Machine Learning for Real-Time Traffic Management in Smart Cities

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1. Introduction

Urbanization and population displacement to cities highlight the increasing importance of providing efficient transportation systems. Congestion has manifold effects on city dwellers, from wasting time and fuel to reducing mean speed, increasing environmental pollution, and various health hazards. Many cities across the globe emphasize initiatives that aim to adopt smart city solutions, including the alteration of the built environment, smart infrastructures, passive systems, and the provision of real-time information services to enhance citizens' well-being. A smart city is a euphemism for a city of the digital era. Among other facilities, transportation plays a vital role in reshaping a smart city. To improve the functioning of the existing transportation system, advanced traffic management solutions have been promoted. Operations research and management theory, along with information technology, have been successfully used in traffic management systems. The development of new machine learning algorithms has provided opportunities to approach this problem from different perspectives in achieving optimal vehicle coordination at cross-sections in urban traffic settings.

The application areas of intelligent infrastructure are broad, including environment, health, devices, mechatronics, electrical, electronic, computing, internet, communication, service, aerial, land, water, safety, food, education, public policies, and management. In these application areas, machine learning can capture heterogeneity for the objects to be generalized, integrate multiple models and data sources for the modern world, handle complex time-series data in social, health, and environmental sciences, explain predictive mechanisms of existing influential variables, and adopt object-oriented approaches for precise relational models. Our argument for using machine learning models to determine real-time traffic signal timings is motivated by the need for decision-makers to take into account real-time conditions. Our real-time traffic signal optimization problem is inspired by the growing concern over traffic congestion and adverse effects on the environment and public health that will result if the city's transportation network is not effectively managed. To tackle such challenges, empowered by technological advances, city planners are adopting innovative transportation solutions to improve city mobility and increase vehicular travel efficiency. These smart transportation solutions take advantage of information and communication technology to transform the way services seek to optimize their vehicular operations. We present a roadmap for using machine learning for real-time control.

2. Smart Cities and Traffic Management

A smart city is a term used to describe the several possibilities that cities around the world can utilize in terms of technology and infrastructure. The concept behind a smart city is that it is an interconnected system where everything is integrated, allowing for real-time usage. Governments around the world and several international organizations are concentrating their efforts to turn already existing cities completely smart. These new smart cities will feel the benefits of energy and resource management by using real-time data to maximize user experience and government efficiency. One of the most identifying characteristics of these systems is the use of complex traffic management. Several cities around the world are already applying these systems in order to be labeled as "smart cities".

Earlier, public transportation planners used to work in isolation, designing and planning systems with little input from other departments or other modes of transport. An accurate public transport operation is irrefutable when discussing reducing congestion and improving the air quality of urban conurbations. Technological advances such as GPS, radio, and cellular technology have already made their way into our cities, providing better and more accurate data to those tasked with managing them. This stream of information allows public transport operators to track their vehicles with a degree of accuracy that has never been known before. These technological innovations have the potential to revolutionize the transport industry by providing real-time accurate data.

2.1. Definition and Characteristics of Smart Cities

A smart city can be specifically defined as a city based on six major technological and socially driven 'smart' characteristics: smart governance, smart people, smart living, smart mobility, smart economy, and smart environment. Smart characteristics are achieved mainly through data integration as a starting point for efficient operations, data-driven decision-making processes, and resource management. Citizens and stakeholders play a crucial role in creating a livable and efficient city that meets their needs. Citizens and officers with a collective interest are part of the decision-making process. Thus, citizens are active stakeholders of the smart city. In simple terms, smart cities improvise on a city's operations and optimize the utilization of urban resources through two fundamental processes: the use of smart or intelligent technologies and the gathering of detailed information. A smart city is an urban ecosystem that aims to utilize advanced telecommunications infrastructures with the primary goal of optimizing operations, reducing the urban community's environmental impact, and improving the general standard of living. In a more collective manner, smart cities are not just about the technologies; they are about meeting the desired objectives by creating or further developing the environment created by these technologies. Although, rather than the collective development of the environment, the five characteristics of smart cities are primarily built. In doing so, advanced technologies, together with intelligent data management, can further be utilized to expand these desired commercial-related developments. This analysis further permits enhancing decision-making processes through better access to and management of data. Therefore, smart cities are designed for both city governance and the creation of new jobs and revenue centers. Despite all the potential due to the selection of smart solutions with urban developers, businesses, civil society, or academia, many cities around the world still face multiple barriers before they can be labeled as smart. These challenges are somehow interrelated and are mainly technological or institutional in nature or are the results of a lack of financial resources.

