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Intelligent Traffic Analysis System Using Deep Learning

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Abstract

Due to the rapid increase in both vehicle traffic and urbanization, effective traffic control systems are now essential. Advanced technologies are used by Intelligent Traffic Analysis Systems (ITAS) to monitor, analyze, and reduce traffic flow. In this review paper, a advanced Convolutional Neural Networks (CNNs), a Deep Learning technology, are integrated with ITAS (Intelligent Traffic Analysis System) to provide accurate and real-time data analysis.. To recognize and keep an eye on cars, trucks, and other pertinent entities in the recorded data, Deep Learning models—which are specifically engineered for object detection and tracking—are utilized. After being modified for traffic analysis, the suggested CNN architecture is trained on datasets using transfer learning from previously trained models to improve its efficiency and avoid road traffic congestion.

Keywords—Machine Learning, Convolutional Neural Networks (CNNs), Deep Learning technology, Artificial Neural Network.

I. INTRODUCTION

In our consistently growing metropolitan cities, the flow of traffic has turned into a difficult challenge, Road traffic the executives frameworks frequently struggle to adjust to the dynamic and complex nature of daily traffic situations. To address this, Intelligent Traffic Analysis Systems (ITAS) have arisen as a strong analysis system, utilizing the capacities of Profound Learning, especially Convolutional Neural Networks (CNNs), to alter how traffic information is caught, examined, and used for insightful choice making. Traffic implies the quantity of vehicles moving along streets. As of now the quantity of vehicles has expanded all through the world, particularly in large urban areas. It has become truly challenging to deal with the big number of street which is expanding step by step. This present circumstance is influencing our lives in numerous ways, for example, medical problems, contamination, and squandered fuel. There are a large number reasons for

traffic like impaired vehicles, unexpected crises, and mishaps that can impede one or more roadways. We ought to accomplish other things exercises to decrease traffic light like versatile sign innovation, individuals ought to involve public vehicle however much as could be expected, and use AI to caution traffic light frameworks. Heavy road traffic is a condition on transport networks that happens as use builds and is described by more slow rates, longer excursion times, and expanded vehicular lining. At the point when traffic request is critical enough that the cooperation between motor cars eases back the pace of the traffic vehicles, this outcomes in some blockage. While blockage is an opportunities for any method of transportation, Counting vehicles gives us the data expected to grasp the progression of traffic in any district under observation.

Along with this, the main information we have attempted to assemble is counting vehicles from accessible traffic recordings from different libraries.

II. LITERATURE REVIEW

Numerous studies and methodologies have been applied to avoid road traffic congestion employing diverse machine learning algorithms, computer vision techniques, and deep convolution neural network techniques. The topic of "Big traffic data analytics for smart urban intelligent traffic system using machine learning techniques" is the focus of Hlaing, S. S., Tin, M. M., and Khin, M. M. [1]. Pages. 299–300 in IEEE 9th Global Conference on Consumer Electronics (GCCE) in 2020. IEEE: In previous 20 years have seen a massive growth in both private and public vehicle usage, which has resulted in a considerable increase in traffic load and congestion. The paper's primary goals are to cut down on fuel use, traffic jams, collisions, and travel time. This research analyzes a large number of traffic information using huge data techniques and deep learning techniques to estimate the ideal amount of traffic on the roads. The goal is to ensure safe, comfortable, and less irritating travelling.

Rahman, Bibi, Zeb, A., and Ghazal, T. M. [2] Khan, M. A., and R. A. Said (2021)."Deep learning-based Edge AI- based automated detection and classification of road anomalies in VANET." Neuroscience and computational intelligence, 2021, 1-16: This study focuses on road surface imperfections as critical issues that affect both safe and efficient traffic movement. Road surface abnormalities are growing more frequently as a result of heavy vehicles, high traffic volumes, poor building material quality, and changing climate conditions. To protect peoples travelling through vehicles, drivers, and vehicles from mechanical issues, such defects must be researched and fixed. Especially with the advent of deep learning (DNN) techniques, autonomous vehicles are an important study area in the modern day that control itself without human commands using in-vehicle sensors.

