5. Chellapilla, H., Sivanandan, R., Chilukuri, B. R., &Rajendran, C. (2023). Bi-objective optimization models for mitigating traffic congestion in urban road networks. Journal of traffic and transportation engineering (English edition), 10(1), 86-103.
6. Chen, X., Jiang, L., Xia, Y., Wang, L., Ye, J., Hou, T., ...& Yu, S. (2022). Quantifying on-road vehicle emissions during traffic congestion using updated emission factors of light-duty gasoline vehicles and real-world traffic monitoring big data. Science of The Total Environment, 847, 157581.
7. Hoffmann, C., &Thommes, K. (2022). Clear Roads and Dirty Air? Indirect effects of reduced private traffic congestion on emissions from heavy traffic. Journal of Cleaner Production, 381, 135053.
8. Bansal, P., & Graham, D. J. (2023). Congestion in cities: Can road capacity expansions provide a solution?. Transportation Research Part A: Policy and Practice, 174, 103726.
9. Wang, C., Atkison, T., & Park, H. (2023). Dynamic adaptive vehicle re-routing strategy for traffic congestion mitigation of grid network. International Journal of Transportation Science and Technology.
10. Nagatani, T. (2023). Dynamic model for traffic concentration and congestion near bridge. Physica A: Statistical Mechanics and its Applications, 621, 128800.