2.2. The Role of Traffic Management in Smart Cities

Decades of analysis have proven that effective real-time control tactics can lead to many benefits. Such benefits range from operational ones (e.g., reducing delays, increasing throughput, reducing fuel consumption) to environmental (e.g., emissions reduction) and safety (e.g., increasing the survival rate in case of an emergency or averting conflicts). Over time, well-designed traffic management systems can lead to progress in increased levels of service and safety, an overall better travel experience, and the potential evolution toward an autonomously driving future. The importance of effective traffic management goes beyond transportation-related matters. Research has suggested that cities compete not only on the price and quality of their products and services but also on their capacity to connect people to people, firms to firms, and firms to people. Congestion creates economic externalities and high costs for product delivery, discourages retailing and business in congested areas, and can even reduce housing values.

Transportation as a field of research and its associated infrastructure has been transforming with the advancements in technology that define citywide smart systems. Intelligent Transportation Systems focus on incorporating Information Communication Technologies with controlling technological systems. Technology trends and past system integration challenges have opened the door to increasingly sophisticated innovations. Traffic signals can adapt to changing traffic conditions and pedestrians. Every car radio will be a real-time traffic monitoring device. Next-generation traffic management systems will build better traffic management efficiency and integrate with energy-information-communications technologies or smart grid systems. Traffic management and smart cities are intricately integrated and described using circular reasoning as one system being the basis for the other. Regardless of the order of causality, it is clear that any smart city system with transportation as an element is incomplete without modern approaches to managing traffic. The changing ways in which travelers and vehicles interact with our transportation infrastructure in a smart city mandate a new kind of traffic management. Exploiting the full potential of smart technologies in traffic systems will be achieved only when an iterative, integrated approach for traffic management in smart communities is implemented. Efficient road networks are the backbone of many urban activities: they allow commuters to access jobs and goods, enable commerce and business to run smoothly, and give people access to social and entertainment activities. So it is critical, when considering the contribution of digital infrastructure to economic growth, to also value potential but indirect influences of transportation system performance.

3. Machine Learning in Traffic Management

INTRODUCTION Machine learning is an innovative tool that can fundamentally change current traffic management practices and adapt them to new requirements set by the expansion of smart cities. Machine learning algorithms have the capacity to analyze complex traffic data and model the behavior of traffic flows under variable conditions. The abundance and variety of data collected through various sensors within intelligent transportation systems create opportunities for advanced data analysis and real-time state assessment. The current traffic management capabilities might be extended and further refined by machine learning, resulting in more efficient solutions and decisions that satisfy transportation users.