"Deep learning-based traffic safety solution for a mixture of autonomous and manual vehicles in a 5G-enabled intelligent transportation system" is used by Yu, K., Lin, L., Alazab, M., and Tan [3]. 22(7), 4337–4347, IEEE

Transactions on Intelligent Transportation Systems: It is anticipated that for many years to come, a

combination of manual and autonomous vehicles will be a part of the intelligent transportation system (ITS). Therefore, it is imperative to solve the safety concerns resulting from this combination of technical and automated vehicles before driverless motor cars become fully mainstream.

An Sadoun & Chaturvedi, M. [4]. "Traffic scheduling strategies based on machine learning for intelligent transportation systems: Prospects and obstacles" 34(9), e4814, International Journal of Communication Systems: An Analysis of Feature Combinations for Image-Based Vehicle Detection, The most representative cutting-edge feature extraction methods are evaluated in this work for the classification of vehicles.

Fadlullah, Z. M., Tang, F., Mao, B., Kato, N., Akashi, O., Inoue, T., & Mizutani, K. (2017). [5] IEEE Communications Surveys & Tutorials, 19(4), 2432-2455.
The rapid development of communication technologies has led to explosive growth in network traffic, challenging current packet-switched systems composed of the Internet core and wired/wireless heterogeneous backbone networks. Evolving machine intelligence offers promising avenues for enhancing tomorrow's intelligent network traffic control systems.

The study of Deep learning for Internet of Things- based intelligent transportation networks is the focus of Khawar, H., Soomro, T. R., & Kamal [6]."In Machine Learning for Modernization, Advancement, and Societal Enhancement" (pp. 112-134). IGI Worldwide: The desire of people to live in cities and the growing global population make city administration challenging. With all of their similarities, traditional cities will not be able to provide human needs. As the amount of data gathered increases, machine learning (ML) approaches are being utilized to expand the knowledge and capabilities of an application. In this assessment, the term "smart transportation" refers to a broad category that includes parking, street lighting, route optimization, and infrastructure applications.
The article "AI-enabled accident detection and alert system using IOT and deep learning for smart cities" by Pathik, N., Gupta [7]. Resilience, 14(13), 7701: Every day, there are more and more traffic accidents as the number of vehicles grows. An annual global survey by the Using a cognitive agent-based collision detection smart accident alarm and rescue system, we can reduce rescue operation delays that could result in the loss of many lives, as reported by the World Health Organization (WHO). The WHO reports that 50 million people are injured and
1.4 million people die, with the primary cause of mortality being either the prolonged rescue operation's reaction time or the absence of medical assistance at the scene of the accident.
Hijji, M., Iqbal, R., Pandey, A. K., Doctor, F., Karyotis, C., Rajeh, W., . & Aradah, F. (2023). [8] “6G connected vehicle framework to support intelligent road maintenance using deep learning data fusion”. IEEE Transactions on Intelligent Transportation Systems This paper proposes an intelligent hierarchical framework for road infrastructure maintenance that exploits the latest developments in 6G communication

technologies, deep learning techniques, and mobile edge AI training approaches. The growth of IoT, edge, and mobile Artificial Intelligence (AI) is supporting urban authorities to exploit the wealth of information collected by Connected and Autonomous Vehicles (CAV), driving the development of transformative intelligent transport applications for addressing smart city challenges. A critical challenge addressed by this framework is timely and efficient road infrastructure maintenance.

Lakshmi Shankar Iyer.[9] "AI enabled applications towards intelligent transportation." Engineering in Transportation 5

(2021): 100083.The ability of a machine to carry out cognitive tasks that humans findnatural, such as seeing, reasoning, learning, and solving problems, is known as artificial intelligence (AI). Because there is now access to such vast amount of data created via the Internet, artificial intelligence (AI) has become more and more popular over the past 20 years. In the recent past, governments and corporations have benefited much from processing this data using sophisticated algorithms.