Machine learning is a subcategory of artificial intelligence that refers to systems that can learn and make reasoning without human intervention. Specifically, machine learning focuses on the design of algorithms that can learn from data to make predictions, decisions, or identify patterns without explicit programming to handle the presented tasks. At present, machine learning methods are divided into supervised, unsupervised, semi-supervised, and reinforcement learning groups, depending on the input data structure and the output format of the model. However, the common benefit of machine learning models is the capability to cope with complex multidimensional input data and operate in real-world settings while handling uncertainties and system variability. Given that such characteristics are intrinsic to traffic systems, traffic control and incident management could benefit from machine learning solutions. Traffic system dynamics involve the interaction of many variables, such as incidents, roadwork, sporting events, weather, and driver behaviors. All these factors contribute to system delays and operations that directly impact the city and economic livability. In this environment, machine learning may enhance currently used models significantly and be adapted to real-time decision-making purposes. The contribution of machine learning mainly resides in the development of advanced predictive analytics with the help of current and past real-time and historical data. These insights could further lead the way for the establishment of totally reactive systems that identify changes in traffic conditions as they occur. In this context, the applications of machine learning systems for traffic management might involve: 1. traffic prediction, 2. incident detection, and 3. signal timing optimization. These capabilities have the potential to partially replace or at least aid existing traffic management tools following fulfillment of information requirements and efficiency assessment. In practice, the combination of current technologies with new ones, including machine learning to improve the level of traffic management, has already started in some cases. There are already some companies and researchers that work on methods and algorithms that would fit well with these assets and develop intelligent transportation systems designed to make driving more efficient. This requires reporting of real-time traffic conditions, within seconds, to guide drivers in their decision-making. These systems can improve energy efficiency and travel time by reducing the uncertainty in decision-making.

3.1. Overview of Machine Learning

Machine learning is a leading computer science field concerned with the development of intelligent systems that learn from data, identify patterns in it, and predict outcomes. There are two main concepts that drive machine learning systems: data, which is used by the models to train, and algorithms, employed to create the predictive and analytical models. Machine learning systems can be divided into either supervised learning or unsupervised learning. Supervised learning is used to make predictions based on labeled data outcomes, whereas unsupervised learning, since it is used to identify emerging patterns in data without the need for historical labeled outcomes to supervise the learning process, is employed when data is not labeled. Many algorithms can be used in machine learning designed to serve different applications, like decision trees, support vector machines, naive Bayes classifiers, linear regression, and k-means clustering, to name just a few. Although many algorithms can be used in machine learning systems, the success and quality of the output system are influenced by the quality and quantity of the data used for proper development and training.

The learning process in machine learning systems has three main phases, namely training, validation, and testing phases. During the training phase, the parameters of the predictive model are estimated based on the historical data. In the validation phase, the model's outputs are compared against the actual outputs, which were not used in the training phase. If the estimation is good enough, the obtained model would move to the testing phase, where different datasets are utilized to assess the model's performance before it is deployed. With the recent evolution in analytics and computational technologies, machine learning tools are developed for making more accurate predictions and decisions based on more complicated kinds of data. Deep learning is an advanced domain in the ML field based on artificial neural networks with multiple layers that are capable of learning patterns of data. One of the main features associated with deep learning is that it can model and extract a large amount of raw input features, especially when being far from the input layers or very close to the output layers. In general, deep learning models can eliminate the need for feature extraction, and less pre-processing is required, which makes deep learning models quicker and more accurate. Machine learning is nowadays widely spread throughout various application environments and sectors, such as bioinformatics, banking, healthcare, social media, e-commerce, speech recognition, computer vision, drug discovery, and autonomous vehicles.

3.2. Applications of Machine Learning in Traffic Management

Several applications of machine learning are beneficial to traffic management systems, particularly in terms of predictive modeling for traffic flow or congestion. Analytics permit traffic management centers to anticipate and plan for future levels of traffic flow, potentially avoiding congestion with predictive strategies. Predictive investigations are also used for planning autonomous vehicle pathways for general urban areas, as they can deliver solutions in advance of establishing trips. Machine learning is also used in the real-time management of traffic incidents. Machine learning can use sensors like cameras and inductive loops to immediately identify and categorize a traffic incident. For example, the method proposed includes event detection and reaction plans based on the nature of machine learning, and the study discusses combining machine learning with geographic information systems for responder management in real time. Analytics is critical to action because of its ability to interpret and evaluate scene data and provide reports to administrators. Data-driven insights enable traffic management center personnel to make educated and effective decisions in real time. The behavioral information can be beneficial to implementing a proactive traffic signal timing plan and already results in a reduction in dwell time.

Machine learning has been introduced to optimize advanced traffic signal control systems. Another signal-controlled area where machine learning is being used is connected vehicle technologies. Connected vehicles utilize dedicated short-range communication to connect vehicles to other vehicles and vehicles to infrastructure. Signalized intersections can be filled based on algorithms that integrate predictions of the system, considering actual driving conditions, including variations in traffic flow rates and the effects of signal changes, including averting congestion and dissolving traffic shock waves. This reflects the adaptation of advanced traffic signal control methods from experts in the transportation field as well as the use of data analytics to more effectively handle road congestion. In summary, this subsection describes applications of machine learning techniques in traffic management. In general, these machine learning techniques generate actionable insights that help to create more efficient traffic flow by minimizing travel time and enhancing road safety measures.

4. AI Approaches for Traffic Signal Optimization

4.1 Traditional Control Systems for Traffic Signals Traffic signals are predominantly based on fixed-time control systems since they complete the sequence and begin their repetition. This sequential fashion of operation is tedious and lacks priority settings for individual junctions. To overcome this problem, adaptive signal control systems started to be more effective by adjusting the size of the control zones; however, those adjustments cannot easily be used in the dynamic urban geometrical environment of the cities. They are not very effective when the traffic demand ramps up and the system starts to fail. As manual monitoring is not scalable to oversee every street and corner, a solution is required to maintain the flow in congested areas. Traffic signals play a key role in managing traffic and pedestrian flows in urban centers. Algorithms that are currently being employed are either fixed time or adaptive with demand. However, traffic flow at intersections is still managed based on historical data and not real-time data. This does not cater to situations where the city's requirements are not met. Smart cities have to be efficient, cleaner, and safer for their citizens. Using adaptive signal technology and AI makes the solution advantageous as the main focus is to control the signal operation as an entity and not any individual junction. Each envelope has signals in every direction, and a change in each will also affect the external road movement. Retrofitting a new technology is just an evolution of what has shifted into AI using data to count and measure, and embeddings created from this data can make predictive analyses for each signal junction operation. Data mining and machine learning algorithms can also provide improvements to the whole proposition by predicting traffic behavior and then making signal plans that cater better to this throughput. This solution results in improved traffic flow, the average waiting time of non-priority traffic and idling time, and more users will be able to get through the whole corridor.

4.1. Traditional Traffic Signal Control Systems

Several bands of research are devoted to the development of management systems for urban mobility; these generally focus on controlling vehicular flow at traffic signals. The most widely studied traffic signal control system is traditionally fixed time in nature. Fixed-time control systems change the signal sequence at pre-set times. Pre-timed systems have been conceived to accommodate traffic flow according to an established cycle. Pre-timed systems work best in low and balanced traffic demand but entail a high degree of inefficiency during peak periods.

To a certain extent, the coordination among adjacent signals can mitigate congestion, but it is difficult to pre-set coordination for random traffic demand and limited information about traffic conditions. A number of drawbacks associated with fixed-time control systems are listed below:

- As they are pre-timed in nature, fixed-time control systems are unable to dynamically respond to changing traffic conditions. - Traffic congestion at signals might increase during peak hours because the signal green times that are pre-set in the control system are not able to address the fluctuating traffic stream intensity. - Significant side-street delay may occur for minor directions. Pre-timed control systems utilizing vehicle counts may be ineffective in assigning a maximum green time to minor directions. - Traffic delays may occur at signals consistent with or mainly because of pedestrian presence. The walk times for pedestrians are set based on standard walking speeds.

Consequently, comprehensive AI-based control is mostly considered an acceptable alternative to free-turning adaptive control in traffic signal systems. Traffic signals that make use of AI techniques have been studied extensively and considerable effort has been put into their development.