Pamuła, T., & Żochowska, R. (2023). [10] "Estimation and prediction of the OD matrix in uncongested urban road network based on traffic flows using deep learning". Engineering Applications of Artificial Intelligence, 117, 105550.Telecom Business Review, 16(1). The input values of the developed model were determined based on data on the structure of the road network, origin and destination points of trips, as well as data on traffic intensity on road network sections recorded by video-sensing devices. In this article, we propose a new method for OD (Origin– Destination) matrix prediction based on traffic data using deep learning. The advantage of the method is that the complex process of data acquisition and processing is not required for the estimation and prediction of the matrix.

Wang, H., Yuan, Y., Yang, X. T., Zhao, T., & Liu, Y. (2023). Deep Q learning-based traffic signal control algorithms: Model development and evaluation with field data. Journal of Intelligent Transportation Systems, 27(3), 314-334.

[11]"Deep Learning-Based Intelligent Traffic Control System." In the last decade, existing studies have made great efforts to develop traffic-responsive signal timing algorithms to contend with traffic congestion on urban networks. More recently, machine learning-based methods have been tested on traffic light timing problems as an alternative to conventional model-based algorithms, showing promising potentials. However, many researchers and practitioners still questioned the feasibility and applicability of adopting machine learning techniques in the ATSC domain. One of the reasons is that these methods assumed flawless detectors and heavily relied on simulators for training and evaluations.

Mall, P. K., Narayan, V., Pramanik, S., Srivastava, S., Faiz, M., Sriramulu, S., & Kumar, M. N. (2023). "Fuzzy Net- Based Modelling Smart Traffic System in Smart Cities Using Deep Learning Models". In Handbook of Research on Data- Driven Mathematical Modeling in Smart Cities (pp. 76-95). IGI Global. [12], The current lockouts, climatic variations, population expansion, and constraints on convenience and natural resource access are making the need for smart cities more critical than ever before. On the other hand, these difficulties may be conquered more effectively with the use of emerging technology. In smart cities, the number of cars

on the road has skyrocketed over the years, resulting in severe problems such as gridlock, accidents, and a myriad of other issues.

Lu, Y., Jin, Y., & Chen, X. (2023). "Recombination- based two-stage out-of-distribution detection method for traffic flow pattern analysis" [13]. Traffic flow pattern analysis has been extensively researched from temporal or spatial viewpoints, utilizing signals from various sources like road sensors, surveillance cameras, and more. However, predominant studies center on historical traffic data patterns, often overlooking potential shifts in traffic flow patterns or distributions arising from newly acquired data.

Sreedhar, S., Philip, A. O., & Sreeja, M. U. (2023). [14] "Autotrack: a framework for query-based vehicle tracking and retrieval from CCTV footages using machine learning at the edge". International Journal of Information Technology, 15(7), 3827-3837. The rise in automobile theft and hit-and- run incidents has escalated the demand for automated tracking systems. However, timely identification and recovery of the vehicles involved in such incidents are paramount, as perpetrators quickly alter vehicle appearances to evade capture. Thus, the presented model introduces a query-based framework aimed at intelligently identifying and tracking vehicles in CCTV surveillance footage. This approach utilizes queries with tailored input features, including vehicle model, make, color, and license plate number.