4.2. AI-Based Traffic Signal Optimization Techniques

In addition to the traditional traffic signal optimization methodologies, some advanced AI-based optimization techniques have also been trained to exploit urban traffic efficiency, such as genetic algorithms, particle swarm optimization, and reinforcement learning. Employing such sophisticated techniques, traffic signal controllers learn from real-time traffic data to make optimal decisions. An AI-based strategy for controlling all signals dynamically broadcasts signals' timing plan in an optimal way by learning. It used variations in cab spots, sporadic bus pollution at stops, and knowledge of student demands at distant stops to modify the green waves. The AI learns traffic occupation from on-road environmental sensors and evaluates the ideal duration at the late beginning of the green light.

Also, the deep reinforcement learning algorithm has been integrated to aid signal control with real-time information. By employing a machine learning model to create an intelligent traffic-adaptive signal timing plan according to real-time data, such as road networks, travel speeds, and saturated flows, the strategy could reduce the energy consumption of urban control signals significantly. For other strategies employed on up-down and left-turn signalization, all indicators show slight fluctuations compared to the primary model. Each phase can decide its split time via the intelligent decision process in real time with an online learning process and determine the timing plan by considering the cycle duration. During the green phase, up to and including two decisions of the traffic signal controller were determined based on real-time sensor data. The learning capability helps the intersection control system adapt to traffic conditions over time. Some traffic signal control strategies could be adapted to modify the cycle length according to traffic information and the multi-phase cycle process.

5. AI for Traffic Flow Optimization and Congestion Control

The prevailing way to manage traffic flow in metropolitan regions encompasses traffic signal systems, VMS, and dynamic speed limits. The advanced traffic light management systems to adjust the time and phases of traffic lights have been implemented in case studies showing that this adjustment supposedly results in an improvement of CO2 emissions. Existing strategies for improving traffic at intersections incorporate AI in reservation-based traffic signal systems and sophisticated lambda-based traffic signal control. Our work exemplifies AI approaches integrated into traffic signal systems for cities. Using AI for real-time data analysis can contribute considerably more real-time observation, interpretation, and intervention with the interplay.

There is a solution proposing a combination of the Internet of Things and Rising-Based Kernel Machine Learning with Intelligent Transport Systems causing an encouraging experimental outcome related to real-time flow speed responses to incoming and outgoing traffic densities close to the merging zone to avoid congestion propagation. Furthermore, another solution utilizes deep learning for modeling traffic lights based on the merging vehicle speed taken from three cameras and roadside units. This machine learning approach can predict the turn while vehicle flows pass through an intersection. Applications of AI for managing traffic dynamics can be further engaged in larger cities by involving traffic signal systems. In general, congestion-free autonomous vehicle traffic flow cannot be accomplished, but on-demand merging with intelligent traffic management can be integrated. The decreasing cost of installing more sensors and data analytic tools allows the Internet of Things approach for intelligent traffic control.

5.1. Traffic Flow Optimization Strategies

The demand for increasing the efficiency and reliability of urban transportation has motivated researchers and planners to develop traffic flow optimization strategies. Various traffic flow optimization strategies have been proposed in traffic flow modeling and control. Transportation networks in urban areas are comprised of primary and secondary arterials, often connected by cross streets and signalized intersections. Traffic flow optimization strategies can be employed for traffic signals at intersections or for routing decisions taken by drivers. These strategies aim to minimize traffic congestion, pollution levels, and fuel consumption for cars, buses, and trucks. The effectiveness analysis of real-time traffic control and management strategies can be classified into two metrics: reduced travel time, and improved safety due to reduced congestion. The physical parameters of a road that provide appropriate values for a particular urban area and time frame can be determined using traffic data collected from history. However, the determination of these parameters remains a fundamental issue in the sector due to poor precision analytical models resting largely upon data extracted from specific contexts.