Osamy, W., Khedr, A. M., Vijayan, D., & Salim, A. (2023). TACTIRSO: "trust aware clustering technique based on improved rat swarm optimizer for WSN-enabled intelligent transportation system". The Journal of Supercomputing, 79(6), 5962-6016. [15]

Over the past years, intelligent transportation systems (ITS) have made significant strides, emerging as a formidable technology in alleviating congested traffic and bolstering traffic safety. Recent studies indicate that the integration of Wireless Sensor Networks (WSN) into ITS can yield cost savings and facilitate the development of collaborative applications that improve traffic efficiency and driver safety. This paper introduces a novel Trust-Aware Clustering Technique based on Rat Swarm Optimizer (TACTIRSO) for WSN-based Intelligent Transportation Systems. This approach ensures secure selection of cluster heads (CHs) by considering the trust value of nodes.

Agarwal, S., Gusain, P., Jadhav, A., Panigrahy, P., Stewart, B., Penmatsa, A., & Daim, T. (2023). "Intelligent Traffic Solutions (Role of Machine Learning and Machine Reasoning)". In latest Analytics: Tools for Competitive benefit (pp. 191-235). [16] Most of the cities in US started making an effort to develop into smart cities. This chapter will discuss the current and future development of the technologies that provide solutions for traffic in different smart cities and help in the creation of a technology landscape analysis which will help Portland, Oregon, to formulate a combination of technologies and goals to achieve smart city goals. For the technology landscaping analysis, a thorough review of literature and an extensive study of use cases along with expert survey are done. This chapter aims to provide a highly detailed customized report and analysis of

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traffic sensors, trends, and recommendations for the Smart City PDX Project.

Reddy, K. H. K., Goswami, R., & Roy, D. R. S. (2023). "A Smart Service Model for Smart City: A Context-Based IOT Enabled Deep Learning Approach for Intelligent Transportation System".[17] The issue at hand is tackled through the introduction of an innovative distributed Fog- cloud architecture, enhanced by IoT capabilities and context awareness. This architecture aims to boost prediction accuracy by employing a hybrid deep learning approach, combining Convolutional Neural Network (CNN) techniques. In this system, each vehicle retains only local knowledge. However, nearby fog nodes are empowered to access global events via incremental federated learning, ensuring continuous updates exchanged between fog and cloud environments.

Akour, I., Nuseir, M. T., Al Kurdi, B., Alzoubi, H. M., Alshurideh, M. T., & AlHamad, A. Q. M. (2024). "Intelligent Traffic Congestion Control System in Smart City".[18] In "Cyber Security Impact on Digitalization and Business Intelligence: Big Cyber Security for Information Management: Opportunities and Challenges" (pp. 223-234), published by Springer International Publishing, congestion within transportation typically refers to an excessive number of vehicles crowding a particular stretch of road at a given time, resulting in slower speeds compared to normal or "free flow" conditions. Achieving congestion-free traffic has been a primary objective for the past decade, leading to the adoption of various methodologies aimed at ensuring unimpeded roadways. However, despite ongoing efforts to enhance traffic flow, outdated traffic lights (tri-variety signals) continue to limit street traffic.

Usman Ahmed , Jerry Chun-Wei Lin , Senior Member, IEEE, Gautam Srivastava , Senior Member, IEEE, Unil Yun , and Amit Kumar Singh , Senior Member, IEEE 1558-0016 © 2022 IEEE.[19] The utilization of software-defined vehicular networks (SDVN) presents an opportunity to analyze and reconfigure network infrastructures. The significant data influx from autonomous vehicles poses challenges in network setup, routing, network attributes, and system workload management. Implementing load balancing techniques in vehicle sensors aids in reducing latency and optimizing resource utilization. This paper introduces a novel load balancing algorithm aimed at mapping sensor data, vehicles, and data centers for task execution. Additionally, a dynamic convergence approach is proposed to assess vehicle system workload factors and compare their termination conditions. Furthermore, a packet-level intrusion detection model is suggested. Following load balancing procedures, this model can effectively monitor network attacks.

Shenghan Zhou , Member, IEEE, Chaofan Wei, Chaofei Song, Xing Pan , Wenbing Chang , and Linchao Yang [20] The study seeks to examine the efficacy of short-term traffic flow prediction within the context of 5G Internet of Vehicles (IoV), leveraging edge computing (EC) to enhance smart city intelligence. Addressing the pressing issue of traffic congestion and road blockages, this research incorporates EC into the existing vehicle network and integrates a novel deep convolution random forest neural network

(DCRFNN). Moreover, it develops a predictive model for short-term traffic flow in a 5G vehicle network using EC and deep learning (DL), evaluating its performance through simulation.

Chen Chen , Senior Member, IEEE, Bin Liu, Shaohua Wan , Senior Member, IEEE, Peng Qiao, and Qingqi Pei , Senior Member, IEEE [21] An integral component of urban infrastructure management, security, and related concerns, intelligent transportation systems (ITS) play a pivotal role. Among its functions, traffic flow detection stands out as crucial. By leveraging real-time urban road traffic data, ITS offers intelligent guidance to alleviate congestion and mitigate environmental impact. Typically, traffic flow detection within ITS operates in a cloud computing framework. However, the proliferation of traffic monitoring poses significant challenges to traditional transportation systems reliant on cloud computing, especially in storage, communication, and processing. To tackle this challenge, this article introduces a traffic flow detection approach centered on deep learning at the edge node.

Technology	Ref.	Advantages	Limitations
Big traffic data analytics	[1]	Traffic Flow Optimization	Technological Dependence
Deep learning, Edge AI- based automated detection	[2]	Improved Human- Machine Interaction.	Complexity and implementation Challenges.
5G-enabled intelligent transportation system	[3]	Accurate Object Detection	Data Privacy and Security Concerns.
Feature extraction	[4]	Adaptability to Changing Conditions	Complexity and Implementation n Challenges
Wired/wireless heterogeneous backbone networks.	[5]	Enhanced Accuracy	High Computational Requirements.
Internet of Things	[6]	Real-time Decision Making	Reliability and Accuracy Issues
AI-enabled accident detection and alert system	[7]	Improved Traffic Management:	Cost of Implementation
deep learning data fusion	[8]	Data-driven Decision Making	Dependence on 6G Connectivity

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Technology	Ref.	Advantages	Limitations
Deep Learning for Image Recognition	[9]	Predictive Analytics	Regulatory and Legal Challenges
Matrix prediction based on traffic data using deep learning	[10]	Real-time Traffic Management	Data Quality and Reliability
Deep Learning- Based Intelligent Traffic Control System.	[11]	Improved Safety	Vulnerability to Adversarial Attacks
Fuzzy Logic	[12]	Adaptive Traffic Control	Generalization to New Environment
Recombinatio n-Based Out- of-Distribution Detection	[13]	Robustness to Unknown Patterns	Computationl Overhead
Machine learning	[14]	Efficient Vehicle Tracking	Resource Intensiveness
Clustering Technique	[15]	Enhanced Security	Scalability Issues
Machine Learning and Machine Reasoning	[16]	Predictive Analytics	Complexity of Implementation
Graph Neural Networks,	[17]	Real-time Traffic Monitoring	Maintenance and Sustainability
Big Cyber Security	[18]	Real-Time Congestion Management	High Initial Investment
Software- defined vehicular networks	[19]	Flexibility and Adaptability	Complexity
5G (5th Generation Mobile Communicati on Technology)	[20]	Massive Device Connectivity	Infrastructure Density
Intelligent transportation system (ITS)	[21]	Improved Traffic Management	Cost

TABLE 1. SUMMARY OF DIFFERENT TECHNIQUES USED FOR INTELLIGENT TRAFFIC ANALYSIS

III. CONCLUSION

To summarize, this literature review holds great promise for revolutionizing traffic management, enhancing safety, and optimizing transportation networks. Through advanced data analytics and predictive capabilities, ITAS can offer real-time insights into traffic conditions, enabling authorities to make informed decisions and implement proactive interventions to alleviate congestion, reduce travel times, and improve overall mobility.

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