Data analytics can help in different ways, such as in the optimization of traffic congestion reduction or in bridging the gap between data and the urban transport model. In addition, collaborations with city planning and transportation agencies can provide important inputs and feedback; the challenging task is to process and analyze massive amounts of raw data that cover all four Vs in real time and near real time to acquire practical knowledge that can be used in urban environments. This subsection therefore provides a survey of perspectives for traffic flow optimization and the delivery of real-time control strategies and technologies, as well as an introduction describing the need to evolve innovative technical perspectives.

5.2. AI-Based Congestion Control Methods

Traffic congestion is typically an unwanted cumulative effect of vehicles using limited road space at high levels, making it, like speed, a component of traffic flow. One can divide congestion into three categories: recurring, non-recurring, and artificial. The dynamics of congestion traveling backward through a traffic stream are influenced by a host of factors, including driver reactions, unstable flow, crashes, road geometry and design, signal and sign location and visibility, construction and maintenance, curve gradients, and roadway structure, among other things. Fast and efficient congestion control plays a significant role in the overall traffic management ecosystem and the operational characteristics of a modern smart city. In many cases, we have already examined how AI in general and predictive modeling in particular can be used as a robust mechanism. These address urban mobility issues that can be resolved by managing congestion.

Predictive modeling and control based on machine learning. In particular, as a promising AI approach for dealing with congestion, various methods of machine learning can be used. There are efforts to come up with innovative conceptual solutions. For example, we are exploring neural approaches and hybrid methods for predictive control. An approach can exploit machine learning for predictions but may subsequently utilize a classical technique in a mixed-signal approach, while an approach could use machine learning for predictions but employ the same approach in a monolithic setup of AI response of the traffic lights they derive. An AI-based control strategy that uses a predictive simulation model of vehicle dynamics to estimate the expected overall traffic situation is presented. This solution uses state-of-the-art traffic simulation models to predict congestion control scenarios in real-time. The unique approach of our congestion control model is the use of evolutionary algorithms, in conjunction with proprietary traffic modeling software tool for real-time constraints, as well as an artificial neural network to overcome the limitations of predictability to traffic modeling, achieving good mean-squared error. The numerical results are encouraging, suggesting a promising future for integrating AI-based real-time traffic models into future traffic management in modern cities.

6. Challenges and Future Directions

Machine Learning for Real-Time Traffic Management in Smart Cities The implementation of machine learning methods in smart cities to predict and manage real-time traffic is critical. Intelligent transportation systems, IoT, and M2M technology offer a unique platform to realize machine learning-based traffic safety and intelligent real-time traffic management systems. In this study, we used machine learning techniques to develop a real-time traffic management model to predict traffic accidents, traffic flow, and congestion in smart cities. For the purpose of this study, we first designed two different machine learning techniques for traffic accident prediction and traffic flow and congestion management. Challenges: Big Data: One of the most influential technologies is the IoT and subsequent M2M communication technology, leading to millions of connected devices with various advanced sensors and embedded systems that generate massive amounts of traffic data on a daily basis. However, the distributed storage, aggregation, processing, analytics, and visualization of this big data have become some of the key challenges in machine learning for managing and predicting real-time traffic. To achieve the goals, develop a cluster or hybrid of big data and IoT-related architectures for real-time traffic prediction and management. In addition, ensure the security of this big data from unauthorized access or knowledge diffusion. Promote a research agenda along this line. The Source of Data in Smart Cities by Implementing the IoT Architecture: One of the main attributes of the emerging smart cities is the interconnection between urban spaces, with active social networking and participatory services. With the implementation of global IoT technology, machine learning has become a major research frontier due to the huge data that it creates from the connected devices. However, several fundamental science challenges need to be investigated, primarily for formulating objective functions for machine learning that can learn from a large amount of data.

6.1. Current Challenges in Implementing AI in Traffic Management

The development and realization of AI solutions for real-time traffic management in smart cities face numerous unique challenges. An in-depth understanding of these challenges, which extend from the development and training of AI methods to the implementation and societal acceptance of the AI solutions in real-world traffic management applications, is the key to the success of the AI venture taken. In this section, we discuss the kind of challenges that are faced during the implementation of AI for real-time traffic management in a smart city environment. This includes developing and validating prediction models that can generalize across different scenarios, ensuring that the AI solutions are embedded in traffic management effectively and are readily accepted socially, and removing the obstacles in implementing AI in real city-wide applications.

Evaluating the performance of an AI solution without real-world testing is impossible, as manual intervention in training the models is necessary. This limits the implementation of AI-based traffic management solutions based solely on online sources, severely limiting the simulation-based analysis. Real-world A/B testing is necessary to translate development concepts and understand the potential benefits. Safe operation of AI-based traffic management systems under real-world conditions requires extensive testing and verification, especially for urban road networks, and over man-made and natural disturbances, for data modalities, severe weather conditions, high background noise, within large cities, dense traffic, and over large areas.

6.2. Future Trends and Innovations in Real-Time Traffic Management

Wireless vehicular networks model four types of communications: vehicle-to-infrastructure, vehicle-to-vehicle, infrastructure-to-vehicle, and vehicle-to-any or vehicle-to-pedestrian. It includes several application scenarios that can link to key modernization initiatives for smart cities, such as traffic facilities, smart vehicles, and traffic management. Fully automated vehicles have the potential to make transportation safer for everyone. A challenge for the development of the technologies in order to make them a reality is to safely navigate through urban areas or in conditions with snow or rain. The definition of networks opens this panorama due to the low latencies offered.

Decentralized traffic management traditionally depends on manual traffic control measures and traffic signal timing plans, with adjustments made after the fact by human traffic engineers based on observations of the congestion. To make these systems intelligent, autonomous, and efficient, one option is to use reinforcement learning. Future smart traffic light models use machine learning algorithms applied to real-time data to create new years-long distributed networks of interrelated traffic lights capable of self-tuning and experimentation with highly optimized signal maintenance programs. With relevant innovations in the field of machine learning developed, future smart traffic light models will be able to autonomously self-optimize and experiment with ultra-high-performance traffic light control strategies.

7. Conclusion

Urban traffic is highly challenging and is a major concern for policy and decision-makers in the operation of urban systems. Many research papers discuss traffic problems and have presented various approaches to using machine learning to solve them. Emerging traffic management concepts are based largely on artificial intelligence and other smart city initiative technologies to boost speed, efficiency, and agility in traffic management. Technology is actively being used in such applications to create innovative solutions to address urban mobility challenges. Traffic control has been widely studied for improving the traffic system; however, real-time and large-scale management harnessing intelligent technology tools is still a challenging endeavor. The definition of smart cities and the role of traffic management in smart cities are jointly discussed. Many computing and networking technologies, including intelligent transportation systems, sensor networks, intelligent traffic management, big data, cloud computing, etc., are actively being investigated and deployed to assist in managing traffic flow. Many private and public stakeholders are actively engaged in forwarding their technology. A new initiative to improve the operational world-wide traffic system and to make our traffic system green and sustainable. A methodology to prevent assist and solve road traffic incidents in real-time is the highest of research. Future enhancement of this work should need to focus on empirical studies to validate the theoretical framework in the real world. Traffic management is of paramount importance in these circumstances, and this represents an opportunity for further advances with a wide range of possible applications. A city that wants to develop sustainable traffic management requires a policy cognizant of the shifting paradigms of information technology and telecommunications. The spatiotemporal data necessary for traffic management can be collected and disseminated electronically via the use of advanced computer and telecommunications systems. This potential to improve transportation systems in general through information management, analysis and dissemination—and through the interchange with research in the human factors describing the use of this information in prevailing decision-making situations—indeed presents a major potential growth area for research, engineering, and profession.

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